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**Barriers to university-industry linkages and international partnerships: the cases of Centres of Excellence in Chile and Peru**

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Submitted in accordance with the requirement for the degree of Doctor of Philosophy

Science Policy Research Unit

**University of Sussex**

September 2020

I hereby declare that this thesis has not been and will not be, submitted in whole or in part to another University for the award of any other degree.

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Pavel Gabriel Corilloclla Terbullino

To whom have been the cornerstone of this achievement:  
My parents, Luz and Saúl, and my brother Omar.

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**UNIVERSITY OF SUSSEX**

Pavel Gabriel Corilloclla Terbullino

Degree of Doctor of Philosophy

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**ABSTRACT**

University-industry linkages (UILs) have been promoted through a variety of policy instruments. This study focuses on one such instrument, the so-called Centres of Excellence (CoEs), to address three gaps in the literature. First, CoEs have existed since the 1980s but a common definition has not yet been agreed, while their structure and practices have been studied to a limited extent. Moreover, experiences in Latin America are quite recent and have been hardly studied at all. Therefore, this thesis compares Chilean and Peruvian centres in terms of their internal organisation to support UILs. In doing so, we also contextualise the study of barriers to UILs and the role of international partners.

Second, studies on National Systems of Innovation (NSI) have cautioned that frameworks for studying UILs in the developed world may offer little guidance for their analysis and policy recommendations in developing countries. Given that barriers to UILs in Latin America have remained under-studied despite the policy attention devoted to these linkages in the region, we approach these phenomena with a conceptual framework that takes account of the conditions of weak NSIs by including three types of barriers: *orientation-related*, *transaction-related* and *capacity-related* barriers.

Third, CoEs in Chile and Peru involve the participation of international partners, mainly research and technology organisations (RTOs) and universities. The internationalisation of these actors has previously been analysed from a *home* country perspective by studying their motivations, practices and benefits. Complementing this approach, we provide evidence on their intermediary roles in developing countries and regarding local actors (i.e. adopting a *host* country perspective).

We conclude that CoEs are partnerships configured as specific *contexts* for UILs, within which several interaction channels are used. Based on this characterisation, we elaborate a conceptual distinction between *CoEs* and *RTOs* as they show different patterns in their interactions in regard to firms and universities. Moreover, we find that the configuration of CoEs in Chile and Peru differ substantially from initiatives in developed countries.

In terms of barriers to UILs, this work advances the understanding of their theoretical foundations, which helps explain *orientation-related* and *transaction-related* barriers, based on differences between the university subsystem and the business subsystem. It also finds that *capacity-related* barriers play a relevant role because they can explain, at least partially, the configuration of the other two types of barriers. Moreover, capacity drawbacks, which comprise weaknesses in actors and in the collaborative infrastructure, may limit international collaboration and provide insights to explain why the international partners of CoEs have been fulfilling a very limited role in building local capabilities and supporting local UILs.

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## LIST OF ABBREVIATIONS

CIC	Centro de Innovación del Cacao / Cocoa Innovation Centre
CAMCHAL	Chilean-German Chamber of Commerce
CoEs	Centres of Excellence
CONCYTEC	Peruvian National Council of Science, Technology and Technological Innovation
CONICYT	Chilean National Council of Science and Technology
CORFO	Production Development Corporation - Chile
CRCs	Cooperative research centres
ERCs	Engineering research centres
FCR	Fraunhofer Chile Research Foundation
FCR-CSB	Fraunhofer Chile Research - Centre for Systems Biotechnology
FCR-CSET	Fraunhofer Chile Research - Centre for Solar Energy Technologies
FhG	Fraunhofer Society
FOMITEC	Fund for Innovation, Science and Technology - Peru
I/UCRCs	Industry/university cooperative research centres
IP	Intellectual property
IPRs	Intellectual property rights
KIBS	Knowledge intensive business services
LA	Latin America
LACs	Latin American countries
MNEs	Multinational enterprises
NLS	National Learning system
NSF	National Science Foundation of the US
NSI	National system of innovation approach
NSIs	National systems of innovations
OECD	Organisation for Economic Cooperation and Development
PSU	Pennsylvania State University
RTOs	Research and technology organisations
S&T	Science and technology
STCs	Science and technology centres
STI	Science, technology and innovation
TTOs	Technology transfer offices
UILs	University-industry linkages
UK	United Kingdom
UNALM	Universidad Nacional Agraria la Molina - Peruvian university
UPCH	Universidad Peruana Cayetano Heredia - Peruvian university
US	United States of America

## CHAPTER 1. Introduction

Linkages between universities and firms have been the concern of policy makers and academics for decades because of their potential effects on innovation, technical change and economic growth. Governments have launched a variety of policy instruments to foster these linkages, and cooperative research centres (CRCs) or centres of excellence (CoEs)<sup>1</sup> have emerged as a distinctive mechanism in this domain. These centres have been characterised as boundary-spanning structures that allow universities and firms to interact with each other through several joint activities (Etzkowitz 2003; Gray et al. 2011; Gray, Lindblad, and Rudolph 2001).

The literature on this field has found that CoEs have brought about an institutional change in how university-industry linkages (UILs) have been promoted, organised and developed in some countries, in that they have been designed to become permanent bridging structures that cannot be found in other schemes such as project-based collaborations (AIRTO 2001; Bozeman and Boardman 2004; Koschatzky 2017; Kroll 2016). CoE programmes were first implemented in the late 1970s and early 1980s in Canada and the US. Nevertheless, the fact that many countries have launched similar programmes during the last decade illustrates their continuing relevance today. These initiatives have been mostly promoted in the developed world, while only a few developing countries,<sup>2</sup> such as Chile (2010) and Peru (2014), have recently launched their own programmes.

Compared to experiences in the developed world, one distinctive feature of the Chilean and Peruvian centres is the involvement of international partners in the form of research and technology organisations (RTOs) and universities, something required by the funding programmes to facilitate local actors' access to global sources of knowledge, networks and

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<sup>1</sup> The terms *cooperative research centres (CRCs)* and *centres of excellence (CoEs)* are used interchangeably in this study. We also sometimes refer to these initiatives with the general term *centres*.

<sup>2</sup> This study uses the United Nations classification of countries, which includes the distinction between 'developed' and 'developing' countries based on their economic conditions, mainly their per capita gross national income (United Nations 2020). However, we have to recognise that this classification has been criticised for not providing clear distinctions between countries, as there are increasing dissimilarities between developing countries (see e.g. Khokhar and Serajuddin 2015).

other assets. Moreover, CoE programmes in both countries can be considered as the most ambitious schemes to foster interactions between academia and the business sector because, compared to previous policy instruments, they included unprecedented conditions in terms of the size of grants and time scales, which have demanded a long-term investment commitment from funding agencies and the centres' partners alike.

Centres with such characteristics have been set up in the Latin American context, where policy efforts to promote UILs do not seem to have been particularly effective, even though they have been one of the foci of innovation policy during the last 15 years (Cassiolato, Lastres, and Soares 2014; Sagasti 2013; Sutz 2000). For this reason, one might have expected a high level of academic and policy interest in the obstacles that have been affecting UILs and policies in this domain, but we found just a couple of studies exploring these aspects in the region (López-Martínez et al. 1994 and Sutz 2000).

Under these circumstances, our academic interest is to understand how schemes designed to promote UILs in developed countries – i.e. centres of excellence (CoEs) – have been working in the rather different context of Latin America. This inquiry is particularly relevant because UILs may exhibit different patterns in different countries, regions or sectors (Mazzoleni and Nelson 2007; Perkmann et al. 2013; Schiller and Lee 2015). Moreover, some authors have argued that frameworks for studying UILs in developed countries may not be appropriate for developing ones (e.g. Albuquerque et al. 2015; Dutrénit and Arza 2010; Schiller and Lee 2015; Torres et al. 2011).

In Latin America, studies on UILs have been focused on actors' motivations for becoming involved in UILs, the various channels of interaction, and their respective benefits (Arza 2010; Comisión Económica para América Latina y el Caribe 2010; Fernandes et al. 2010). In contrast, other aspects such as CoEs, the barriers to UILs and the role of international partners have been studied only to a very limited extent. The almost non-existent academic attention to CoEs could be explained by their comparatively recent implementation in the region. Regarding barriers to UILs, most studies have been focused on developed countries save for the two studies mentioned earlier.

Moreover, the involvement of foreign RTOs and universities in CoEs can be regarded as part of their internationalisation process. This phenomenon has generally been approached from the *home* country perspective by studying the motivations of these foreign organisations to develop international connections, the type of activities they perform (patterns) and the benefits from them. We could not find studies on the roles of foreign RTOs and universities in local UILs and innovations systems – i.e. adopting a *host* country perspective.

These gaps in the literature and the limitations of existing analytical frameworks provide compelling arguments for carrying out research on UILs in developing countries. Understanding the barriers to UILs and the role of international partners in CoEs might also help the implementation of policy measures ‘tailored’ to the particular conditions of Latin American countries (LACs), which have been characterised as having weak or less developed national systems of innovation (NSIs) (Freeman 1995; Patel and Pavitt 1994; Viotti 2002). These concerns motivate our research endeavour.

While designing this project, we had the opportunity to hold exploratory discussions with people involved in CoEs in both countries.<sup>3</sup> From these, we could note that centres’ stakeholders were not clear about the nature of the centres, something which became more evident with the first interviews in the fieldwork phase. For that reason, we decided to begin the empirical analysis by explaining the organisation of centres and the interactions within them. In doing so, we could address another gap in the literature, namely the lack of a widely agreed-upon definition of CoEs and the limited academic attention devoted to the structure and practices within centres (Bozeman 2013; Gray, Boardman, and Rivers 2013; Koschatzky 2017).

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<sup>3</sup> A preliminary exploration of CoEs in Chile and Peru was carried out in two stages. In the first stage, a number of actors involved in CoEs in both countries were contacted to inquire if they would be interested in participating in the study. In a second stage, we met people involved in the set-up and operation of CoEs on the occasion of an international event about technology transfer (APEC 2018). Meetings in these two stages provided us with some insights about the need to clarify the boundaries of these centres.

Consequently, the general question of this study is how interactions within CoEs in Chile and Peru have been working. We approach this research inquiry with three specific questions:

- 1) How have CoEs and linkages within them been working in two different countries?
- 2) What are the main barriers to UILs within CoEs?
- 3) What roles have international partners been performing in this context?

In what follows, we will explain the framing of our work, some methodological aspects and the organisation of the thesis.

### 1.1. Framing the study of CoEs and UILs in LACs

The field of UILs is complex and diverse because it encompasses a variety of channels of interaction, performed in different contexts by multiple actors such as universities and firms, sometimes including the involvement of public agencies, intermediaries, and international partners. For that reason, our study begins with the analysis of the National Systems of Innovation (NSI) approach, which has proved to be flexible and comprehensive in studying various aspects relating to innovation and interactions. In [Chapter 2](#), we analyse whether the NSI concept is appropriate to study CoEs and UILs in Latin America.

In this regard, there has been some concern about the appropriateness of the NSI concept since it has been mostly applied in developed countries and hence may offer little guidance for the developing world (Lundvall et al. 2002; Teixeira 2014; Watkins et al. 2015). Even though the adoption of the NSI concept is a relatively new phenomenon for developing countries, as recognised by some authors (Fagerberg and Srholec 2008; Watkins et al. 2015), we would argue that it is nevertheless suitable for analysing innovation aspects in these contexts as long as their particularities are taken into account.

According to some authors, universities, firms and intermediaries in Latin America have particular characteristics and face specific challenges. For instance, firms show different patterns of innovation between developed and developing countries (Crespi et al. 2014), while universities seem to face specific challenges such as a lack of financial resources, a trend towards privatisation, limited UIL experience and a 'brain drain' problem (Brundenius,

Lundvall, and Sutz 2009). Moreover, intermediaries face problems in regard to their limited capabilities (Intarakumnerd et al. 2010). For these reasons, one would expect different patterns of UILs, barriers and intermediary roles in LACs.

Therefore, our analysis of CoEs and UILs (first specific question) starts with the delineation of a potential conceptual distinction between *channels* of interaction and *CoEs* (Section 2.3). We first highlight the range of channels used by universities and firms and the importance of the context for those interactions. Then, we characterise CoEs based on the experience in various countries, concluding that they are partnerships configured as boundary-spanning structures between universities and firms, which allow multiple actors to engage in several activities and adopt a mid- to long-term perspective. Given these characteristics, we conclude that centres might be better regarded as specific *contexts* for UILs rather than as a type of UIL *channel*. In doing so, we frame the first specific question of this study: how have CoEs and UILs within them been working in Chile and Peru?

In order to address the second specific question, Section 3.2 discusses the theoretical foundations of barriers to UILs and sets out a preliminary conceptual framework. In this field, some studies (Bruneel, D’Este, and Salter 2010; Hewitt-Dundas, Gkypali, and Roper 2019) have classified these barriers as either *orientation-related* or *transaction-related* barriers and explained their origins drawing on certain cultural differences between two communities of researchers – scientists in academia and technologists in firms – developed by certain authors (in particular Dasgupta and David 1994). The divide between these two communities refers to differences in the type of research (basic versus applied), practices (disclosure of results versus secrecy) and reward systems. We argue, however, that such a divide can only offer a partial explanation of barriers to UILs because interactions between universities and firms extend beyond the science subsystem.

Moreover, some studies of Asian countries (particularly Schiller and Lee 2015) have highlighted a different type of barrier to UILs, which relates to the lack of capabilities in universities and firms as well as certain drawbacks in the collaborative infrastructure. This



type of barriers seems to be relevant for LACs because these have been characterised as having weak or less developed NSIs.

Therefore, in order to study barriers to UILs in the context of CoEs, Section 3.2.2 sets out a tentative conceptual framework based on three categories of barriers: *orientation-related*, *transaction-related*, and what we have labelled as *capacity-related* barriers. This framework incorporates the various forms in which these barriers have been expressed in the extant literature. As some studies have not specifically classified barriers, we have made an effort to relate their description to one of the three categories.

## 1.2. How does the study of CoEs draw on the intermediary literature?

Following our research inquiry, we found that studies in the field of innovation intermediaries can contribute to addressing two specific questions of this study. The first question refers to how CoEs have been working. In this regard, we acknowledge that these centres may be configured as boundary-spanning structures that play an intermediary role between universities and firms. Therefore, the analysis of how CoEs have been performing such a role would complement the previous argument about these centres constituting specific *contexts* for UILs.

The field of intermediary roles also supports our approach to the third specific question, which refers to the role of foreign RTOs and universities in Chilean and Peruvian centres. Section 3.3.1 shows that some studies have recognised the intermediary roles of RTOs and universities in their national or regional innovation systems (Albuquerque et al. 2015; Giannopoulou, Barlatier, and Pénin 2019; Mina, Connell, and Hughes 2009; Qiu, Liu, and Gao 2017), while studies on their internationalisation have been focused on the motivations, activities and benefits from a *home-country* perspective (Altbach and Knight 2007; Youtie et al. 2017; Zacharewicz, Sanz Menendez, and Jonkers 2017). In this study, we would like to understand what roles these organisations have been playing in the Chilean and Peruvian centres and systems – in other words, adopting a *host-country* perspective.

To address these two questions, therefore, Section 3.3.1 explores the domain of intermediaries, a field that has proven to be very diverse and comprises various individuals,

organisations with different characteristics, and multi-organisation structures. We provide a very preliminary classification that helps distinguish between different types of intermediaries such as universities, RTOs and CoEs. Moreover, Section 3.3.2 identifies certain patterns of intermediary roles emerging from the extant literature, which can serve as a reference to our analysis of the roles of international partners in CoEs.

### 1.3. How to approach the study of these phenomena

UILs have proved to be complex phenomena because they involve the participation of several actors, each with their own priorities and interests. A line of criticism to the literature in this field is its *one-sided* focus, since most studies have considered only one side of the interaction, with a small proportion including the perspectives of both universities and industry (i.e. *two-sided* studies) or even that of intermediaries. Such a criticism relates to the partial understanding of UILs and, consequently, difficulties in deriving well-founded policy implications from *one-side-focused* studies.

Addressing this criticism from a methodological viewpoint, this thesis was designed to include the perspective of all the actors involved in CoEs in Chile and Peru: universities (researchers and internal intermediaries) and business actors as well as policy makers, external intermediaries and international partners. The aim of this approach is to integrate the perspectives of such diverse actors, who bring to UILs their own priorities, interests and understandings of certain issues such as innovation and research.

Regarding the methodological approach, previous work has identified certain criteria that can lead to the adoption of a qualitative approach (Creswell 2007; Eisenhardt and Graebner 2007; Verschuren 2003; Yin 2013). First, the research questions set out earlier are of the type “how”, “what” and “why” as they are intended to explore and explain certain phenomena that have been understudied in LACs. Answering this type of questions in the context of Latin America is relevant because the existing analytical frameworks for studying CoEs and UILs have been mainly applied in developed countries, as pointed out earlier.

Second, CoEs are contemporary initiatives in LACs and are relatively limited in number: seven in Chile and three in Peru (one without public funding). Most centres are still in their

early phase of operation, although there have been some important changes over time. These conditions limit, to some extent, the possibility of using quantitative methods.

To generate evidence for both Chile and Peru, we have adopted a comparative case study strategy, focusing on one centre in each country. The selection of cases has been based on what is called theoretical sampling by choosing cases that can provide stronger evidence about the studied phenomena and allow us to avoid arriving at findings that can be specific to just one case. In that sense, we chose different countries with CoE programmes and within them, centres that could be comparable to some extent.

Cases were selected on the basis of two broad criteria: technological approach and target industry. This means that some activities – research or business lines – are related to the same technological field (i.e. biotechnology) and the CoEs are intended to respond to the needs of similar industries, namely agriculture and food industry in our cases. Therefore, we selected the Fraunhofer Chile Research – Centre for Biotechnology Systems (FCR-CBS) in Chile, and the Cocoa Innovation Centre (CIC in the Spanish acronym) in Peru.

The comparison is based mainly on primary information gathered through interviews but complemented and triangulated with secondary data. The information collected from fieldwork is quite extensive, with 22 interviews in Peru, 19 in Chile and seven in Germany. Most interviewees have been involved in the studied cases (18 in Peru and 15 in Chile), while the remaining ones have been involved in other CoEs and related international activities. Interviewees come from very diverse institutional backgrounds, and most of them are high-profile people, with a broad and critical understanding of the subject matter under analysis, something which helps minimise the risk of information bias, according to Eisenhardt and Graebner (2007).

To compare the cases, we used the so-called pattern-matching technique, based on which we first identified certain patterns from the extant literature, and then we identified patterns emerging from our cases to compare them, through an iterative process. The advantage of this technique is twofold. First, identifying theoretical patterns provides a reference point for collecting data and then empirically comparing our cases. Second, it

allows one to make empirical-theoretical comparisons by comparing the Chilean and Peruvian centres with experiences in the developed world.

A detailed discussion about the research design, research questions and methodological aspects of this study is presented in [Chapter 4](#). The methodological contributions of the study are discussed in [Chapter 9](#).

#### 1.4. Organisation of the thesis.

The study begins with this introductory chapter (Chapter 1), outlining the reasons for undertaking this research endeavour, explaining how it fits into certain bodies of the extant literature, and discussing some methodological considerations. Then, [Chapter 2](#) presents a synthetic view of the literature upon which this study draws, [Chapter 3](#) sets out a conceptual framework for analysing and understanding barriers to UILs and offers certain conceptual insights for analysing the role of international partners, and [Chapter 4](#) details our methodological approach.

The remainder of the thesis is organised as follows. [Chapter 5](#) contextualises this study by describing the implementation of CoE programmes in Chile and Peru. It includes the main characteristics of the Chilean and Peruvian NSIs, explains what the CoE programmes look like in each country, and adds details of the studied centres.

After that, we present the results of the empirical analysis in three chapters, each addressing one of the specific questions highlighted earlier. [Chapter 6](#) explores the organisation of CoEs in terms of their structure to support UILs and the range of channels of interaction used by their partners. It presents not only a comparison between the Chilean and the Peruvian centres but also between these and centres from the developed world. From this chapter, we draw two conceptual distinctions: one between *channels* of interaction and CoEs as the *context* for UILs, and another between *CoEs* and *RTOs*.

[Chapter 7](#) analyses the barriers to UILs found in this study. We compare barriers in the Chilean and Peruvian centres based on the three types included in our provisional conceptual framework. We analyse the configuration of these barriers and their theoretical foundations to see whether they differ from the barriers found in previous work. The

chapter complements our provisional conceptual framework by identifying certain relationships between the three types of barriers as well as highlighting the importance of *capacity-related* barriers.

The last empirical chapter has two parts. The first part refers to the intermediary roles of certain actors in the set-up process of CoEs. We decided to extend the analysis to these actors because our findings have revealed some insights that may enrich our understanding of intermediaries in the context of CoEs. The second part analyses the role of international partners in regard to the potential benefits brought to local actors and systems (i.e. from a *host-country* perspective). In this Chapter, we compare these aspects between the Chilean and Peruvian cases and elaborate some possible explanations for our findings.

[Chapter 9](#) brings together all parts of this research inquiry to arrive at the main conclusions and contributions, setting out the methodological, empirical and conceptual aspects. There is a section on the overall contribution of the thesis and a discussion about the generalisability of the findings. This chapter also highlights various limitations of the study and identifies potential avenues for further research.

The main conclusions of our study can be summarised as follows. In terms of the internal organisation of CoEs, we found that the Chilean and Peruvian centres differ from each other in certain respects such as the type of actor leading the centres, their internal structure to support UILs, and the participation of firms in their governance. However, when they are compared with initiatives in developed countries, they seem to be quite similar to each other while exhibiting sharp differences with the latter. For instance, in developed countries centres do pre-competitive research at least partially funded by firms, which also participate in the centres' governance (business-driven centres). In contrast, Chilean and Peruvian centres tend to develop pre-competitive research with public resources and with limited involvement of firms in their governance.

Regarding barriers to UILs, we found that *orientation-related* and *transaction-related* barriers seem to stem not only from the divide between two different communities of researchers in the science subsystem but also from different characteristics of the university

and the business subsystems. These two subsystems differ in terms of their understanding of innovation and research as well as their incentives and interests. Moreover, *capacity-related* barriers seem to play a major role in the resulting conceptual framework, not least because they help explain some of the other two types of barriers.

Finally, the CoE programmes expected certain outcomes from attracting international partners: in particular, building local capabilities and allowing local actors to access global sources of knowledge and technology. Contrary to those expectation, we found that international actors have been playing a relatively limited role. We attempt to provide some explanation for these findings, drawing on the literature on technical change as well as on our findings regarding *capacity-related* barriers.

## CHAPTER 2. University-industry linkages and centres of excellence

### 2.1. Introduction

The aim of this study is to understand how universities, business actors and international partners interact with each other in the context of centres of excellence (CoEs) in Chile and Peru. We focus the enquiry on three aspects: how university-industry linkages (UILs) develop, what barriers emerge, and what roles international partners perform in the context of CoEs. In order to position this study within the broad field of innovation studies, this chapter is divided in two sections, one dedicated to framing our research inquiry by exploring the National Systems of Innovation (NSI) approach, and the other one devoted to examining the most relevant aspects in the UIL literature.

Regarding the NSI concept, we explain why it may be a suitable conceptual framework for this study. We discuss the origins and evolution of the concept and the importance of universities and UILs for innovations systems. One of the main insights from this body of literature is the broad definition of innovation, which is understood as an interactive process of learning. We also highlight the importance of certain complementary approaches such as the sectoral, regional and technological innovation systems as well as the internationalisation of certain aspects of NSIs.

Moreover, we explore the main lessons from successful and unsuccessful experiences in technological development in some countries, analysing the role of universities and UILs. Then, drawing on the extant literature, we discuss the extent to which the NSI approach is appropriate for countries with weak or less developed innovation systems, something which is characteristic of Latin American countries (LACs). We conclude that it is suitable as long it is kept flexible as to decide which subsystems should be included and studied in specific situations.

The second section focuses on certain strands of the literature on UILs that help with the delineation of this study. We highlight that previous work can be labelled as *one-side-focused* because most authors have considered just one side of interactions, either university or business actors. We also recognise the importance of intermediaries for innovation systems, innovation processes and UILs. Then, we analyse the broad set of

channels of interaction and their complementarities in the process of capability building in firms and universities.

Given that certain classifications include CoEs as a specific type of UIL channels, we characterise these centres and explore whether they are *channels* or they are rather a sort of *context* for UILs, concluding that the latter is a more plausible way to conceive of them. In this domain, we also found that experiences and studies of CoEs have been focused on the developed world, while few countries in Latin America (LA) have launched similar initiatives and studies on them are relatively few.

Finally, we provide a brief account of studies on barriers to UILs and on the roles of intermediaries, which opens the discussion on the necessity of having particular analytical frameworks for analysing these phenomena in LACs. The analytical framework and associated conceptual insights for barriers to UILs and intermediaries will be developed in the next chapter.

## 2.2. National Systems of innovation: framing the study of UILs

### 2.2.1. An overview: origins and evolution of the concept

Concerns with explaining the differences in growth rate across countries and understanding the processes of ‘catching-up’ and ‘forging ahead’ have led some authors to include the concept of National Systems of Innovation (NSI) in their discussions. The concept has been adopted not only by scholars and researchers, but also by policy makers as well as national and international organisations such as the National Science Foundation (NSF) in the United States (US) and the Organisation for Economic Co-operation and Development – OECD (Freeman 1995; Lundvall et al. 2002).

The origins of the term ‘NSI’ are attributed to Freeman and Lundvall, while its core ideas can be traced back to Adam Smith and Friedrich List (Freeman 1995, 2002; Mowery and Oxley 1995; Teixeira 2014). In the NSI literature, we found somewhat different or nuanced features of this concept. For instance, Mowery and Oxley (1995: p. 68) have reduced the scope of the NSI concept to “the network of public and private institutions that fund and perform R&D, translate the results of R&D into commercial innovations and affect the diffusion of new technologies,” while other authors have argued for



adopting a somewhat broader concept (Edquist 2011; Lundvall 2016b; Nelson and Rosenberg 1993).

For instance, Lundvall (2016) has defined innovation as an interactive process of learning and argued for a broad sense of systems of innovation. He has stated that the *narrow sense* of NSI includes organisations and institutions involved in searching and exploring activities, such as firms' R&D departments, technological institutes and universities, while the *broad concept* encompasses all these organisations alongside aspects of the economic structure and institutional set-up of the process of learning (involving production, marketing, and financial subsystems).

In the evolution of the NSI concept, we observe that some authors have used different sets of indicators for making comparisons (Table 1). For instance, to describe and compare the innovation systems of Japan and the ex-USSR, Freeman (1995) used one particular set of characteristics and indicators, and for Brazil and South Korea a different set.

Meanwhile, Nelson (1993) has compared countries within the same category: low-income, large high-income and small high-income countries, implying that there exist differences between groups of countries that should be taken into account when making comparisons. In a similar vein, Lundvall et al. (2009) have proposed to compare systems with similar characteristics ('families') in order to have a better understanding of them, it being more appropriate to compare Latin American countries (LACs) with each other and separately from any analysis of Asian countries.

Despite the differences in the set of indicators used by some authors, we could identify certain commonalities that are useful for this study. First, most authors have highlighted the role of the higher education subsystem (universities, graduates, engineers and scientists) and research institutes (science subsystem). Second, they have recognised the need for linkages between the science-technology infrastructure and industry as well as the importance of networks for exploiting technology.

*Table 1. Set of indicators used to compare NSIs*

<b>Freeman (1995)</b> Comparing LAC (Brazil) and East Asian countries (South Korea)	<b>Freeman (1995)</b> Comparing Japan and Ex-URSS	<b>Nelson (1993)</b> Comparing low-income, large high-income and small high-income countries	<b>Viotti (2002)</b> Comparing South Korea and Brazil (NLS)
<ol style="list-style-type: none"> <li>1. Education system, participation of tertiary education and proportion of engineering graduates.</li> <li>2. Import of technology combined with local efforts of technical change and enterprise commitment (R&amp;D)</li> <li>3. Industrial R&amp;D</li> <li>4. Science-technology infrastructure and linkages with industry</li> <li>5. Levels of investment.</li> <li>6. Levels of networking in technology</li> <li>7. Investment in advanced telecommunication infrastructure.</li> <li>8. High tech products, exports and feedback from international markets.</li> </ol>	<ol style="list-style-type: none"> <li>1. GERD/GNP and the proportion of military/space R&amp;D</li> <li>2. Proportion of total R&amp;D at enterprise level and company-financed</li> <li>3. Integration of R&amp;D, production, and technology import at the enterprise level</li> <li>4. Linkages between marketing, production and procurement (user-producer and subcontractor networks)</li> <li>5. Incentive to innovate at enterprise level involving both management and workforce.</li> <li>6. Level of competition in international markets.</li> </ol>	<ol style="list-style-type: none"> <li>1. GDP/capita, official exchange rates</li> <li>2. GDP/capita, purchasing power parity</li> <li>3. Population</li> <li>4. Average growth rate, GDP/hour average</li> <li>5. Gross domestic investment/GDP average</li> <li>6. Manufacturing output/GDP</li> <li>7. Manufacturing exports/GDP</li> <li>8. Total exports/GDP</li> <li>9. Literacy rate</li> <li>10. Secondary level enrolment ratio</li> <li>11. Third level enrolment ratio</li> <li>12. Engineers as percentage of population</li> <li>13. Scientists and engineers/Population</li> <li>14. R&amp;D/GNP</li> <li>15. Private R&amp;D/Total R&amp;D</li> <li>16. Business R&amp;D/Total R&amp;D</li> <li>17. Private business R&amp;D/Total business R&amp;D</li> <li>18. Direct foreign investment/GDP</li> </ol>	<ol style="list-style-type: none"> <li>1. National patterns of education and training of the labor force (Adult literacy, secondary education rate, performance of secondary students, tertiary education rate, index of tertiary students, etc.)</li> <li>2. National patterns of technology acquisition (Imports of capital goods as percentage of GDP, FDI, direct purchase of technology)</li> <li>3. National patterns of commitment of resources to technological learning (Expenditure of R&amp;D - total and from firms-, government preferential financing for R&amp;D, scientists and engineers engaged in R&amp;D, researcher according to working place)</li> <li>4. Outcomes of national technology effort (National patents, US patents, Trade in high-tech products with US, diffusion of new productive technologies)</li> </ol>

Author's own elaboration.

Note: In Nelson's (1993) study, the set of indicators varies according to the group of countries, omitting or including some of them for comparisons within each group.

Besides this ‘early’ literature on NSIs, Watkins et al. (2015) identified two subsequent developments (or waves). The ‘second wave’ emerged in response to criticisms about the national scope of the approach, by proposing the concepts of technological (Carlsson and Jacobsson 1994; Carlsson and Stankiewicz 1991), sectoral (Malerba 2002, 2011) and regional (Cooke, Gomez Uranga, and Etxebarria 1997) innovation systems. According to Sharif (2006), these concepts have sometimes been regarded as alternatives and sometimes as complements to the NSI approach.

We adopt the idea of complementarity following Malerba (2002), who has recognised that national institutions (e.g. the patent system) have different effects across countries and thus may have different effects on the same sector in different countries, something which is consistent with some empirical studies on UILs (Giuliani and Arza 2009; Meyer-Krahmer and Schmoch 1998). In the same line of argument, regional innovation systems are influenced by policies and aspects outside the boundaries of a region, such as the national science and technology policy (Padilla-Pérez, Vang, and Chaminade 2009).

The ‘third wave’, according to Watkins et al. (2015), relates to the internationalisation of certain aspects of NSIs. Carlsson (2006) has surveyed the literature on this subject and concluded that there are different patterns of internationalisation for different aspects (international relationships between researchers, multi-national corporations’ operations, internationalisation of R&D activities). Carlsson has also stated that several institutions that are country-specific, such as higher education, funding and financial institutions, alongside monetary and trade policies, still play important roles. This conclusion reinforces the idea of complementarity between the NSI concept and other approaches.

According to Watkins et al. (2015), the second and third ‘waves’ of studies are focused on understanding processes, dynamics and spatial relations between different actors involved in the generation and diffusion of new technologies. Moreover, all these developments bring both richness to the study of innovation systems and certain challenges to the building of theoretical foundations that can give this field a degree of coherence, as explained in a recent study (Rakas and Hain 2019).

Another issue for discussion concerning the NSI concept is, therefore, based on disagreements about the need for theorizing the concept versus maintaining its flexibility. There has been criticism that this concept is vague and aggregated, open to misinterpretation and too inclusive (flexible) to be practical, while many NSI studies have been descriptive and lacking a formalised methodology (Balzat and Hanusch 2004; Lundvall et al. 2002; Teixeira 2014; Watkins et al. 2015).

The tension between developing a theoretical basis for the concept and the option of keeping it flexible is explained by Sharif (2006) in terms of two different communities using it. On one side, there is an academic community trying to find a technical solution to the under-theorization of the approach and, on the other side, there are policy makers applying the concept in a context of social choices to define what is to be included in the system. This tension has been seen as one of the main strengths of the concept because it “allowed for cross-fertilization by theoretical and practical considerations, and this accelerated the spread of the NIS concept” (Sharif 2006: p. 762).

Therefore, we can argue that the NSI concept should be flexible to some extent in order to be applied to countries with different characteristics. In doing so, we also recognise, following Edquist (2011), that it is a conceptual framework rather than a formal theory.

#### 2.2.2. NSI and technical change: What can be learnt from successful experiences?

The NSI approach, as pointed out earlier, is a useful tool for understanding the processes of technical change and economic growth in countries with different characteristics. In this section, we turn briefly to experiences of some countries in their attempts to forge ahead or catch up with developed countries, some of which have succeeded while others have not.

From successful catch-up experiences in the 19th and 20th centuries – by the US, Germany, Japan, South Korea and Taiwan – some studies have identified common features such as a reliance on cross-border flows of people and technology, active support of government to industrial development (various forms of protection as well as direct and indirect subsidy), and intellectual property regimes that did not seriously restrict the ability of companies to replicate technologies (Mazzoleni 2008; Mazzoleni and Nelson 2007). Those countries also relied heavily on indigenous technological and

scientific capabilities, higher education and training. Moreover, the forging ahead experiences of Britain in the 18th century and the US in the 19th and 20th centuries have shown the relevance of scientific culture and respect for invention, science and technology (Freeman 2002).

On the other hand, there have been unsuccessful cases of attempted catch-up processes. Some studies have compared LACs, particularly Brazil and Argentina, with Asian countries to demonstrate differences in their NSIs, catch-up processes, and economic performance (Freeman 1995, 2002; Mazzoleni and Nelson 2007; Nelson 1993; Viotti 2002). Because of certain deficiencies in LACs, their NSIs have been labelled by some as myopic (Patel and Pavitt 1994).

In Latin America, during the 1960s and 1970s there were some efforts to strengthen countries' NSIs, through the creation of national organisations for science, technology and innovation (STI) and policies aimed at building scientific and technological capabilities. However, those efforts might have not been enough to create a propitious environment for a successful 'catch up' process. Those attempts were, to some extent, reversed during the 1980s when the region faced a serious economic crisis (Alcorta and Peres 1998; Cassiolato, Lastres and Soares 2014; Sagasti 2013). According to Sagasti (2013), during the so-called 'lost decade' of Latin America (i.e. the 1980s) and the early 1990s, governments largely neglected STI policies.

Since the late 1990s, countries in the region have shifted towards policies aimed at fostering their competitiveness, but they still face certain problems. For instance, technology organisations and research programmes are detached from users' demands, there is little experience with UIs, and the domestic demand for endogenous knowledge is not well-developed. Moreover, local capacity to generate and commercialise knowledge is weak, while firms' investment in R&D is low and concentrated on just a few of them (Alcorta and Peres 1998; Arocena and Sutz 2000, 2010; Cassiolato, Lastres and Soares 2014; Sargent and Matthews 2014).

Policies promoting linkages between research organisations and firms have been one of the main concerns in LACs in the last period, but they do not seem to have been very effective. In general, few firms use this mechanism in their innovation processes (Sagasti

2013); for example, in Brazil only 3% of innovative firms interact with universities or research institutes while the average in the OECD is around 10% (Cassiolato et al. 2014). This general trend has been confirmed in a recent study on research collaboration in LA (Confraria and Vargas 2019), albeit based only on publications co-authored by academics and researchers in firms.

The experiences of success and failure described above show that LACs face major challenges in creating the conditions to build indigenous capabilities and foster successful technical change. Under these circumstances, what is the path for LACs to promote technical change and economic growth? The first part of the answer is given by a number of authors who have stated that knowledge, technologies and innovations produced in and for developed countries may not be appropriate for less developed ones (e.g. Acemoglu 2002; Freeman 1995; Fu, Pietrobelli, and Soete 2011; Lundvall 2016a).

The solution for developing countries, the second part of the answer, is to create conditions not only for absorbing the most suitable foreign technologies but also for generating domestic innovations and indigenous technological capabilities (Acemoglu 2002; Alcorta and Peres 1998; Arocena and Sutz 2010; Bell and Pavitt 1993; Fu, Pietrobelli and Soete 2011; Mazzoleni and Nelson 2007; Sagasti 2013). In this context, Mazzoleni and Nelson (2007) and Nelson (2004) have recognised that the domestic base of scientists and universities has an increasing role to play in the changing conditions for catching up in the 21st century.<sup>4</sup>

At this point, following Fagerberg and Srholec (2008), we can conclude that capability building is a pre-condition for a successful catch-up process. We can also conclude that the process of capability building is carried out within the particularities of each NSI,

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<sup>4</sup> Compared to East Asian countries' experiences in the late 20th century, technological accumulation is becoming more complex because it depends more on intangible capital (specialised and tacit knowledge), and it has become increasingly decoupled from the accumulation of production capacity (machinery and physical facilities), particularly in high-growth sectors such as chemicals, electronics, and materials (Bell and Pavitt 1993). Moreover, international conditions such as the growing integration of markets, including international trade treaties, and tighter intellectual property regimes, have changed the conditions for catching up (Mazzoleni 2008; Mazzoleni and Nelson 2007; Nelson 2004). Industrial protection, direct and indirect subsidies to firms, and imitation (with loose intellectual property regimes) – characteristic of successful experiences in Asian countries – are now more difficult to implement.

where universities and research organisations as well as their interactions with firms play important roles.

In this regard, Perkmann et al. (2013) have argued that differences in NSIs, including differences in the higher education system, economic structure and public science system, tend to result in UILs exhibiting different patterns. Moreover, depending on the stage of economic development in each country, the roles of universities and the patterns of UILs may differ (Mazzoleni and Nelson 2007; Schiller and Lee 2015).

### 2.2.3. Concluding remarks on the NSI concept

In this section we examine aspects about the relevance and utility of the NSI concept for developing countries and for studying UILs. In this respect, some concerns have emerged because the concept has previously been mostly applied to developed countries, and it may offer little guidance for policy recommendations for the developing world (Lundvall et al. 2002; Teixeira 2014; Watkins et al. 2015).

For example, some authors have argued that developing countries face several conditions and weaknesses that make the NSI approach less appropriate for them (Mathews 1999; Viotti 2002). Viotti (2002) has stated that innovation is characteristic of industrialised countries, while the process of technical change in industrialising economies is generally limited to the absorption and improvement of innovations produced in the industrialised world (which is better described as *technological learning*). For that reason, Viotti has proposed that the NSI approach should be used exclusively for advanced industrial countries, while for the late industrializing economies the concept of National Learning Systems (NLS) is, he argues, more suitable.

In this regard, we recognise that LACs face certain challenges such as low indigenous scientific and technological capabilities, lack of experience in building UILs, and low participation of the private sector in R&D investment (Section 2.2.2). However, these characteristics are not sufficient to discard the NSI approach as an appropriate analytical framework. We support this conclusion on the basis of the broad definition of innovation discussed earlier (i.e. an interactive learning process); a definition that is not limited to R&D activities and disruptive innovations, but also refers to all actions relating to the generation, dissemination and use of knowledge. Moreover, in the case of Peru,

some scholars have specifically argued for the adoption of such a broad definition of NSI (Bazán and Sagasti 2014; Sagasti, Kuramoto, and Bazán 2003).

Moreover, as some Latin American scholars (e.g. Lastres and Cassiolato 2005) have recognised, the advantage of the innovation system approach is its focus on learning, capability building and interactions between different actors as well as the importance of international linkages and their effects on local systems. The NSI approach is, therefore, appropriate to address the general question of this study about the dynamics between local universities, firms and international actors in the context of CoEs in Latin America.

Even though one can find other conceptual frameworks to analyse UILs, we argue that the NSI concept is better suited to understanding the complex phenomenon of CoEs in Chile and Peru. For example, the Triple Helix approach, developed by some authors to explain innovation in a knowledge-based society (Etzkowitz 2003; Etzkowitz and Leydesdorff 2000; Ranga and Etzkowitz 2013), lacks the flexibility to incorporate into the analysis certain actors and interactions such international partners and global networks. The other approach, the Open Innovation paradigm, is mainly focused on R&D and firms' strategies, and seems to neglect other actors' behaviour and the variety of channels they use (Chesbrough 2003, 2006; Henkel, Schöberl, and Alexy 2014; Howells, Ramlogan, and Cheng 2012; Laursen and Salter 2014). More details about these frameworks can be found in [Appendix A](#).

Finally, we also should bear in mind that the NSI literature has included few studies on developing countries and the adoption of this approach for them is thus a relatively new phenomenon (Fagerberg and Srholec 2008; Watkins et al. 2015). Keeping these considerations in mind, we turn now to specific strands of the literature on UILs.

### 2.3. University-industry linkages

The main objective of this study is to generate evidence on how university-industry linkages (UILs) have been working within centres of excellence (CoEs) in two Latin American countries, Chile and Peru. In the previous section, we have justified why the NSI approach offers an appropriate framework to understand these phenomena in



developing countries. Drawing on that, this section analyses aspects relating to UILs that will support our empirical study of CoEs.

First, studies in this field are very diverse, with a focus on several aspects and different contexts (countries, regions, and so forth). As diverse is the literature on UILs, so are the concepts and definitions used by scholars, which can sometimes contain important conceptual distinctions and different policy implications. For instance, *linkages* and *interactions* are terms with a broad scope, encompassing an open range of activities, while *relationships* and *collaboration* are generally used in a narrower sense, implying the active involvement of both firms and universities. For practical reasons, we will use *linkages* and *interactions* as interchangeable terms.

This section analyses the multiplicity of actors involved in UILs, the relevance of the context of UILs, the range of interaction channels, and the characteristics of CoEs. Finally, this section briefly visits the literature on barriers to UILs and intermediaries to highlight the need for particular conceptual insights to study these phenomena in LACs.

#### 2.3.1. Diversity of actors around UILs

Simplifying the phenomenon, we can state that UILs are based on the activities, functions and strategies of actors in both universities and firms. For this reason, the starting point of some studies in this area was the third mission of universities (Bruneel, D'Este, and Salter 2010; D'Este and Patel 2007; Gilman and Serbanica 2014; Muscio and Vallanti 2014; Perkmann et al. 2013) and firms' open innovation strategy and absorptive capacity (Arza 2010; Brehm and Lundin 2012; Bruneel et al. 2010; Dutrénit, de Fuentes, and Torres 2010; De Fuentes and Dutrénit 2016; Perkmann and Walsh 2007).

Even though it is clear that UILs imply the participation of actors from both sides, most studies have focused only on one side. For instance, according to Ankrah et al. (2013), studies on academic engagement with industry are concentrated on one side (49.1% on academics and 19.3% on industry) while only a small proportion include both actors or even intermediaries (28.1% and 1.7% respectively).

Some authors have studied the determinants of academics' engagement in UILs (Perkmann et al. 2013), factors explaining the diversity of channels university researchers develop (D'Este and Patel 2007), and their motivations for interacting with

external organisations (Abreu et al. 2009; Franco and Haase 2015). On the other hand, studies focused on firms have analysed the effect of public research on firms' R&D and innovative activities (Baba, Shichijo, and Sedita 2009; Cohen, Nelson, and Walsh 2002; Haus-Reve, Fitjar, and Rodríguez-Pose 2019; Robin and Schubert 2013; Scandura 2016) and the determinants of their involvement in interactions with universities (Antonioli, Marzucchi, and Savona 2017; Arza and López 2011; Fontana, Geuna, and Matt 2006; Maietta 2015).

Besides those *one-side-focused* studies, there are few analyses looking at both sides, i.e. academia and firms. Ankrah et al. (2013), for instance, have analysed the motives of and outcomes for individuals in both universities and firms engaged in a UK programme (the Faraday Initiative). Moreover, Dutrénit and Arza (2010) have compared UILs in four Latin American countries based on motivations and strategies of both sides, public research organisations (including universities) and firms. Dutrénit and Arza have stated that studies on one side of UILs contribute to an understanding of certain factors such as motivations and benefits but tend to have limited policy implications because aspects from the other side are often missing.

Moreover, we found few studies on university-industry linkages that have considered intermediaries as their source of information. Those studies have conducted, for instance, interviews with technology transfer officers in universities and external intermediaries (Ankrah et al. 2013; Brimble and Doner 2007; Decter, Bennett and Leseure 2007; Lockett, Kerr and Robinson 2008; Wright et al. 2008). The domain of intermediaries is vast and includes a range of actors such as technology transfer offices (TTOs), research and technology organisations (RTOs) as well as boundary-spanning structures such as cooperative research centres (CRCs).

Regarding the influence of intermediaries, a number of studies have highlighted their importance for national (Andersen and Le Blanc 2013; Mina et al. 2009), regional (Dossou-Yovo and Tremblay 2012; Kodama 2008; Smedlund 2006) and sectoral systems of innovation (Dutrénit, Rocha-Lackiz, and Vera-Cruz 2012; Klerkx and Leeuwis 2008), as well as their roles at the international level (Bramwell and Wolfe 2008; Khan, Lew, and Sinkovics 2015). Intermediaries have also been recognised as important sources of information for firms' innovation processes (Bessant and Rush 1995; Cosh and Hughes

2010; Knockaert, Spithoven, and Clarysse 2014) and as actors fostering UILs (Abreu et al. 2009; Villani, Rasmussen, and Grimaldi 2017; Yusuf 2008)

However, alongside the positive effects of intermediaries, they can also bring certain risks for UILs and innovation. Gatekeepers could, for instance, play a negative role in the process of knowledge transfer because they may desire to maintain their power and influence over the process, thereby hindering knowledge flows (Haas 2015; Khan et al. 2015; Paul and Whittam 2010).

In summary, the actors involved in UILs are not limited to university and business spheres; UILs can encompass a broad variety of intermediaries who may bring their own interests and priorities. For that reason, *one-side-focused* studies of UILs, despite their relevance to understanding certain aspects, may be limited with regard to providing policy recommendations because aspects from other actors are often missing.

### 2.3.2. Importance of context in studying UILs

In Section 2.2.2, we have argued that UILs may exhibit different patterns in different contexts. In this regard, some authors have argued that frameworks for analysing UILs in developed countries may not be appropriate for the developing world (Albuquerque et al. 2015; Arza 2010; Schiller and Lee 2015; Torres et al. 2011). This concern seems plausible given that universities, firms and intermediaries in developing countries have specific characteristics. For instance, universities face specific challenges such as financial shortages, a trend towards privatisation, limited experience with UILs and a 'brain drain' problem (Brundenius et al. 2009); intermediaries lack certain capabilities (Intarakumnerd et al. 2010); and patterns of innovation may differ markedly between advanced and developing countries (Crespi et al. 2014).

Schiller and Lee (2015) have stated that motivations, channels and benefits of UILs depend on the stage of economic and technological development of each country. According to them, at an 'early stage' firms look for consultancy and problem-solving skills from universities, while at 'medium stages' they rely more on contract research and joint projects, and at 'mature stages' firms prefer more open access channels (conferences and publications). They found, for instance, that in Asian countries formal channels and closed types of collaboration are more common than informal channels,

which contrasts with what has been found in developed and Latin American countries (see Section 2.3.3).

It is important to note that Schiller and Lee's study should be considered within an Asian context, where public research organisations have played important roles in building technological capabilities and promoting innovation in firms, while universities have focused mainly on training human resources. This distribution of labour has been changing in recent years as public research organisations have not been able to satisfy private sector demand for knowledge, and universities have attempted to become more relevant to firms (Brehm and Lundin 2012; Schiller and Lee 2015).

Regarding other contexts, studies have found that UILs exhibit different patterns in different global networks that include several countries and sectors (Britto et al. 2015), in peripheral areas compared to urban areas (Pinto, Fernandez-Esquinas, and Uyarra 2015), and in regional clusters working in different countries (Giuliani and Arza 2009). Moreover, previous work has found different patterns of UILs across technology fields (Meyer-Krahmer and Schmoch 1998) and scientific disciplines (Hughes and Kitson 2012).

Therefore, the main conclusion of this section is that the context of interactions matters, and hence analytical frameworks applied in the developed world may not be appropriate for analysing UILs in developing countries. Moreover, interactions between firms and universities are not limited to countries' boundaries, for these actors are sometimes involved in international or global networks.

### 2.3.3. Channels of university-industry linkages

Regarding channels of interactions, there is little consensus in the literature about either the set of channels or their categorization. Some authors have just included a set of channels (e.g. Cohen et al. 2002; Perkmann et al. 2013), while others categorised them according to different criteria (Table 2). For example, they have been classified according to the type of external actors with which university researchers develop linkages (Hughes and Kitson 2012), firms' purposes (Torres et al. 2011), the level of personal contact (Dutrénit and Arza 2010; Dutrénit et al. 2010; Perkmann and Walsh 2007) and the complexity in their development (Comisión Económica para América Latina y el Caribe 2010).

From these diverse lenses, it is worth highlighting a couple of aspects. First, most studies, regardless if they have classified channels or not, have found that both academics and businesspeople prefer informal interactions and people-based channels more than commercialisation (i.e. patenting, licensing and spin-offs). Second, there seems to exist a sort of complementarity between channels, as most actors tend to use several channels in their capacity-building process.

For example, D'Este and Patel (2007) have studied the determinants of the variety of channels used by UK academics to interact with industry, under the argument that academics' technology integration skills are built through their engagement in several channels. D'Este and Patel have defined *technology integration skills* (a knowledge management concept) as the capability to integrate scientific knowledge and the worlds of manufacturing and product application. They have also stated that this concept implies a bidirectional knowledge flow, especially from firms to universities, which is often neglected in the analysis of UILs.

On the firms' side, Perkmann and Walsh (2007) have found that firms value channels with high relational involvement (research partnerships, for instance) more than 'unidirectional knowledge transfer' because the former seem to respond to their capacity-building and learning interests. Moreover, as Torres et al. (2011) have found, firms tend to interact with universities to obtain both short-term problem-solving capabilities and insights for their long-term innovative strategies.

Regarding the flows of knowledge, some authors have distinguished channels according to their 'bidirectional' and 'unidirectional' flows of knowledge (e.g. Dutrénit and Arza 2010; Perkmann and Walsh 2007). In this regard, we argue that in a broader perspective, even those UIL channels that seem to embody only a unidirectional flow of knowledge (publications and mobility of researchers, for example) can imply bidirectional flows between university and industry spheres. For instance, a report elaborated by Elsevier (2016) has found that UK firms use articles authored by universities and research institutions, while academics use articles authored by corporate researchers, showing a rich pattern of cross-sector knowledge flows.

Table 2. Channels of university-industry linkages: different categories

Hughes and Kitson (2012) Interaction with an external organisation in general	Torres et al. (2011) Categories based on the purpose of the interactions	D'Este and Patel (2007) Categories according to channels' intrinsic characteristics	Perkmann and Walsh (2007) Categories according to the extent of relational involvement	Dutrénit, De Fuentes and Torres (2010) Dutrénit and Arza (2010) Categories according to the level of personal contact/interaction
<p><u>People-based activities:</u></p> <ul style="list-style-type: none"> <li>- Giving invited lectures</li> <li>- Student placements</li> <li>- Participating in networks</li> <li>- Standard-setting forums</li> <li>- Curriculum development</li> <li>- Enterprise education</li> <li>- Attending conferences</li> <li>- Sitings on advisory boards</li> <li>- Employee training</li> </ul> <p><u>Community-based activities:</u></p> <ul style="list-style-type: none"> <li>- Lectures for community</li> <li>- Public exhibitions</li> <li>- Schools projects</li> <li>- Community-based sports</li> </ul> <p><u>Commercialisation activities:</u></p> <ul style="list-style-type: none"> <li>- Licensed research</li> <li>- Patenting</li> <li>- Spun out company</li> <li>- Formed/run consultancy</li> </ul> <p><u>Problem-solving activities:</u></p> <ul style="list-style-type: none"> <li>- Informal advise</li> <li>- Research consortia</li> <li>- Prototyping and testing</li> </ul>	<p><u>Information:</u></p> <ul style="list-style-type: none"> <li>- Publications and reports</li> <li>- Public conferences and meetings</li> <li>- Informal exchange of information</li> <li>- Involvement in network that includes HEI/PRC</li> </ul> <p><u>Human Resources:</u></p> <ul style="list-style-type: none"> <li>- Recently hired graduates with advances degrees</li> <li>- Short stays of students in firm</li> <li>- Training</li> <li>- Temporary personnel exchange</li> </ul> <p><u>Services and products of research:</u></p> <ul style="list-style-type: none"> <li>- Consultancy with individual researchers</li> <li>- Contract research with HEI/PRC</li> <li>- Joint or cooperative research projects</li> <li>- Patents</li> <li>- Licensing technology</li> </ul> <p><u>Firms setting-up:</u></p> <ul style="list-style-type: none"> <li>- Firms' incubators</li> <li>- Science and/or technology parks</li> <li>- Firms owned by HEI or PRC</li> <li>- Spin-off firms from HEI/PRC</li> </ul>	<p><u>Meetings and conferences (personal informal relationships):</u></p> <ul style="list-style-type: none"> <li>- Industry sponsored meetings</li> <li>- Conferences with industry and university</li> </ul> <p><u>Consultancy and contract research (formal agreements with specific objectives):</u></p> <ul style="list-style-type: none"> <li>- Consultancy work</li> <li>- Contract research (commissioned by industry and undertaken by university)</li> </ul> <p><u>Physical facilities (involving a heavy commitment by university):</u></p> <ul style="list-style-type: none"> <li>- Setting up spin-offs</li> <li>- Creation of physical facilities with industry funding (campus laboratories, incubators and cooperative research centres)</li> </ul> <p><u>Training:</u></p> <ul style="list-style-type: none"> <li>- Postgraduate training in company (e.g. joint supervision of PhDs)</li> <li>- Training company employees (course enrolment or personnel exchange)</li> </ul> <p><u>Joint research (former research agreements):</u></p> <ul style="list-style-type: none"> <li>- Joint research agreements (involving research undertaken by both parties)</li> </ul>	<p><u>High:</u> relationships</p> <ul style="list-style-type: none"> <li>- Research partnerships (collaborative research, and university–industry research centres)</li> <li>- Research services (Contract research and consulting)</li> </ul> <p><u>Medium:</u> Mobility</p> <ul style="list-style-type: none"> <li>- Academic entrepreneurship</li> <li>- Human resource transfer</li> </ul> <p><u>Low:</u> transfer</p> <ul style="list-style-type: none"> <li>- Commercialization of IP (e.g. licensing)</li> </ul> <p>Use of scientific publications, conferences and networking can accompany all categories.</p>	<p><u>Bi-directional (interpersonal contact is essential and in a long-term basis):</u></p> <ul style="list-style-type: none"> <li>- Networking with firms</li> <li>- Joint R&amp;D projects</li> <li>- Research contract</li> </ul> <p><u>Commercial (personal contact required and bidirectional flow of knowledge):</u></p> <ul style="list-style-type: none"> <li>- Patents</li> <li>- Technology licenses</li> <li>- Incubators</li> <li>- Spin-off from PRO</li> </ul> <p><u>Services (short-term personal interaction and unidirectional flow of knowledge):</u></p> <ul style="list-style-type: none"> <li>- Staff mobility</li> <li>- Consultancy and technical assistance</li> <li>- Informal information exchange</li> <li>- Training staff</li> </ul> <p><u>Traditional (no personal interaction and unidirectional flow of knowledge):</u></p> <ul style="list-style-type: none"> <li>- Conferences and expositions</li> <li>- Publications</li> <li>- Graduates recently employed in industry</li> </ul>

Author's own elaboration.

Consequently, the main conclusion of this section is that UIL channels are very diverse, but studies have shown certain commonalities. First, technology transfer (commercialisation) is generally the least important interaction channel for academics and firms; therefore, giving too much attention to it may neglect a wider array of channels and their contribution to innovation. Second, UILs contribute to the process of capacity building in both firms (absorptive capacity) and universities (academic capabilities or technology integration skills). And third, a degree of complementarity among channels seems to exist, which is relevant for the process of building capabilities.

Finally, we have noticed that some authors (e.g. D'Este and Patel 2007; Hughes and Kitson 2012; Perkmann and Walsh 2007) have included research partnerships and cooperative research centres (CRCs) as specific types of channels of interaction. Given that this type of initiative in Chile and Peru is the subject matter of this study, we review the literature on this field in the following section.

#### 2.3.4. Centres of Excellence: channels or contexts?

As pointed out earlier, this study provides insights about centres of excellence (CoEs) in two Latin American countries, Peru and Chile, with a particular focus on the barriers to UILs and the role of international partners. In this section, we explore programmes aimed at creating centres based on university-industry linkages. These initiatives have received different names such as research partnerships, centres of excellence (CoEs), cooperative research centres (CRCs), and industry/university cooperative research centres (I/UCRCs).

The term 'centres of excellence' was used in connection with instruments with different aims. For instance, some countries launched CoE programmes to promote research of excellence, which can be internationally recognised, while creating a propitious environment for research, training new researchers, and generating knowledge related to their national problems (Aksnes et al. 2012; Malkamäki et al. 2001; World Bank 2013). However, in this study we will use the term CoEs to refer to a specific type of organised collaboration between university and industry, the origin of which can be traced back to the experiences of Canada and the US in the 1970s and '80s (Bell 1996).

In the US, we can identify at least three examples, namely industry/university cooperative research centres (I/UCRCs), engineering research centres (ERCs) and science and technology centres (STCs). In this regard, Bozeman and Boardman (2004: p. 366) have stated that *“there has been no more important institutional change in the past three decades of U.S. science and technology policy than the movement from department-based, principle investigator-oriented university science to a new center-based model encouraging universities to work with industry and work beyond the strictures of academic disciplines”*. According to these authors, the experience in the US has had a strong influence not only on other agencies within that country, but also on other countries’ policies.

The I/UCRCs in the US are defined as university-based industrial research consortia, which are complex boundary-spanning organisations. They involve a diversity of elements such as multiple stakeholders, a broad range of research activities, leadership, communication at different levels, and monitoring systems (Davis and Bryant 2010; Gray, Lindblad and Rudolph 2001). Some authors have found that the major contributions of I/UCRCs to firms’ innovative activities are delivered through a variety of channels: faculty consulting, joint research and joint authorship, and the hiring of graduate students (Adams, Chiang, and Starkey 2001; Stone 2015).

In the UK, partnerships aimed at encouraging closer interactions between universities and firms have been developed under the ‘Faraday Principles’. These principles refer to the promotion of an active flow of people and ideas among partners, research that will underpin business opportunities and relevant post-graduate training, leading to lifelong learning (AIRTO 2001; Ankrah et al. 2013). A Faraday Partnership is more than a project programme; it represents a fundamental change in the infrastructure that brings together different partners, requires a long-term strategy with cultural changes in all participants, and expects short-term benefits to maintain enthusiasm and to encourage further efforts (AIRTO 2001).

Similar initiatives have been implemented in several countries, such as the Business-Led Network of Centres of Excellence in Canada (Performance Management Network INC.



2012), the Strategic Centres for Science, Technology and Innovation in Finland (Lähteenmäki-Smith et al. 2013), the Cooperative Research Centres in Australia (Sinnewe, Charles, and Keast 2016; Turpin, Garrett-Jones, and Woolley 2011), Research Campus in Germany (Koschatzky 2017; Kroll 2016), and so forth. All these share similar characteristics: partnerships that require the involvement of different actors such as firms, research institutions and universities, interacting through several channels.

In Latin America, experiences in promoting this type of centres seem to be relatively new. For example, the Brazilian agency, FINEP, and the Ministry of Science, Technology and Innovation jointly created the Brazilian Agency for Industrial Research and Innovation, EMBRAPPII (Empresa Brasileira de Pesquisa e Inovação Industrial), which finances units that are non-profit research and technology organisations and their interactions with firms (Azevedo et al. 2018). This experience started in 2012 with four pilots and began formally with the first call in 2014. The CoE programme in Chile started in 2010, and in Peru in 2014 (see more details in [Chapter 5](#)).

The features of these centres lead to the question of whether they are a type of interaction channel, as some authors have considered them to be (D’Este and Patel 2007; Hughes and Kitson 2012; Perkmann and Walsh 2007), or whether they provide the context in which UILs develop. We are inclined towards the second option because these centres are expected to build a permanent organisation supporting a variety of interactions between universities and firms. We will explore this aspect empirically by studying the organisation and interactions within Peruvian and Chilean CoEs ([Chapter 6](#)).

As a preliminary observation, we should note that we could not find a clear definition of the term *channel*, which, according to Perkmann and Walsh (2007), is an imprecise term. For that reason, following the broad definition of UILs provided by these authors, we can define *channel* as a way through which knowledge flows from one actor to others. On the other hand, to define the term *context* we turn first to its common meaning, which is “the situation within which something exists or happens, and that can help explain it” (Cambridge Dictionary). Therefore, based on the characteristics of CoEs (initiatives involving

multiple actors undertaking several joint activities), we can argue that CoEs seem to be configured as *contexts* for UILs.

Given the particular features of these centres, it is also necessary to distinguish them from other arrangements such as project-by-project collaborations and research units. According to Gray, Johnson and Gidley (1987), university-industry projects differ from university-industry centres in several aspects such as goals, funding schemes, the participation of industrial partners, and the processes of linking university academics with firms. Compared to projects, centres are intended to create a new permanent organisation to bridge those two worlds, where firms sponsor the centre's activities and linkages are mediated by that new organisation (Gray, Johnson and Gidley 1987; Kroll 2016).

Another form of organising research is the so-called 'research units', which can be defined as research-producing bodies within universities that operate independently from academic departments, mobilising human and financial resources and developing training programs (Clausen, Fagerberg, and Gulbrandsen 2012; Gray et al. 2001; Lee 2010).<sup>5</sup> Compared to these units, CoEs are not circumscribed by the boundaries of universities, but they are built as boundary-spanning structures that allow different organisations (universities, firms, and intermediaries) to interact with each other.

Consequently, the initiatives studied here may be characterised as CoEs for research and innovation, which can be considered as a relatively new and different policy instrument. Some authors refer to this phenomenon as an 'institutional change' in science and technology policy (Bozeman and Boardman 2004), a 'fundamental change in infrastructure' that brings together different partners (AIRTO 2001), a 'new strategic model of science-industry R&D collaboration' (Kroll 2016), or a 'new form of cooperation' through public-private partnerships for research and innovation (Koschatzky 2017).

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<sup>5</sup> Research units can be promoted not only in universities but also in other research organisations such as public research institutes and government agencies. However, according to Clausen et al. (2012), universities usually provide the most propitious environment for them.

Finally, we may note that virtually all these initiatives and studies have been focused on developed countries, while experiences in LA are quite recent and have been studied to only a very limited extent. This is one of the gaps being addressed by this study. At the same time, by understanding CoEs in Chile and Peru, we may contextualise the other two aspects under study: the barriers to UILs, and the role of international partners. For that reason, the following section examines briefly the extant literature in these fields, leaving the development of theoretical analysis and conceptual insights to the next chapter.

#### 2.3.5. Barriers to UILs and intermediary roles

In the field of barriers to UILs, some studies have used certain classifications (Bruneel et al. 2010), while most of them have just listed barriers without any attempt at classifying them. Some studies have focused on academics (Abreu et al. 2009; Hughes and Kitson 2012; Muscio and Vallanti 2014; Ramos-Vielba, Sánchez-Barrioluengo, and Woolley 2016; Tartari, Salter, and D'Este 2012) and others on firms (Bruneel, D'Este, and Salter 2010; Fontana, Geuna, and Matt 2006; Hall, Link, and Scott 2001; Howells, Ramlogan, and Cheng 2012). Few authors have taken into account the perspectives of different actors (e.g. Gilsing et al. 2011; Lockett, Kerr, and Robinson 2008).

It is also important to highlight that the previous work does not provide a clear definition of the term *barrier*, as most studies just list the barriers to UILs with little discussion about definitions and theoretical considerations. In its common meaning, the term *barrier* is understood as anything acting to block something from happening (Cambridge Dictionary). In that sense, barriers to UILs could be defined as obstacles faced by university and firms when they initiate and develop interactions with one another. However, the actual scope of the term, with regard to the aspects limiting UILs, will be analysed in this study.

Moreover, the literature on barriers to UILs has been concentrated on the developed world with a few studies of Asian countries. We could find just two studies analysing barriers in LACs, one for Mexico (López-Martínez et al. 1994) and the other for Uruguay (Sutz 2000). This situation has two important implications for our study. First, according to some authors, innovation policy in Latin America in the last two decades has been focused on the

promotion of UILs, but it does not seem to have succeeded (Cassiolato et al. 2014; Sagasti 2013; Sutz 2000; Velho, Velho, and Davyt 1998). In this regard, there is not too much evidence to understand why policies in this domain have not achieved the expected results, and there is still limited academic and policy interest in understanding this phenomenon.

The second implication relates to the note of caution raised in Section 2.3.2 about the limitations of existing analytical frameworks for studying UILs in, and guiding policy recommendations for, the developing world. Therefore, it is necessary to consider whether building a conceptual framework specifically to study these phenomena in Chile and Peru is advisable. The need for such a framework will be discussed in the next Chapter.

Regarding intermediaries, this study analyses two aspects. The first refers to the characterisation of CoEs as boundary-spanning structures between universities and firms, which means these centres may fulfil intermediary roles between those two worlds. The question is how such structures fit into the broad picture of intermediaries and how they have been fulfilling those roles, something which will be analysed empirically in [Chapter 6](#).

Moreover, there are a few studies on CoE initiatives in Latin America. For example, we could only find one study on the creation of EMBRAPA units in Brazil (Azevedo et al. 2018), two studies on CoEs in Chile (Klerkx and Guimón 2017; Prado 2017) and none in Peru. These studies have explored the origins and characteristics of funding programmes and the current stage of CoEs. None of them has analysed how UILs develop within centres, what barriers their partners have been facing, and the role of international actors, three themes that form the main focus of this study.

The second aspect regarding intermediaries is the participation of foreign RTOs and universities in Chilean and Peruvian CoEs. The objective of having collaborations with these foreign organisations was to facilitate access to knowledge and technology available globally and to build local capabilities in knowledge transfer and innovation (FONDECYT 2015; Innova Chile 2012). For that reason, we consider intermediary roles as an appropriate reference framework to study empirically the role of international partners in CoEs.

Given the objectives of the Chilean and Peruvian CoE programmes, international collaboration does not seem to be linked to research activities only, which is the focus of a different body of literature (Chen, Zhang, and Fu 2019; Georghiou 1998; Ponds 2009; Wagner, Whetsell, and Mukherjee 2019), but to collaboration in terms of technology transfer and innovation activities as well as the building of local capabilities in these areas. Moreover, international partners are not multinational companies, but RTOs and universities from developed countries. We could not find studies on the intermediary role of these type of organisations in developing countries.

Summing up, we can conclude that most studies on CoEs have been focused on experiences from developed countries, with a few exceptions regarding LACs. Moreover, the intermediary role of foreign universities and RTOs in Latin America have been studied to a very limited extent. This work addresses these gaps in the literature and, in order to do so, the next chapter will develop some conceptual considerations to guide this research inquiry.

#### 2.4. Conclusions

The field of university-industry linkages (UILs) is complex and diverse because it encompasses a variety of channels of interaction, performed in different contexts by multiple actors such as universities and firms as well as government, intermediaries, and international partners. In this study, we have concluded that the NSI concept provides a comprehensive and flexible framework for studying UILs in LACs: comprehensive because it considers a diversity of actors and elements and is based on a broad meaning of innovation – an interactive learning process. It is flexible because it allows both scholars and decision makers to choose which sub-systems can be included under particular circumstances.

These characteristics should also make academics and decision makers cautious when it comes to using the NSI approach. As some authors have warned, most studies have been focused on developed countries so their conclusions and implications may offer little guidance for interpreting certain phenomena in LACs (Lundvall et al. 2002; Teixeira 2014).

Moreover, it has been recognised that the adoption of the NSI concept is a relatively new phenomenon in developing countries (Fagerberg and Srholec 2008; Watkins et al. 2015). For these reasons, doing research using the NSI concept in LACs would require one to ‘tailor’ the approach and to decide on the inclusion of specific sub-systems.

Using the NSI concept as an umbrella framework, this chapter has analysed certain aspects of UILs that relate to the main purpose of our study. First, we have highlighted that most studies have been focused on either universities or firms, while only a small proportion has examined both sides and even fewer have looked at intermediaries. Integrating the perspective of both sides with that of other relevant actors should provide a more comprehensive understanding on how interactions work. A more integrated view of the phenomenon can also provide the basis for better policy recommendations.

Second, the actors involved in UILs, the channels they use, and other aspects would depend on the specific context where they are developed. The most recurrent contexts considered in the literature are countries, regions, scientific disciplines and technology fields, and sectors. The main conclusion in this respect is that the context of UILs matters and, based on that, some authors have suggested that existing analytical frameworks, coming mainly from developed countries, may not be appropriate for the developing world (Albuquerque et al. 2015; Arza 2010; Schiller and Lee 2015; Torres et al. 2011).

Third, drawing on previous work on CoEs, we characterised these initiatives as partnerships between universities and firms, which encompass a permanent structure bridging these two worlds by allowing them to develop several joint activities. Based on these features and the literature on channels of interaction, we have proposed a distinction between CoEs, which seem to be configured as *contexts* for UILs, and UIL *channels*. This conceptual distinction will be analysed empirically in [Chapter 6](#).

These centres have been implemented and studied in several countries, particularly developed ones such as Australia, Canada, Finland, France, Germany, the UK, and the US. These initiatives have represented one of the most important institutional changes in the infrastructure of collaboration between universities and firms, exhibiting substantial

differences from other arrangements such as project-based collaborations and research units. In LACs, these centres have been recently promoted but little studied up to now.

Moreover, CoEs in developed countries have proven to be a relevant change in the way UILs have been promoted, organised and performed, having required ambitious programmes. For these reasons, generating evidence on how UILs have been working within CoEs in LACs is essential to understand whether they represent an actual change for these countries as well. It is important to know if these centres perform with similar characteristics and conditions to those in developed countries and, if not, to explain the differences.

Fourth, in the context of CoEs in Chile and Peru, we will study two aspects: barriers to UILs and the role of international partners. Regarding the first, we found only a few studies dealing with barriers to UILs in LA, despite the importance of this aspect. Doing research on this phenomenon is worth pursuing because it could help explain why policies fostering UILs in the region have not generally been successful, despite the efforts made by governments over recent decades. The conceptual framework to study barriers to UILs is developed in the next chapter.

In terms of the international partners of CoEs, the funding programmes in Chile and Peru required their participation to facilitate local actors' access to knowledge and technology available globally and to build local capabilities in technology transfer and innovation. In that sense, international connections in the context of CoEs do not refer to international research collaboration but rather to innovation intermediary roles at the international level. The conceptual insights needed to study these roles empirically are also developed in the following chapter.

## CHAPTER 3. Conceptual Framework

### 3.1. Introduction

In the previous chapter we have framed our study in the broad NSI approach, which highlights the relevance of university-industry linkages (UILs) and provides compelling arguments for doing research on Latin American countries (LACs), given the limited generalisability of analytical frameworks used to investigate innovation in developed countries. The importance of generating evidence for LACs also relates to the limited research on barriers to UILs in a region where governments have been making efforts to promote these interactions, but with apparently rather poor results.

CoE programmes are one more attempt to promote innovation through the interaction between firms and universities. These schemes have demanded unprecedented efforts not only from governments but particularly from actors around the centres, i.e. universities, firms and international partners. These observations highlight the importance of studying barriers to UILs and the role of international partners in the context of CoEs in Chile and Peru.

The previous chapter has also cautioned about certain issues to consider when doing research in this field. First, the NSI approach should be kept flexible to decide which subsystems are relevant in a particular context. Second, the UILs arena is complex because of the involvement of multiple actors using a broad range of interaction channels. And third, patterns of UILs may depend on the contexts in which they are developed. In this regard, we have hypothesised that CoEs are *contexts* for UILs within which actors develop several joint activities with a mid- to long-term perspective.

We take on board all these considerations to study three aspects related to CoEs: how they are organised internally to fulfil their boundary-spanning roles, the barriers to UILs, and the role of international partners. To do so, this chapter develops a tentative conceptual framework to study barriers to UILs and provides insights on intermediaries of innovation to guide our research endeavour. How the conceptual framework and insights fit into the research design will be explained in [Chapter 4](#).



### 3.2. Barriers to UILs

#### 3.2.1. Theoretical considerations

As highlighted earlier, in the literature there is no clear common understanding about what a barrier to UILs is; therefore, building upon the common meaning of the term ‘barrier’, we define it broadly as an obstacle faced by firms and/or universities when they initiate or develop interactions with each other. In this section we discuss the scope and theoretical foundations of these barriers.

A first clarification is that this study does not address questions on firms’ barriers to innovate, which is the subject matter of a different but related body of studies (Coad, Pellegrino, and Savona 2016; D’Este et al. 2012; Filippetti and Savona 2017). For example, there seem to be certain relations between barriers to innovation and UILs; Antonioli, Marzucchi, and Savona (2017) have found that some barriers to innovation can foster UILs as firms search for support from universities, while others (e.g. firms lacking both capabilities and financial resources) can hamper UILs.

This study focuses rather on barriers to initiate and develop UILs, which imply the participation of both firms and university actors. In this regard, Bruneel et al. (2010) have categorised barriers as either ‘*orientation-related*’ or ‘*transaction-related*’ barriers. In the first type, these authors included aspects such as the ‘mutual lack of understanding about expectations and working practices’ and the ‘long-term and pure-science orientation of universities’. In the second type, ‘potential conflicts on intellectual property’ and ‘unrealistic expectation of universities’ have been considered. These authors found that UK firms perceive orientation-related barriers to be lower than transaction-related ones, while the importance given to each type varies across sectors.

For previous studies, barriers to UILs stem mainly from cultural differences between universities and firms (Bruneel et al. 2010; Hewitt-Dundas et al. 2019; Mora Valentín 2000). Drawing on the distinction between two scientific communities (i.e. scientists and technologists), Dasgupta and David (1994) have stated that differences between those communities are not in their methods of inquiry or the nature of the knowledge they generate, but in their goals, norms of behaviour (disclosure of knowledge, for instance) and reward systems. Consequently, it seems that barriers to UILs can be explained by “a

decisive difference of the research cultures at industrial firms and universities” (Meyer-Krahmer and Schmoch 1998: p. 841).

According to Sauermann and Stephan (2013), there are two different institutional logics, *academic* and *commercial*, which are sometimes considered as ‘ideal types’ that represent a division of labour in science between academia and the business sector.<sup>6</sup> However, these authors have recognised that in the real world the two logics can co-exist within each sector. This implies that, for instance, the sharing/secretcy tension can be experienced in both universities and firms (Nelson 2016). Universities, with their third mission, have become ‘ambidextrous’ organisations managing to balance research and knowledge transfer activities (Sengupta and Ray 2017), while firms tend to share their research results and IPRs for different reasons such as attracting collaborators and R&D employees, preventing patents by competitors, or encouraging subsequent innovations of a specific product (Henkel, Schöberl, and Alexy 2014; Nelson 2016).

These previous studies, however, seem to limit UILs to channels relating to R&D and its outcomes (i.e. the science system), while Section 2.3.3 has shown that there exists a broader set of channels through which academics and firms interact with one another. Therefore, we can argue that sources of barriers to UILs go beyond a difference in the research culture in firms and universities. There are other important sources such as the so-called social contract of universities, which implies the performance of and tensions between their three missions: teaching, research and contribution to the economy and society (Martin 2003; Martin and Etzkowitz 2000).

One of the main expressions of a university’s third mission is the emphasis on commercialisation of research results and, therefore, an increasing interest in intellectual property issues (Mowery and Sampat 2005; Perkmann et al. 2013). Such an emphasis can be seen reflected in the trend of creating technology transfer offices

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<sup>6</sup> To define the term ‘institutional logics’, Sauermann and Stephan (2013) cited Thornton and Ocasio (2008, p. 101), who defined institutional logics as “the socially constructed, historical patterns of material practices, assumptions, values, beliefs and rules by which individuals produce and reproduce their material subsistence.” The idea of different institutional logics seems to match the phrase ‘different research cultures’ used by some authors to explain the origins of barriers to UILs (Ankrah et al. 2013; Decter et al. 2007; López-Martínez et al. 1994; Meyer-Krahmer and Schmoch 1998). That might explain why some authors used the analogy of ‘two worlds’ interacting (D’Este and Patel 2007; Hall, Link, and Scott 2001; Hewitt-Dundas, Gkypali, and Roper 2019).

(TTOs), which started in the US in the 1980s and diffused to the UK, Europe and elsewhere. However, the third mission of universities is not limited to commercialising research results through the exploitation of IPRs, for it encompasses services, consultancy and training for firms as well as other forms of knowledge exchange.

On the other side, firms tend to use a range of information sources in their innovation processes, and universities are one of these (Laursen and Salter 2004; Mina, Bascavusoglu-Moreau, and Hughes 2014; Tether 2002). Even though universities do not appear at the top of the list (Howells et al. 2012; Laursen and Salter 2004), they still play a relevant role. Firms tend to link with universities not only for R&D inputs but also for consultancy and the training of human resources (Borah, Malik, and Massini 2019; Cohen et al. 2002; Perkmann and Walsh 2007), activities that seem to be more important than commercialisation channels at least in LACs (Dutrénit and Arza 2010; Dutrénit et al. 2010).

Consequently, the divide between two communities of researchers may provide only a partial explanation for the broad range of interactions between universities and business actors. Indeed, such a divide may explain certain *orientation-related* and *transaction-related* barriers, especially those referring to the type of research (basic versus applied), the management of research results (disclosure and sharing versus secrecy), and conflicts over IP issues. However, it may provide little guidance to understanding the barriers encountered with channels not related to R&D activities.

Including a broader range of UIL channels in the analysis may result in barriers to UILs exhibiting different configurations, in terms of both *orientation-related* and *transaction-related* types. Moreover, it is important to note that these two types of barriers seem to be part of the mainstream literature on UILs, which is mostly based on developed countries. For that reason, our academic concern is whether the same types of barriers, with their specific configurations, exist in LACs.

In this regard, Schiller and Lee (2015) have presented evidence about Korean firms' perception of barriers to UILs, highlighting a different but relevant group of barriers: the lack of capabilities in both academics and firms, the lack of public support, and the lack

of collaborative infrastructure.<sup>7</sup> These authors have stated that the most common barriers for Asian firms are the weaknesses in R&D activities in firms and academics and the lack of mutual understanding that may be explained by the mismatch of capabilities.

This group of barriers becomes relevant for Latin America because countries in this region have weak or less-developed NSIs, characterized by low indigenous scientific and technological capabilities, low private investment in R&D, little experience with UILs, and generally ineffective public policies (see Section 2.2.2). Compared with developed countries, universities, firms and intermediaries in Latin America seem to face different challenges (as highlighted in Section 2.3.2), so we might expect different configurations of barriers to UILs. Given these particularities, Schiller and Lee's findings lead us to think of a new type of barriers that can be labelled as '*capacity-related*' barriers.

*Capacity-related* barriers are focused primarily on a lack of capabilities in firms, universities and the innovation system. For universities, the term 'capabilities' refers to 'technology integration skills', understood as the capacity to relate the worlds of research and product application (D'Este and Patel 2007), or 'academic capabilities' that include skills and the organizational ability to perform activities of technological learning and upgrading (Schiller and Lee 2015). Capabilities in firms, on the other hand, refers to absorptive capacity (Cohen and Levinthal 1989), which includes not only technical capacities but also managerial and communicational ones (Bruneel et al. 2010; De Silva and Rossi 2018; Sutz 2000).

### 3.2.2. An integrated conceptual framework to study UILs in LACs

Following the discussion in the previous section, we propose a tentative conceptual framework with three types of barriers to UILs, namely *orientation-related*, *transaction-related* and *capacity-related* barriers. Distinguishing these three types of barriers may help to identify their patterns and provide researchers and decision makers with insights on how to deal with such barriers in a more effective, integrated way.

In order to obtain a more comprehensive view of how each type of barrier is configured, Table 3 displays a detailed characterisation of them, including expressions used in

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<sup>7</sup> In this study we adopt the common meaning of the term 'infrastructure', this is "*the basic structure of an organization or system which is necessary for its operation*" (Cambridge Dictionary); in this case, we are concerned with the structure necessary to develop UILs.

previous work. As we will see, most studies do not classify barriers, which makes the analysis more difficult, but we tried to see whether some barriers can fit into our three-category framework.

Considering firms' perceptions, some studies have presented lists of barriers, most of which could easily fit into one of the three categories of the conceptual framework, with just a few being difficult to classify (Fontana et al. 2006; Howells et al. 2012). For instance, 'firms lack awareness of what universities can offer them' (Howells, Ramlogan and Cheng 2012) may be a *transaction-related* barrier because either firms searching for information or a university signalling through information involves certain costs, but it could be also regarded as a weakness of the collaborative infrastructure as it may mean a lack of information in the system (a *capacity-related* barrier).

Regarding studies on academics' perceptions, some authors have included barriers related to internal and external aspects of universities (Abreu et al. 2009; Hughes and Kitson 2012; Schiller and Lee 2015). Some internal aspects, for instance the lack of time for new activities, insufficient rewards, and a lack of interest in interacting with external organisations, can be classified as *orientation-related* barriers. Other aspects such as insufficient resources and poor marketing and negotiation skills can fit into the *capacity-related* type. External factors can also enter in our three-type-barrier framework.

Hughes and Kitson (2012) also found that UK academics' perceptions about barriers to UILs differ across disciplines. For instance, intellectual property (IP) issues are being much more important in STEM disciplines and Health Sciences than in other disciplines because, according to these authors, academics from the former tend to make greater use of commercialisation channels, where conflicts over IP are more likely to emerge.

López-Martínez et al. (1994) identified a set of barriers in the Mexican context, based on interviews with both university researchers and firms' executives. They found that the most important barrier for both actors is the 'instability of public universities' and the 'technology gap between the university research laboratory and the production unit of firms', both seeming to fit into the category of *capacity-related* barriers. This is one of the few studies on barriers to UILs in LA, and its findings support the relevance of including *capacity-related* barriers in our analytical framework.

*Table 3. Conceptual framework for studying barriers to UILs*

Type of barriers	Barriers (Description)	Studies
Orientation-related barriers	<ul style="list-style-type: none"> <li>Differences in research orientation: Universities focus on pure/big science, while firms are focused on more applied research (different research questions).</li> </ul>	(Bruneel, D'Este and Salter 2010; Fontana, Geuna and Matt 2006; Schiller and Lee 2015)
	<ul style="list-style-type: none"> <li>Differences in time scale: Long-term orientation of research in universities, while firms need short-term solutions.</li> </ul>	(Abreu et al. 2009; Bruneel, D'Este and Salter 2010; Fontana, Geuna and Matt 2006; Howells, Ramlogan and Cheng 2012; Hughes and Kitson 2012; Muscio and Vallanti 2014)
	<ul style="list-style-type: none"> <li>Lack of interest in firms and universities in interacting with one another: Lack of incentives for researchers, which might stem from several factors: lack of time to fulfil all the missions of universities (conflict between the missions), lack of recognition of the third mission (biased incentives toward teaching and research), and the idea that the third mission has no influence on academic reputation or it may even be detrimental to career progression.  University researchers live in an ivory tower (university research is not relevant for firms), while firms do not generate cutting-edge research (uninteresting outcomes from working with firms).</li> </ul>	(Abreu et al. 2009; Howells, Ramlogan and Cheng 2012; Hughes and Kitson 2012; Lockett, Kerr and Robinson 2008; Muscio and Vallanti 2014; Schiller and Lee 2015)
	<ul style="list-style-type: none"> <li>Mutual lack of understanding, in terms of expectations, objectives, priorities and practices: Universities do not understand firms' line of business. Differences in dialogue, lack of or difficulties in communication (different languages), incompatibilities. Mutual distrust of capacity of human resources and of institutional responsiveness to objectives. Academics' fear of losing knowledge.</li> </ul>	(Bruneel, D'Este and Salter 2010; Fontana, Geuna and Matt 2006; Howells, Ramlogan and Cheng 2012; Muscio and Vallanti 2014; Schiller and Lee 2015)
	<ul style="list-style-type: none"> <li>Cultural differences/gap. Freedom of research rules collaboration with firms out.</li> </ul>	(Abreu et al. 2009; Fontana, Geuna and Matt 2006; Hughes and Kitson 2012; Schiller and Lee 2015)

Type of barriers	Barriers (Description)	Studies
Transaction-related barriers	<ul style="list-style-type: none"> <li>Disagreements concerning research/interactions costs: Liaison offices have unrealistic expectations, while firms are unwilling to meet the full costs of the project/interaction.</li> </ul>	(Abreu et al. 2009; Bruneel, D'Este and Salter 2010; Hughes and Kitson 2012)
	<ul style="list-style-type: none"> <li>Potential conflicts on intellectual property (IP) issues: Disagreements over economic aspects, distribution of benefits and protection of resulting IP. Disagreements over confidentiality and disclosure of research results (firms often seek to delay disclosure, while academics want to publish).</li> </ul>	(Abreu et al. 2009; Bruneel, D'Este and Salter 2010; Hughes and Kitson 2012; Muscio and Vallanti 2014; Schiller and Lee 2015)
	<ul style="list-style-type: none"> <li>Difficulty in identifying/finding partners. Firms lack information on what universities can offer them, while universities find it difficult to find innovative firms.</li> </ul>	(Abreu et al. 2009; Howells, Ramlogan and Cheng 2012; Hughes and Kitson 2012; Muscio and Vallanti 2014; Schiller and Lee 2015)
Capacity-related barriers	<ul style="list-style-type: none"> <li>Lack of capabilities in universities. Quality of research is low, lack of capabilities of professors. Universities lag behind industry. Insufficient internal resources devoted by universities to collaboration. No extra funding for collaboration. Lack of entrepreneurs/entrepreneurial mentality. Poor marketing, technical and negotiation skills. Lack of experience in dealing with firms, lack of established procedures for collaboration.</li> </ul>	(Abreu et al. 2009; Fontana, Geuna and Matt 2006; Hughes and Kitson 2012; Muscio and Vallanti 2014; Schiller and Lee 2015)
	<ul style="list-style-type: none"> <li>Lack of capabilities in firms: Lack of internal resources to manage interactions with universities. Lack of experience in dealing/interacting with universities. Firms' high personnel turnover and poor industrial strategies.</li> </ul>	(Abreu et al. 2009; Hughes and Kitson 2012; López-Martínez et al. 1994; Muscio and Vallanti 2014; Schiller and Lee 2015)
	<ul style="list-style-type: none"> <li>Lack of collaborative infrastructure. Lack of experience in UILs. University networks include few firms and vice versa. Lack of funding for further development, lack of government funding schemes.</li> </ul>	(Bruneel, D'Este and Salter 2010; Decter, Bennett and Leseure 2007; Muscio and Vallanti 2014; Schiller and Lee 2015)

Author's own elaboration.

Taking multiple perspectives, we found a few studies that incorporated the intermediaries' point of view (Decter, Bennett and Leseure 2007; Lockett, Kerr and Robinson 2008). For instance, Decter, Bennett and Leseure (2007) studied certain aspects of university-to-industry technology transfer in the UK and the US, based on a survey of university TTOs. They found that the importance given to barriers does not apparently vary across countries, with 'cultural differences' (an *orientation-related* barrier) and 'funding for further development' (a *capacity-related* barrier) being the main barriers.

Summing up, most studies on barriers to UILs have focused on developed countries and included certain barriers that form part of the *capacity-related* group, implying that this type of barrier is not exclusive to the developing world. However, we would expect capacity weaknesses to be pervasive in LACs because of the characteristics of their NSIs. Moreover, *capacity-related* barriers in both developed and developing countries lead us to consider actors' capabilities not in absolute terms, but in relation to the process of building UILs in specific contexts.

We can also conclude that the literature on barriers to UILs shows a great diversity with regard to the types of barriers, actors whose perspectives are taken into account, and the patterns of barriers in different contexts. We can, however, provide a preliminary conceptual framework in an attempt to systematise the study of such diversity.

### 3.3. Intermediaries

In [Chapter 2](#), we explained the need for doing research on two aspects about intermediaries: the boundary-spanning nature of CoEs, and the role of their international partners. In this section, we explain briefly the origins, concept and roles of intermediaries, which will then guide the empirical analysis of these phenomena.

We first present the variety of actors and structures performing intermediary roles and classify them based on previous studies. This classification recognises the intermediary nature of certain organisations and allows us to make distinctions between them. We also characterise intermediaries closely related to our study: universities, RTOs and cooperative research centres (CRCs). Given that foreign RTOs and universities have



taken part in Chilean and Peruvian CoEs, some insights about their internationalisation process are also provided.

Then, we analyse the range of intermediary roles. In this regard, the literature has revealed a very broad set of roles, which can differ across countries, regions and other contexts. Insights from this part will serve as a reference to study empirically the function of international partners in Chilean and Peruvian CoEs and to support potential explanations for our findings ([Chapter 8](#)).

### 3.3.1. The range of intermediaries: How do CoEs and international partners fit in?

The role of intermediation is not a recent phenomenon. Some authors have traced its origin back to the 17th and 18th centuries, when the so-called middlemen played some role in diffusing technologies in the agriculture, wool and textile sectors in the UK (Howells 2006). Moreover, studies on intermediaries have been part of different areas of interest such as management, technology transfer, systems of innovation, and knowledge-intensive business services – KIBS (Haas 2015; Howells 2006).

In the literature we found different terms such as ‘boundary spanners’, ‘gatekeepers’, ‘intermediate organisations’, ‘intermediaries’ and so forth. Despite the importance of developing certain conceptual distinctions, in this study we will use a general definition of an intermediary: *“an organization or body that acts an agent or broker in any aspect of the innovation process between two or more parties. Such intermediary activities include: helping to provide information about potential collaborators; brokering a transaction between two or more parties; acting as a mediator, or go-between bodies or organizations that are already collaborating; and helping find advice, funding and support for the innovation outcomes of such collaborations”* (Howells 2006: p. 720).

Given the variety of actors that might fit into this definition, some authors have classified them according to certain criteria. For instance, Mina, Connell, and Hughes (2009) and Wright et al. (2008) have distinguished between internal and external intermediaries, including universities’ TTOs in the first group, and venture capitalists in the second. Moreover, Wright et al. (2008) and Meyer (2010) have recognised the existence of intermediary structures, such as science parks and science shops. We consider *centres of excellence* (described in Section [2.3.4](#)) as a specific case of intermediary structures.

There is also a distinction between individual and organisational intermediaries. Haas (2015) has stated that gatekeepers and knowledge brokers can be analysed at the individual and organisational levels, while Khan, Lew, and Sinkovics (2015) have argued that the literature on boundary spanners has been primarily focused on individuals, often neglecting the inter-organisational level. Finally, Yusuf (2008) has classified intermediaries into four types: i) general purpose intermediaries such as universities that produce and disseminate knowledge; ii) specialised intermediaries such as TTOs in universities; iii) financial actors such as venture capitalists and angel investors, and iv) institutional intermediaries such as public agencies.

The broad definition of ‘intermediaries’ leads us to consider studies on Knowledge-Intensive Business Services (KIBS) and Specialist Knowledge Providers (SKP) (Howells 2006; Pinto et al. 2015; Tether and Tajar 2008). This particular body of literature has shown that universities sometimes fulfil the role of KIBS in peripheral regions, but in general KIBS complement universities’ functions by intermediating between them and firms (Pinto et al. 2015). Such a complex arrangement of functions shows that sometimes there is no clear dividing line between different types of intermediaries.

In an effort to present a comprehensive picture of the diversity of intermediaries, we have adapted the classification provided by Yusuf (2008) and constructed [Table 4](#) with five categories. It is not our purpose here to analyse each type of intermediary as this is beyond the scope of this study. Therefore, in the remaining part of this section we will only describe those intermediaries that might be closely related to this study, namely centres of excellence, RTOs and universities.

We begin with the ‘general purpose’ universities. Under a specific approach for developing countries, some authors have argued that universities might play intermediary roles in the process of technology transfer from foreign firms and international knowledge sources towards local firms and local innovation systems (Albuquerque et al. 2015; Qiu et al. 2017; Schiller and Lee 2015; Vaaland and Ishengoma 2016). However, this approach is not exclusive to the developing world given that an intermediary function has been found, for example, for the University of Waterloo in Canada (Bramwell and Wolfe 2008).

Previous studies, therefore, have considered universities' international connections as a means to support the local environment in which they are embedded (their home country or region). Moreover, studies on the internationalisation of universities have focused on their motivations, strategies, and international activities from the point of view of their home country (Altbach and Knight 2007; Bennell and Pearce 2003; Knight 1999; Youtie et al. 2017). From a different perspective, our study refers to the participation of foreign universities in CoEs in Latin America and their contribution to local actors – i.e. adopting a *host country* perspective.

The second group of intermediaries includes the so-called Research and Technology Organisations (RTOs), which are different from universities, KIBS and companies, despite some overlap in terms of roles (Berger and Hofer 2011; Giannopoulou et al. 2019). Even though the RTOs group is very heterogeneous, they share certain characteristics such as having significant public funding that is complemented by other sources, doing applied research and development, bridging the gap between basic science and market solutions, and delivering services to firms and other clients (Berger and Hofer 2011; Giannopoulou et al. 2019; Mina et al. 2009; Sharif and Baark 2011; Zacharewicz et al. 2017).

Like universities, the participation of RTOs in CoEs in Peru and Chile is also related to their process of internationalisation. However, this study is not focused on motivations, benefits and costs of RTOs' internationalisation, which have already been studied to some extent by others (Berger and Hofer 2011; Jonkers and Cruz-Castro 2010; Zacharewicz et al. 2017), but on the kind of activities and intermediary roles they perform in regard to their local partners in the host country.

Finally, at the inter-organisational level, we identified three intermediary structures: international joint ventures, cooperative research centres (CRCs) and knowledge integration communities (KICs). For the purpose of this study, we focus only on CRCs or CoEs (described in Section 2.3.4), which are complex boundary-spanning structures that support interactions between universities and firms (Davis and Bryant 2010; Koschatzky 2017). Because of the diversity of stakeholders and the range of activities within these centres, their leaders are required to possess skills to establish internal and external linkages by undertaking boundary-spanning functions (Davis and Bryant 2010).

*Table 4. Classification of intermediaries*

Type	Intermediaries	Sources
General purpose intermediaries	Universities	(Albuquerque et al. 2015; Bramwell and Wolfe 2008; Yusuf 2008)
	Science parks	(Chau, Gilman, and Serbanica 2017; Díez-Vial and Montoro-Sánchez 2016; Wright et al. 2008)
	Incubators	(Bergek and Norrman 2008; Chau et al. 2017; Rothaermel and Thursby 2005; Wright et al. 2008)
	Science shops	(Hellemans 2001; Meyer 2010; Tryon and Ross 2012)
	Science and technology journalists	(Meyer 2010; Murcott and Williams 2013)
Specialised intermediaries	Technology Transfer Offices Knowledge Transfer Offices Technology Licensing Offices	(Abrams, Leung, and Stevens 2009; Carlsson and Fridh 2002; Chau et al. 2017; Jefferson et al. 2017; Weckowska 2015; Wright et al. 2008; Yusuf 2008)
	Specialist Knowledge providers Knowledge Intensive Business Services	(Howells 2006; Lee and Miozzo 2019; Leiponen 2006; Pinto et al. 2015; Tether and Tajar 2008)
	Gatekeepers in firms	(Chau et al. 2017; Haas 2015; Sutz 2000; Tushman and Katz 1980)
Financial Actors	Venture Capitalists	(Wright et al. 2008; Yusuf 2008)
	Angel investors	(Paul and Whittam 2010; Wright et al. 2008; Yusuf 2008)
	Surrogate entrepreneurs	(Lundqvist 2014; Wright et al. 2008)
Institutional intermediaries (Organisations)	Public agencies (Regional Development Agencies)	(Dutrénit et al. 2012; Wright et al. 2008; Yusuf 2008)
	Research and Technology Organisations - RTOs Public research institutes Technology and Innovation Centres	(Andersen and Le Blanc 2013; Giannopoulou et al. 2019; Intarakumnerd and Goto 2018; Mina et al. 2009; Sharif and Baark 2011)
	Collective Research Centres	(Knockaert et al. 2014; Spithoven and Knockaert 2012; Wright et al. 2008)
	Industrial Associations	(Brimble and Doner 2007; Dossou-Yovo and Tremblay 2012; Kodama 2008; Sutz 2000; Watkins et al. 2015)
Inter-organisational structures	International joint ventures	(Khan et al. 2015)
	Cooperative Research Centres Centres of excellence	(Ankrah et al. 2013; Bell 1996; Bozeman and Boardman 2004; Davis and Bryant 2010; Koschatzky et al. 2015; Kroll 2016; Sinnewe et al. 2016)
	Knowledge Integration Communities (KICs)	(Acworth 2008)

Author's own elaboration.

Considering our research questions, set out in the introduction and developed in [Chapter 4](#), the empirical analysis of this study will focus on the internal organisation of CoEs to fulfil their intermediary roles. Moreover, the intermediary nature of foreign universities and RTOs allows us to analyse their roles in Chile and Peru. In the following section we develop some insights in this regard.

### 3.3.2. Intermediary roles: framing the role of international partners

Intermediary roles can be analysed in different contexts and regarding specific types of actors. In this field, Howells (2006) has undertaken a literature review and identified ten main intermediary functions ([Table 5](#)). He then compared those functions with the activities performed by 22 organisations in the UK and found that previous studies have included a rather limited set of roles such as information scanning and gathering and communication, when they actually perform more, and more complex, roles.

According to Howells (2006), the wide range of intermediary functions can be explained by two main factors, the emergence of new needs and requirements from users, and intermediaries' strategies to diversify their operations. He has also argued that intermediaries operate in complex networks that require them to build and manage complex relationships that can be labelled as 'many-to-one-to-many' or even 'many-to-many-to-many' collaborations, with short and long-term approaches. The changing nature of intermediary roles in response to changes in firms' needs has also been highlighted for RTOs in several Asian and European countries (Intarakumnerd and Goto 2018; Sharif and Baark 2011; Shiu, Wong, and Hu 2014).

The complexity and variety of roles have been highlighted by Kodama (2008) in his case study of the TAMA association, which was created to promote the generation of new technologies and products in the Metropolitan Area of Tokyo through collaborations between product-developing SMEs, universities, and large firms. Regarding TAMA's functions, this author has stated that besides UILs, inter-firm linkages are also important, especially in the phase of product creation and commercialisation.

For the agriculture sector in Latin America, Dutrénit et al. (2012) identified four intermediary roles: the identification and integration of the offer of R&D and technological solutions, the articulation of farmers' demands, the matching of demand

with an offer of technological solutions and R&D, and the management of innovation. This study found that both agency staff and small farmers highly value the articulation of farmers' demands and the matching of demand with an offer of technological solutions and R&D. However, the identification and integration of the offer of R&D and technological solutions is regarded as relatively unimportant, something which could be explained, according to these authors, by the long-term vision needed to perform this task and the short-term focus of farmers.

Dutrénit and colleagues found that intermediary roles in the agriculture sector in Mexico differ from those in developed countries such as the Netherlands. One potential explanation for such difference is the characteristics of the agricultural system in each country. For example, there is private funding for the provision of R&D, KIBS and extension services in the Netherlands (Klerkx and Leeuwis 2008), while in Mexico those activities are still financed with public resources (Dutrénit et al. 2012).

In [Table 5](#), we include the experience of the so-called Technology and Innovation Centres and RTOs. Andersen and Le Blanc (2013) have undertaken a comparative study of European Technology and Innovation Centres, based on nine functions, and found that most centres reported having performed at least seven of those functions. Mina, Connell, and Hughes (2009) have analysed the characteristics of different models of RTOs in Europe and Asia and found that they develop several intermediary roles.

Finally, we found that international joint ventures also play intermediary roles in developing countries, not necessarily by supporting UILs but by building linkages between local and global providers of MNEs. From the description provided by Khan, Lew, and Sinkovics (2015), we can conclude that the main roles of these inter-organisational bodies are focused on bridging local and global providers and on building local capabilities.

What roles have foreign universities and RTOs been performing in LACs within centres of excellence? Are they similar to the intermediary roles we have identified in this section? This study addresses these specific questions.

*Table 5. Roles of innovation intermediaries*

<b>Howells (2006)</b> Innovation intermediary functions UK	<b>Kodama (2008)</b> Activities of TAMA Association as intermediary Japan	<b>Mina et al. (2009)</b> Research and Technology Organisations Europe and Asia	<b>Andersen and Le Blanc (2013)</b> Technology Centres Europe	<b>Dutrénit et al. (2012)</b> Innovation Intermediaries Agriculture sector Mexico
<ol style="list-style-type: none"> <li>1. Foresight and diagnostics.</li> <li>2. Scanning and information processing.</li> <li>3. Knowledge processing and combination/recombination.</li> <li>4. Gatekeeping and brokering.</li> <li>5. Testing and validation.</li> <li>6. Accreditation.</li> <li>7. Validation and regulation.</li> <li>8. Protecting the results.</li> <li>9. Commercialisation.</li> <li>10. Evaluation of outcomes.</li> </ol>	<ol style="list-style-type: none"> <li>1. Information networking among members, including data bases of products, technologies and research activities.</li> <li>2. Dispatching TAMA Coordinators for assisting firms in several decisions.</li> <li>3. Supporting R&amp;D activities in several aspects.</li> <li>4. Organizing events and business matching sessions.</li> <li>5. Supporting new business creation, linking with investors, incubators, etc.</li> <li>6. Supporting member firms to recruit human resources and collaborate with universities to enable students respond to firms' needs.</li> <li>7. Operating the TAMA virtual Laboratory system.</li> <li>8. Sales promotion of product of member firms.</li> <li>9. Organizing mini TAMA meetings to promote frequent opportunities to meet other members.</li> </ol>	<ol style="list-style-type: none"> <li>1. Development and application of technological know-how.</li> <li>2. Linkages with the research base (universities, research councils and public research institutes).</li> <li>3. Linkages with firms through the provision of contract research and joint R&amp;D.</li> <li>4. Dissemination of R&amp;D results, directly via dedicated events or via universities.</li> <li>5. Brokering agreements.</li> <li>6. Patenting and commercialisation of technology. Licensing of local technologies.</li> <li>7. Facilitation of risk-sharing, support to new business creation.</li> <li>8. Management of venture capital.</li> <li>9. Screening, selection and incubation of innovative ideas.</li> <li>10. Formation of human capital at postgraduate level, and training of engineers and entrepreneurs.</li> <li>11. Participation in international standard setting.</li> </ol>	<ol style="list-style-type: none"> <li>1. Collaborative research project.</li> <li>2. Arranged joint conferences or workshops.</li> <li>3. Shared publications.</li> <li>4. Informal knowledge sharing.</li> <li>5. Participate in higher education and training.</li> <li>6. Business spin-off/start-ups.</li> <li>7. Shared patents, or another formal IP.</li> <li>8. Borrowing/lending equipment, laboratories, etc.</li> <li>9. Placement of staff.</li> </ol>	<ol style="list-style-type: none"> <li>1. Identification and integration of the offer of R&amp;D and technological solutions.</li> <li>2. Articulation of farmers' demands.</li> <li>3. Matching of demand with an offer of technological solutions and R&amp;D and network brokerage.</li> <li>4. Managing innovation.</li> </ol>

Author's own elaboration

Given the lack of clarity about the type of roles they are actually performing, the taxonomy of the previous table should not be regarded as a specific conceptual framework, but more as a set of *conceptual insights* – a term used in this chapter – that will serve as a point of reference for analysing this phenomenon. We prefer not to assume any specific type of roles as there is limited literature on the role of international partners in the context of CoEs, as argued in section 2.3.

### 3.4. Conclusions

Addressing the concerns raised in [Chapter 2](#) regarding the need for analytical frameworks ‘tailored’ to the conditions of NSIs in Latin America, this chapter has developed an integrative conceptual framework to study barriers to UILs, and has provided certain insights to frame the analysis of intermediary roles of CoEs and international partners in Chile and Peru.

The tentative conceptual framework comprises three types of barriers: *orientation-related*, *transaction-related* and *capacity-related* ones. With this framework, we advance the debate on the theoretical foundations of barriers to UILs by arguing that they stem not only from cultural differences in the science subsystem – i.e. differences between researchers in universities and in firms – but also from other considerations in universities and the business sector such as different interest and needs beyond R&D.

We have concluded that such a cultural divide can explain the barriers to UILs only partially. The distinction proposed by some authors (Dasgupta and David 1994; Meyer-Krahmer and Schmoch 1998; Sauermann and Stephan 2013) between the science community (scientists in the public sector) and the technology community (scientists in industry) seems appropriate to justify the co-existence of, and the balance between, these two spheres and to explain certain barriers to UILs under the premise that both actors perform R&D activities. Therefore, the first question that emerges from this perspective is whether such a cultural divide can be found in countries where there are limited indigenous scientific and technological capabilities and the participation of firms in R&D is also limited.



In countries with those characteristics, we argue, alongside *orientation-related* and *transaction-related* barriers, there are also aspects linked to capabilities of the actors involved in UILs. For that reason, we include ‘*capacity-related*’ barriers in our framework, which will guide our empirical analysis in [Chapter 7](#).

Turning to the field of intermediaries, we have provided certain insights into this broad and complex domain, which will serve as a reference to understand how CoEs have been working in Chile and Peru and what roles have been performed by international partners. We presented a classification of intermediaries that provides some insights to distinguish CoEs from other intermediaries. How the specific structures called CoEs have been fulfilling boundary-spanning roles in Chile and Peru will be analysed empirically in [Chapter 6](#).

At this point, it is important to mention that this chapter does not attempt to set out a conceptual framework for characterising the organisation and practices of Chilean and Peruvian CoEs. Such a framework is instead developed later in [Chapter 6](#) because the study of these aspects has been approached in a more inductive manner. As described in [Chapter 1](#), this thesis focused initially on the barriers to UILs and the roles of international partners, while the characterisation of centres only came up later on as a necessary intermediate step for studying those phenomena.

The second dimension regarding intermediaries refers to the role of foreign RTOs and universities participating in CoEs. As explained in Section 2.3.5, CoE programmes in Chile and Peru have promoted the involvement of international actors to allow local actors to access new knowledge and technology as well as global innovation networks. In this regard, most studies on the internationalisation process of RTOs and universities have been focused on the motivations for and benefits from international connections under the perspective of their *home* country. Complementing those studies, we analyse their roles from a *host* country perspective ([Chapter 8](#)), something which has been studied to a very limited extent up to now.

## CHAPTER 4. Methodological approach: comparative case study of CoEs

### 4.1. Introduction

Previous chapters have highlighted certain gaps in the literature on university-industry linkages (UILs) and the importance of addressing them in the Latin American context. Moreover, we have argued that *one-side-focused* studies can provide only a partial understanding of the dynamics of these interactions. A methodological approach designed to integrate the perspective of multiple actors is useful not only to generate evidence on how linkages work, but also to gain better insights for policy recommendations, particularly for complex schemes such as *centres of excellence* (CoEs).

These centres, as defined in Section 2.3.4, are recent and contemporary phenomena in Latin America, something which may explain why we have found so few studies focused on these experiences.<sup>8</sup> CoEs have been mainly implemented – and studied – in developed countries, which have different characteristics compared to developing ones in terms of their NSIs. These differences led us to question whether centres and the interactions within them in Latin American countries (LACs) exhibit similar patterns to those found in other contexts.

According to the literature on NSI and UILs ([Chapter 2](#)), barriers to UILs and international connections would show different patterns in different contexts. For that reason, we have developed a tentative conceptual framework for barriers to UILs, identified several types of intermediaries, and presented some insights about their roles ([Chapter 3](#)).

Starting from our research questions, this chapter seeks to define the scope of this study and delineate its potential contributions. Then, we describe the research design that includes the following aspects: i) the reasons why a comparative case study approach is suitable and advisable; ii) how we selected our cases; iii) a description and explanation of the process of data collection and; iv) how the data gathered has been processed and analysed. At the end, we present some conclusions and possible limitations of this study.

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<sup>8</sup> In section 2.3.5, we highlighted that there seem to have been just two previous studies regarding CoEs, both about Chilean experiences, but none related to the questions of this study.

#### 4.2. Research questions: delineating potential contributions

Literature on NSI has highlighted the importance of UILs and the relevance of understanding this phenomenon in specific contexts. Previous work on UILs in LACs has been mostly focused on the motivations, channels and expected benefits of these interactions, leaving CoEs, barriers to UILs and the intermediary roles of international partners relatively understudied.

Regarding CoEs, we could identify only three recent experiences in the region: Chile launched a programme in 2010, Brazil in 2012, and Peru in 2014. Moreover, programmes aimed at attracting international partners, which is one of the main features in the Peruvian and Chilean experiences, are new to the region. According to Klerkx and Guimón (2017), the Chilean programme is the first of its kind in Latin America.

Consequently, the main objective of this study is to understand this recent phenomenon in the context of two Latin American countries and in regard to three specific aspects: UILs developed with CoEs, the barriers to UILs, and the roles of international partners. The general research question of this study can be stated as follows:

*How do universities, firms and international actors build linkages among themselves within Centres of Excellence?*

In order to approach this broad inquiry, we constructed the following specific questions:

- ***How have CoEs and linkages within them been working in two different countries?***

This question aims at understanding what CoEs actually are in the Chilean and Peruvian contexts, based on how interactions have been working within them, and why they exhibit particular patterns. We expect to provide a comprehensive understanding of how these initiatives have been developed and, in doing so, be able to compare CoEs in Chile and Peru.

- ***What are the main barriers to UILs within CoEs?***

The purpose of this question is to generate evidence on whether actors involved in CoEs have encountered the three types of barriers included in our preliminary

conceptual framework: orientation-related, transaction-related, and capacity-related barriers. By addressing this question, we may be able to explain, for instance, whether actors in Chile and Peru are dealing with similar barriers to those found in developed and Asian countries.

- ***What roles have international partners been performing in the context of CoEs?***

With this question, we expect to understand whether international actors involved in CoEs have been performing intermediary roles at the national and international levels. If so, we should be able to explain how they have been performing those roles.

By addressing these three research questions, we can delineate the potential contributions of this study. A first contribution is to understand and compare CoEs in two Latin American countries, particularly in terms of their organisation to support UILs and the interactions generated within them. This is relevant because centres will be analysed in countries with limited scientific and technological capabilities and relatively low participation of the private sector in R&D investment and activities. Understanding CoEs in Chile and Peru is also relevant to contextualise the study of barriers to UILs and the roles of international partners.

The second potential contribution refers to the analysis of barriers to UILs. This study aims at highlighting differences and similarities to the barriers found in other contexts and elaborating some explanations for the specific constellations derived from the empirical analysis. Finally, a third potential contribution relates to the participation of international organisations in CoEs in Chile and Peru. These international actors have been mainly foreign universities and RTOs, which have been identified as organizations fulfilling intermediary roles in both developed and developing countries. This study is aimed at explaining whether these international partners are carrying out a significant intermediary role in countries with weak NSIs (i.e. adopting a *host* country perspective).

#### 4.3. Research design: dealing with a qualitative comparative case study

This study is framed within the experience of Peru and Chile in fostering innovation through the promotion of linkages between universities, industry and international partners under the umbrella of the so-called CoEs.

Alongside national boundaries, literature on innovation systems has recognised other contexts for UILs such as sectors, regions, and technology fields. Moreover, some authors have considered cooperative research centres (CRCs) as *channels* of interaction instead of *contexts* within which interactions are performed (e.g. D’Este and Patel 2007; Hughes and Kitson 2012; Perkmann and Walsh 2007). In this regard, we have argued that these centres might be configured as *contexts* for UILs (Section 2.3.4), where different partners may interact with each other through several channels.

Nonetheless, this is just part of the explanation about what a CoE actually is. It means that besides the identification of centres elements (actors and activities) based on previous experiences in developed countries, it is important to understand, through our empirical data, how interactions within CoEs have been working in the developing world. Therefore, the first step in our inquiry is to develop a full understanding of the CoEs (i.e. the context for UILs) in order to then study the barriers to UILs and the role of international partners. This step is important because, according to Nelson (2016), in social sciences and particularly in innovation studies, context may play an important role in the research design and the selection of research methods.

With these considerations in mind, we now explain the reasons for having chosen a qualitative approach and a multiple-case study strategy. According to some authors, one criterion to know whether a research project can adopt a qualitative approach is the type of questions it addresses (Creswell 2007; Eisenhardt and Graebner 2007; Verschuren 2003; Yin 2013). The research questions set out in Section 4.2 are of the “how”, “what” and “why” type as they intend to obtain a holistic understanding of certain phenomena that have previously been little studied in LACs.

According to Eisenhardt and Graebner (2007), a qualitative approach, in particular a case study strategy, can be carried out when: a phenomenon is important for certain reasons, there is limited evidence about it, and the existing analytical tools are not suitable for explaining it. In [Chapter 2](#) and [Chapter 3](#), we have argued, based on the extant literature, that understanding the subject matter of this study is relevant for both academic and policy reasons, while the existing frameworks to analyse it have been mostly applied to the developed world, with little basis for providing suitable insights for LACs.

Moreover, one characteristic of CoEs is that they are contemporary phenomena in the LA context. Centres have been implemented in Chile only since 2010 and in Peru since 2014, while public support and the process of building interactions are currently still in place. This phenomenon involves a limited number of initiatives: three in Peru (one without public funding) and seven in Chile, something which makes it difficult if not impossible to select a random sample and to use quantitative techniques.

Given these features, a case study approach seems to be the most suitable. Yin (2014) has stated that a case study is an empirical inquiry that investigates a contemporary phenomenon within its real-world context, where context and phenomenon are not always distinguishable. In order to have a better understanding of the subject matter of this work and to draw sound conclusions, we developed a comparative case study between centres in Chile and Peru.

Regarding other features, a case study approach relies on multiple sources of information and benefits from prior developments of theoretical propositions to guide the process of data collection and analysis (Eisenhardt 1989; Yin 2013). These propositions can be derived from the literature, a theory or researchers' experience (Almutairi, Gardner, and McCarthy 2014). Even though having previous constructs is important to guide researchers, they have to remain tentative, as recommended by Eisenhardt (1989).

For that reason, this study has developed a tentative conceptual framework with a set of concepts relating to barriers to UILs (Section 3.2.2) and has identified certain patterns of intermediary roles (Section 3.3.2). These elements have guided the refinement of the

research questions and the process of data collection. They have also been useful for the data analysis by allowing the use of the so-called pattern-matching technique, which is recommended by Yin (2014). Therefore, our approach is not purely inductive because we depart from some ideas and concepts developed mainly from previous studies. Thus, we can call this an inductive-deductive study, following some authors who have used a similar approach (Gioia, Corley and Hamilton 2013; Horvat, Dreher and Som 2018; Mayring 2000). Later on, we explain how this approach is applied in this study.

In summary, the case study strategy is a holistic approach towards a selected number of CoEs (our cases), involving an iterative and flexible process of inquiry. We included the following steps to address our research questions: selection of cases, data collection, and data processing and analysis.

#### 4.3.1. Selection of cases

For the empirical analysis, each Centre of Excellence (CoE), as a mechanism to organise and develop a set of UILs, is the unit of analysis. In that vein, the first objective of this study is to provide evidence on how CoEs are organised to facilitate UILs and what types of interaction channels are developed within these centres. Then, we analyse two specific aspects relating to the UILs being developed within CoEs: barriers to UILs and the role performed by international partners.

This is a comparative analysis between CoEs in Chile and Peru. These countries have been chosen because they have launched similar funding programmes in terms of the type of actors involved and funding conditions. A multiple-case study has the advantage of providing the basis to arrive at stronger conclusions as it minimises the risk of building spurious explanations based on findings that may be specific to one particular case. As stated by some authors (Eisenhardt and Graebner 2007; Ridder 2017; Yin 2013), the rationale for using a multi-case study approach rests on the strength of the replication logic. In this study, we adopt the so-called literal replication, with cases that were selected to predict similar results (Ridder 2017; Zach 2006).

Following Eisenhardt (1989) and Yin (2014), the selection of cases was based on theoretical reasons rather than on statistical random sampling. According to previous studies, UILs show different patterns in different contexts such as countries, sectors and scientific fields. For that reason, and following the literal replication logic, we selected centres based broadly on either their scientific or their sectoral focus. As a result, our cases have similar characteristics in terms of their scientific focus (biotechnology and chemistry) and sectoral target (agriculture and food industry). In the fieldwork, the Peruvian case was approached first and analysed in a preliminary manner, while the Chilean case was carried out subsequently.

The CoEs included in this thesis are:

- In Peru: The *Centro de Innovación del Cacao* - CIC (Cocoa Innovation Centre), the main focus of which is the agriculture sector, particularly the production and processing of cocoa, as well as the food industry based on chocolate and by-products of cocoa. Its activities relate to biotechnology and chemical analysis.
- In Chile: *Fraunhofer Chile Research - Centre for Systems Biotechnology* (FCR-CSB), the main focus of which is related to biotechnology applied to agriculture and the food industry, aquaculture, and sustainability.

Selecting similar cases in terms of scientific fields and related industries may bring some limitations to the scope of the conclusions with regard to other scientific fields and industries. To address this concern, albeit to a limited extent, we have included interviews with people involved in other CoEs in each country. Moreover, having used broad criteria to select cases, we should still be able to distinguish certain differences in the sectors served by each studied case: the Chilean centre focuses on the fresh fruit sector, winery and sustainability, while the focus of the Peruvian centre is specific to the cocoa value chain.

#### 4.3.2. Data collection and data sources

The process of gathering information was based mainly on in-depth interviews with a range of actors around each CoE. Given the contemporary nature of centres in Peru and Chile,



there are few other available sources of information. For instance, there are not evaluations of these programmes, or they are not publicly available yet.

We used semi-structured interviews with three main bodies of questions (the interview protocol can be found in [Appendix B](#)). The first group starts with a few general questions about the interviewee's experiences, the type of activities the centre performs and how they are developed. The second part refers to barriers to UILs and is the most extensive because it includes not only questions on different barriers but also about additional factors that could have affected the development of UILs.

The third part of the interview guide has questions about the roles of international partners in supporting interactions between local actors and connecting them with global networks. In order to understand the position of international partners, we included some questions about their difficulties in working in the host country and how their relationships with local universities have been working.

The interview program was organized in terms of the following stages, although not always consecutively: i) preparation of the interview guide (protocol), ii) the process of identifying suitable interviewees, and iii) the carrying out of interviews.

### **Preparation for interviews**

The phase of preparing interviews included the following actions:

- Characterization of the barriers to UILs, the result of which was a tentative conceptual framework.
- Characterization of intermediary organizations and their roles based on the literature.
- Analysis of administrative data relating to CoE programmes and proposals, reports from funding agencies, institutional web sites, and so on.
- Elaboration of the interview guide (protocol).
- Ethical approval by the relevant authority in the University of Sussex. The project was approved in March 2018.
- Piloting of the interview guide. In this phase, we had two interviewees. One of them was a civil servant of the Peruvian funding agency. The second person was a senior researcher

who led applications in two calls for CoEs in Peru. The process of revising the interview guide continued even during the early parts of the interview phase.

### **Identification of interviewees**

In this phase, we followed various different approaches. At the very beginning of the process, we had exploratory discussions and communications with civil servants from funding agencies and general managers of some CoEs. The first contact with people in Peru was in August 2017, when some civil servants and general managers of two CoEs expressed interest in participating in this study.

The first approach to Chilean actors was made in January 2018 by contacting a senior staff member of the Fraunhofer Centre for Biotechnology Systems (FCR-CBS), who expressed interest in participating. Moreover, in an event organised by the Asian-Pacific Economic Cooperation Forum (APEC) in June 2018, two people involved in other CoEs in Chile were contacted.

In order to identify potential interviewees, before and during fieldwork, we carried out the following steps:

- We requested civil servants in charge of the CoE programmes to participate in our study as interviewees and asked them for their help in identifying managers of CoEs and other relevant actors.
- Identification – in parallel – of managers of each CoE and representatives of their main partners (firms, universities, and international organisations), using administrative and public data (reports, web sites, previous contacts, and social networks).
- Identification of new interviewees from the first contacts (i.e. a snowball technique).

### **Interviews development**

Fieldwork started in April 2018 and the last interview was completed in October the same year. Most interviews were carried out in person, with some exceptions that required Skype or phone calls. To start communications with potential interviewees, a first ‘formal’ invitation to participate was sent by email. If a positive answer was given, a second email was sent providing detailed information about the project and a consent form.

Table 6 shows the main outcomes of fieldwork activities. In total, we conducted 48 interviews: 22 in Peru, 19 in Chile and seven in Germany. Here, we have to clarify that most, but not all, interviewees are directly connected to our cases. For example, in Peru 18 out of 22 participants are directly linked to the CIC, while the remaining four are related to other CoEs. In Chile, 15 are involved in the FCR-CSB while four are linked to other centres.

In Peru we were able to interview three civil servants who have been involved in the CoE programme and have information about our case, while in Chile we only could interview one. In both countries, we interviewed people in charge of managing CoEs, their general managers and some senior staff members. Therefore, we were able to capture the perspective both of people who have designed and supervised CoEs from the government side and of people who have been operating them.

*Table 6. Fieldwork outcomes for each CoE*

<b>Fraunhofer Chile Research - Centre for Biotechnology Systems</b>  <b>FCR-CBS</b>	<b>Innovation Centre for Cocoa</b>  <b>CIC</b>
<ul style="list-style-type: none"> <li>➤ 19 interviews</li> <li>➤ 15 interviews linked to the FCR-CBS:               <ul style="list-style-type: none"> <li>○ 1 civil servant</li> <li>○ 2 CEOs, the former and the current</li> <li>○ 4 centre staff members</li> <li>○ 3 staff members of universities' internal units</li> <li>○ 1 external intermediary</li> <li>○ 4 universities' researchers</li> </ul> </li> <li>➤ 4 actors from two other CoEs: 2 CEOs and 2 university's intermediaries.</li> </ul>	<ul style="list-style-type: none"> <li>➤ 22 interviews</li> <li>➤ 18 interviews linked to the CIC:               <ul style="list-style-type: none"> <li>○ 3 civil servants</li> <li>○ The current CEO</li> <li>○ 4 industrial actors</li> <li>○ 3 staff members of universities' internal units</li> <li>○ 1 external intermediary</li> <li>○ 5 universities' researchers</li> <li>○ 1 interview to two researchers of the international partner.</li> </ul> </li> <li>➤ 4 actors from two other CoEs, one CEO and 3 academics.</li> </ul>
<ul style="list-style-type: none"> <li>➤ Average interview duration: 01:09</li> <li>➤ Average waiting time to conduct an interview: 16 days</li> </ul>	<ul style="list-style-type: none"> <li>➤ Average interview duration: 01:05</li> <li>➤ Average waiting time to conduct an interview: 18 days</li> </ul>

Author's own elaboration.

On the university side, we had two types of actors, academics and staff members of universities' internal units. We interviewed five university researchers in Peru and four in Chile. Moreover, by internal units we refer to any actor inside universities that played a role

in connecting partners, such as people working for technology transfer offices, innovation offices or pro vice-chancellors of research. The same number of interviews came from universities' internal units in both countries.

On the firm side, we were able to interview four actors involved in the cocoa sector and the chocolate industry in Peru. In Chile it was not possible to contact firms because of confidentiality issues. For that reason, in the Chilean case we had to search for people with a perspective close to that of firms in the CoE environment. As a result, we interviewed people working for the centre in developing linkages with firms directly. However, having firms' direct perspective would have been helpful and, therefore, this omission could be a potentially significant limitation of the study.

For each case, we interviewed one external intermediary, whose organisations performed a bridging role between different partners, particularly in the process of setting up the CoEs. We identified these intermediaries through a snowball technique as they were mentioned by some interviewees as important actors.

Field work activities were extended to Germany because actors from this country have been actively involved in CoEs in both countries. In Chile they are taking part in two CoEs, while in Peru they took part in CoE proposals that did not receive public funding. In Germany, we interviewed seven people with experience in the process of internationalisation of RTOs and universities and people with specific connections with LACs. All interviewees are knowledgeable people, and three of them have been directly involved in the promotion of partnerships of German organisations with Chilean and Peruvian actors.

As can be observed, we conducted a substantial number of interviews with people coming from different backgrounds, who brought their own perspective, priorities and interests. Moreover, most of them are relatively high-profile and knowledgeable people such as managers, head of units, senior researchers and even university pro vice-chancellors. Therefore, following Eisenhardt and Graebner (2007), we can argue that risks of bias in the information reported by interviewees should not represent a serious problem for this study.

Finally, during fieldwork, we took notes and made a very preliminary analysis based on them, following the recommendation of Eisenhardt (1989). Therefore, we were able to identify certain similarities and differences between interviewees' statements and learn from new and interesting issues emerging from the interviews.

#### 4.3.3. Data processing and analysis

During and after fieldwork, transcription and translation of interviews were carried out. Most interviews were conducted in Spanish and a few in English. Because this is an inductive-deductive study, it is important to maintain the data collected as precisely as possible. In this regard, translation could introduce a source of bias into the analysis. In order to minimise this risk, we were very careful in considering cultural aspects and typical expressions in each country during the translation phase, something which was feasible because I come from Peru and have lived in Chile for two years.

The process of coding was done using NVIVO, a software tool for qualitative data analysis. The process involved the following steps: i) the coding of four key interviews from each country in order to identify the main themes, the result of which was a list of around 190 codes; ii) a revision of the first list of codes and themes; this included the organisation, reorganisation, re-coding, and merging of codes, which resulted in 10 themes and 43 codes; and iii) the application of the resulting list of themes and codes to the remaining interviews, identifying new themes, reorganising codes and re-coding when necessary.

NVIVO was used only to organise the empirical data in terms of themes and sub-themes because of the software's ability to manage the large amount of information processed. Even though this software contains several commands for coding automatically and analysing data, we did not use these options. Instead, the data analysis was carried out manually alongside the coding process by making notes and identifying relationships between codes. The second stage of analysis involved the elaboration of memos relating to each code, looking for similarities and differences between interviewees' perspectives.

In order to enhance the internal validity of the study, we used the technique of 'pattern-matching' by comparing concepts derived from the conceptual framework with empirically-

found patterns, as suggested by Yin (2013) and explained in detail by Almutairi, Gardner and McCarthy (2014). The process of iteration between data collected and our propositions made this study an inductive-deductive one.

Under this approach, the first step was to develop our preliminary conceptual framework for analysing barriers to UILs and deriving analytical insights about intermediary roles, while later on we developed a conceptual framework to analyse CoEs as cooperative research centres (CRCs), as explained earlier. From this work, we built the following propositions:

- 1) CoEs in Chile and Peru are boundary-spanning partnerships which have been configured as contexts for UILs and differ from other policy instruments.
- 2) Barriers to UILs in the context of CoEs are not necessarily situated on the divide between two communities within the science system, but on the divide between two subsystems, the university and the business ones.
- 2) Barriers to UILs in the context of CoEs not only encompass orientation-related and transaction-related barriers, but also capacity-related barriers.
- 4) International partners of CoEs fulfil limited intermediary roles regarding local actors in developing countries, while the roles that they do fulfil show certain particularities.

To analyse this propositions empirically, we take into consideration the patterns<sup>9</sup> identified in the literature and set out in [Table 3](#) and [Table 5](#) as well as Section 6.4.

The second step was to code and analyse the data collected by developing categories based around our research questions. This phase started with the organisation of data into themes and codes and the elaboration of memos, and continued by writing down the interpretation of our results, highlighting the patterns we found. And, the third step was to compare the empirically found patterns with the those derived from our conceptual framework.

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<sup>9</sup> The common meaning of the term *pattern* is: “a particular way in which something is done or organized, or in which something happens” (Cambridge Dictionary). In the field of case study research, Almutairi, Gardner, and McCarthy (2014: p. 240) have stated that the term *pattern* is understood as “an arrangement of occurrences, incidents, behavioral actions, or the outcomes of interventions that are apparent in the raw data.”

#### 4.4. Summary and further considerations (including possible limitations)

In this chapter, we have described our research design, understood as the logical connection between the research questions, data collection, data analysis and conclusions (Yin 2013). Our research design also rests upon other pieces of work outlined in previous chapters. The first is the preliminary conceptual framework derived from the extant literature, which was fundamental for refining our research questions, preparing the data collection instruments and analysing the empirical data. The second essential element supporting our research enquiry is the context of the phenomena being studied. In this respect, we describe the Peruvian and Chilean national systems of innovation and CoE programmes, which frames our study of CoEs (see [Chapter 5](#)).

Turning to the research design, our first specific question is directly linked to understanding the CoEs under study. Using empirical data, we will describe our cases and should be able to explain what CoEs actually are, how interactions have been working within them and why they reveal certain patterns. This analysis will include a comparison between CoEs in Chile and Peru, and between these and similar initiatives in developed countries (see [Chapter 6](#)).

Addressing the second specific question, we will study barriers to UILs and how different they may be from the barriers found in other contexts such as developed and Asian countries. This will encompass the identification of different constellations of barriers, the emergence of new constellations, and the explanation of why such new configurations exist (see [Chapter 7](#)). And, the third specific question refers to the understanding of the roles performed by international partners ([Chapter 8](#)).

Because of the characteristics of CoEs and our research questions, we use a comparative case study approach, which allows us to develop a holistic perspective of this contemporary phenomenon. Data collection was based mainly on in-depth, semi-structured interviews with several actors from each case as well as additional interviews with people linked to other CoEs. Therefore, this study has benefited from the perspective of actors coming from a number of different backgrounds including academia, government, international partners, firms and staff from the centres.

The collected data was processed using the software called NVIVO. Our analysis is based on an inductive-deductive approach with an enriching interactive process between our empirical data and the preliminary conceptual framework. We support our analysis with the pattern-matching technique.

Finally, this study faces two main limitations with regard to sources of information. First, administrative data about CoEs was quite limited, with the proposals for CoEs, monitoring and evaluation reports having been almost impossible to access. The absence of this kind of information restricted possibilities for triangulation of information. The effect was mitigated by integrating the perceptions of several types of actors involved in CoEs.

The second limitation refers to the potential source of bias given by not having interviews with business actors in Chile. This may cause some bias in our understanding of how firms conceive UILs, barriers to UILs and the role of international partners in the context of CoEs. In order to deal with this problem, we were able to interview staff members of the centres working directly with firms, although this does not eliminate the absence of information.

Adding to these considerations, the following chapter is devoted to contextualising the empirical analysis of CoEs in Chile and Peru. This includes a description of their NSIs and CoE programmes.



## CHAPTER 5. Contextualising the study: Centres of Excellence programmes in Chile and Peru

### 5.1. Introduction

In this study, we have argued that depending on the context, innovation and university-industry linkages (UILs) may show different patterns. In this regard, we found that centres of excellence (CoEs), as defined in Section 2.3.4, have been promoted and studied mainly in developed countries, where they have brought significant changes in the way interactions between academia and industry are organised and performed.

Certain Latin American countries (LACs) have lately implemented CoE programmes but evidence about them is still relatively scarce. As mentioned in Section 2.4, generating evidence on how CoEs have been working and how barriers to UILs have been configured, seems to be valuable and feasible. Following Lundvall et al. (2009), who recommended undertaking comparisons between countries of the same ‘family’ (Latin America in this case), this chapter briefly describes the Chilean and Peruvian NSIs and their experiences with regard to CoEs.

We describe the public programmes promoting CoEs, their objectives and main characteristics. However, a deep analysis of centres’ internal organisation will form part of the empirical study in the subsequent chapters.

### 5.2. Peruvian and Chilean national systems of innovation: contexts for CoEs

As described in Section 2.2.2, LACs show particular characteristics in terms of their NSIs, especially relating to the low scientific and technological capabilities in both universities and firms, a lack of experience in linking these two worlds, and the low level of investment by firms in R&D.

These features are shared by two countries that have exhibited similar advances and challenges in certain fields. Chile and Peru have had similar trajectories in terms of macro-economic performance and face similar challenges regarding science, technology and innovation (STI) aspects. On the one hand, after years of economic crisis (1970s-1980s) and

a subsequent period of structural reforms and stabilization in the 1990s, Peru experienced rapid economic growth that averaged over 5% annually for at least 15 years, matching the figure of other middle-income countries such as Chile, Malaysia, and Taiwan (OECD 2015; United Nations 2011; World Bank 2015). The main drivers of this phenomenon have been macroeconomic and political stability and external factors such as high international commodity prices.

However, the Peruvian economy still faces challenges to make growth sustainable in the medium and long term and to avoid what is often called ‘the middle-income trap’<sup>10</sup>. These challenges refer to the low productivity growth, large inequalities, poor diversification of the economy, and a large informal sector with low labour productivity (OECD 2015; World Bank 2015). Furthermore, the macro-economic performance in Peru has not been mirrored by investment in promoting innovation capacities and competitiveness – i.e. human resources, entrepreneurship and institutions (United Nations 2011).

On the other hand, the macroeconomic reforms in Chile began in the 1980s and led to an impressive economic growth rate in the subsequent decades. However, the country still lags behind most OECD countries in aspects related to STI (OECD 2014). According to a recent report (OECD 2016), despite its positive macro-economic performance, Chile still faces certain challenges such as a disarticulated innovation system, limited social mobility and high inequality, which prevent an important proportion of the population from participating in innovation activities.

Regarding NSIs in Latin America, previous work has highlighted that they still exhibit certain weaknesses (Alcorta and Peres 1998; Arocena and Sutz 2000; Crespi et al. 2014). The Chilean and Peruvian systems do not seem to be an exception. In order to understand a little more about these two NSIs, we constructed [Table 7](#) including some indicators that have been used by Freeman (1995), Nelson (1993) and Viotti (2002) in their comparative

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<sup>10</sup> The ‘middle-income trap’ is understood as “an extensive period of middle-income limbo” in contrast to earlier periods of economic growth. Countries in this stage face particular challenges: the need for institution-intensive reforms to increase productivity (education and innovation) and political obstacles to undertaking those institutional reforms (Doner and Schneider 2016).

studies as well as other indicators that capture related information. At this point, we would like to clarify that this chapter is not intended to produce a thorough comparison of the two systems, which would be beyond the scope of this project, but to give a picture of the broader context within which CoEs have been implemented.

In Peru, the total expenditure on R&D in 2016 reached 0.12% of its GDP, far below the average of Latin America (0.67% of GDP). In terms of outputs, this country reported 1,163 patent applications in total (by residents plus non-residents), which represents 1.8% of Latin America (LA) figures, and 1,636 publications in SCI journals, which is 1.6% of the scientific production of the region (See [Table 7](#)).

Regarding additional indicators, high-technology exports of Peru in 2016 represented only 4.2% of its total manufactured exports, and its Index of Technological Sophistication was 1.53 in 2007, both indicators being far below the average level reached by LA. In terms of education and human resources, the country achieved 94.4% literacy among the adult population in 2015, the gross enrolment ratio in tertiary education reached 43% in 2012, and the number of researchers per thousand of labour force was 0.22 in 2014.

Moreover, according to the Peruvian I National Census of Research and Development in Research Institutions – 2015, only 25% of research centres have links with industry, pursuing several objectives and through different channels. For instance, 45.5% of public research institutions that interacted with firms did so through conferences, congresses, seminars and training activities, while only 34.5% aimed at developing R&D projects and 28.3% at delivering technical assistance (CONCYTEC, 2016).

Compared to Peru, Chile performs better in all the indicators while, considering LA more widely, it outperforms the region in terms of some indicators but lags behind in others. Chile outperforms the region in terms of human resources for R&D (researchers per thousands of labour force), but lags behind regarding R&D investment, high-tech exports and technological sophistication. Regarding university-industry collaboration, according to the Innovation Survey of Chilean Firms (2013-2014), only 13.4% of innovative firms cooperated

with other actors in their innovation activities, and just 22.6% of them collaborate with universities or other higher education organisations (Ministerio de Economía 2016).

*Table 7: Indicators of NSI in Peru, Chile and Latin America*

Indicator	Unit	Peru	Chile	LAC
R&D/GDP* (2016)	%	0.12	0.36	0.67
Patent applications* (2016)	N	1,163	2,907	63,825
Scientific publications (LAC share)* (2016)	%	1.64	10.50	100.00
High-tech exports/Total of manufactured exports** (2016)	%	4.2	6.9	12.1
Index of technological sophistication** (2007)	Index	1.53	1.58	2.16
Adult literacy rate, population 15+ years, both sexes** (2015)	%	94.4	96.6	—
Gross enrolment ratio, tertiary** (2013)	%	43 (2012)***	83.82	44.51
Researchers per thousand of labour force* (2014)	N	0.22	1.44	1.3

Sources: \* RICYT, \*\* The World Bank, \*\*\* OECD (2015)

Author's own elaboration.

As we can observe at this point, even though Peru and Chile differ with regard to some indicators, they still face similar challenges regarding certain aspects of their NSIs. For that reason, governments in both countries have been taking measures to overcome that situation by promoting, for example, UILs and innovation in firms, but those measures are still relatively limited.

In Peru, there are at least three funding agencies promoting UILs through different instruments. For example, the National Council for Science, Technology and Innovation (CONCYTEC in the Spanish acronym) launched a Special Programme of Technology Transfer and Extension (2016) to strengthen universities' capabilities in technology transfer, and it manages the R&D Tax Incentive Law, which promotes linkages between universities and industry. Another initiative of CONCYTEC to strengthen linkages between universities, firms and other actors is the Centres of Excellence programme, the main object of this study.

On the Chilean side, the Production Development Corporation (CORFO in the Spanish acronym), the main funding agency for innovation, has put in place several instruments to foster linkages between research organisations and firms. We can mention, for instance,

the Technology and Licensing Offices programme for universities, the R&D tax incentive programme, and collaborative innovation projects, all of them alongside the Centres of Excellence programme.

### 5.3. Centres of excellence: What do the funding programmes look like?

The CoE programme in Peru was launched in 2014, when the Peruvian Government created the Fund for Innovation, Science and Technology (FOMITEC in the Spanish acronym). According to the regulations of the second call, a centre of excellence *“constitutes a strategic alliance formed by Peruvian renowned research entities, international research centers of excellence and Peruvian companies (...) which must be formed by a legal entity or sign and register a consortium agreement in the context of the Peruvian Legislation, which expresses long-term collaboration commitments accepted by its members in order to become a CoE of local, regional or world reference.”* (FONDECYT 2015: p. 4).

In Chile the programme is called “Attraction of International Centres of Excellence” and its objective is to set up international centres of excellence in Chile in order to perform R&D, technology transfer and commercialisation activities in forefront areas of technology, and to strengthen national capacities (Innova Chile 2012: p. 8). The second call stated that centres must include the participation of an international organisation and at least one national actor with R&D capabilities as a *co-executing partner* (Innova Chile 2012: p. 11).

In those terms, the CoE programmes in Chile and Peru seem to be similar to each other because they require the existence of an alliance between international and national partners. International organisations attracted by the Chilean programme are aimed at forging alliances not only with local universities but also with firms, something which has been highlighted by Klerkx and Guimón (2017) in their study of the design and implementation of the Chilean programme.

Table 8 summarises the main characteristics of CoE programmes in both countries. We can see that they have **similar objectives** such as performing R&D, technology transfer and commercialisations activities as well as pursuing capability-building goals.

Table 8. Characteristics of CoE programmes in Chile and Peru

Characteristics	Chile (Innova Chile 2012)	Peru (FONDECYT 2015)
Objectives	<p>To set up international CoEs to perform R&amp;D, technology transfer, and commercialisation, in forefront technology areas, and strengthen national capabilities of R&amp;D.</p> <ul style="list-style-type: none"> <li>• To contribute to the international competitiveness of the national economy.</li> <li>• To establish international networks.</li> <li>• To promote the generation of scientific and technological capabilities and infrastructure, through national and international alliances.</li> <li>• To contribute to the increase of productivity and competitiveness in firms as well as entrepreneurship.</li> <li>• To implement extension and training programmes.</li> <li>• To contribute to the development of technology-based industry.</li> </ul>	<p>To generate solutions to concrete problems of strategic production sectors by developing R&amp;D, promoting effective technology transfer and commercialization of the results.</p> <ul style="list-style-type: none"> <li>• To contribute to the competitiveness of the Country.</li> <li>• To establish national and international cooperative networks.</li> <li>• To contribute to production diversification and entrepreneurship.</li> <li>• To contribute to the training of highly qualified human capital scientific and technology abilities.</li> </ul>
Expected impacts	<ul style="list-style-type: none"> <li>• Faster access to new technology and knowledge sources.</li> <li>• Direct creation of new job opportunities for highly qualified professionals.</li> <li>• Generation of a critical mass of highly specialised personnel, advanced infrastructure of S&amp;T, networks and competitive institutions for STI.</li> <li>• Contribution to strengthening technology transfer culture within universities and national R&amp;D centres.</li> <li>• Development of entrepreneurship based on R&amp;D.</li> <li>• Firms' productivity increase through knowledge transfer.</li> <li>• Increased competitiveness of the country and its regions through innovation.</li> <li>• Contribution to setting up Chile as an innovation and entrepreneurship hub in the region.</li> </ul>	<ul style="list-style-type: none"> <li>• Access to new technologies and knowledge sources.</li> <li>• Creation of new working opportunities for highly qualified professionals.</li> <li>• Highly specialized critical mass of trained personnel, advance infrastructure in S&amp;T, networks and competitive institutions for STI.</li> <li>• Contribution to strengthening technology transfer in universities and national R&amp;D centres.</li> <li>• Development of entrepreneurship based on R&amp;D.</li> <li>• Increased competitiveness of the country and its regions, based on innovation.</li> <li>• Development of technology-based industries.</li> <li>• Positioning Peru internationally as a technology production centre.</li> </ul>
Parties	<ul style="list-style-type: none"> <li>• International Partners</li> <li>• Local research and technology organisations (<i>co-executing partners</i>)</li> <li>• Firms (not mandatory)</li> </ul>	<ul style="list-style-type: none"> <li>• International partners</li> <li>• Local research organisations such as universities.</li> <li>• Local firms</li> </ul>
Funding conditions	Core funding: up to US\$ 12.8 million	Core funding: up to US\$ 6 million

Characteristics	Chile (Innova Chile 2012)	Peru (FONDECYT 2015)
Co-financing	2/3 of the centre's budget in the last stage of operation.	75% of the centre's budget, in kind and cash.
Time scale	5-10 years	5-10 years
Leading organisation	In the two calls, international partners.	In the first two calls, any actor. In the third call, firms.

Source: Call for CoE's regulations.

Author's own elaboration.

Thus, their **expected impacts** are also similar. For example, they both expect centres to have access to new technologies and sources of knowledge; to build capabilities in terms of human resources, advanced infrastructure, and networks; to build technology transfer capabilities and culture within universities; and to position the country at the international level.

Regarding partners, the programmes in both countries consider three types of **actors**: international partners, local universities and research organisations, and firms. Supported initiatives would be granted **core funding** for five to ten years of up to US\$ 12.8 million in Chile and up to US\$ 6 million in Peru. There are, nonetheless, some differences in their **budget structure** because in Peru centres' partners have to contribute 75% percent of the total budget of the initiative, both in cash and in kind, whereas the CoE in Chile is required to cover 2/3 of the annual budget of the initiative in the last stage of the subsidy (i.e. around the 7th and 8th years of operation).

Compared to previous policy instruments aimed at fostering UILs, the CoE programmes in both countries emerged as an unprecedented initiative in terms of the size of the grant and the time scale. For instance, the Chilean funding agency (CORFO) has been financing three-year collaborative projects between firms and universities up to US\$ 200,000.<sup>11</sup> On the other hand, the Peruvian Ministry of Production has offered grants that reached US\$ 150,000 for two-year collaborative projects between firms and universities<sup>12</sup> and up to US\$

<sup>11</sup> Source: call regulations (CORFO 2020).

<sup>12</sup> Source: call regulations (Peruvian Ministry of Production 2020a).

500,000 for corporate consortia initiatives to be executed in less than three years.<sup>13</sup> Consequently, the effort required from all the stakeholders of CoEs seems to be quite unique in the Chilean and Peruvian innovation systems. Moreover, there are substantial differences in how collaboration is organised in project-based initiatives and in CoEs, which has been highlighted in Section 2.3.4 and will be analysed empirically in [Chapter 6](#).

An important difference between Chilean and Peruvian centres refers to their ***leading organisation***. In Chile, the programme regulations called for international partners to lead the initiatives. However, as highlighted earlier, they are required to form alliances with local partners from both the academic sector and firms. In Peru, the first two calls let partners decide who would lead and how they would organise the governance of the CoEs, while the third call required firms to lead the initiatives. We provide a list of the seven centres set up in Chile and two in Peru in [Appendix C](#). In the following section, we provide a preliminary view of the two cases under study.

#### 5.4. A preliminary overview of the cases under study

In Section 4.3.1, we explained the criteria against which we have chosen the cases to be studied. Before starting the empirical analysis, we provide a first look at these centres, based on secondary data. The Fraunhofer Chile Research - Centre for Systems Biotechnology (FCR-CSB) is described in [Table 9](#) in terms of its focus (industries and activities), objectives and partners.

The original scope of the Chilean centre seems to be quite broad in terms of its research agenda and related sectors or industries. There are research lines relating to biotechnology, chemical analysis, biocomputing, sustainable use of natural resources and so forth. According to an institutional report, Fraunhofer IME, founder of this CoE, works with a broad network of German universities and other Fraunhofer institutes and initiatives, and the Centre for Systems Biotechnology (FCR-CSB) “*can gain access to this expertise as part of these established Fraunhofer networks*” (Fraunhofer Chile Research 2015: p. 17).

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<sup>13</sup> Source: call regulations (Peruvian Ministry of Production 2020b).



Table 9. Main characteristics of the Chilean case

Fraunhofer Chile Research - Centre for Systems Biotechnology – FCR-CSB	
Country	Chile
Focus (field, sector, industry, etc.)	<p><b>Sectors:</b> Agriculture, Aquaculture, Sustainability</p> <p><b>Research lines:</b>  Agriculture: improvement of production processes in the fruit sector.  Aquaculture: solutions to the health problems of the salmon industry, new technologies and certification processes.  Biocomputing and applied genetics: sequence and biological data for new product development.  Nanobiotechnology: nanomaterial that can eliminate unwanted chemicals in industrial processes.</p>
Objective	To become the premier Centre in Systems Biotechnology in Latin America based on the Fraunhofer model of innovation, with close collaboration with industry to develop new products or processes.
Specific Objectives	<ol style="list-style-type: none"> <li>1. The establishment and operation of research centres in cooperation with Chilean and German organisations.</li> <li>2. The promotion of work from scientific discoveries to practical application.</li> <li>3. The promotion of knowledge transfer, know-how, and research results to local industries.</li> <li>4. The training of staff and the exchange of researchers and technical personnel between Chilean and German institutions.</li> </ol>
Reach (Founding members and network members)	
International research and technology institutions	<p><b>Founder:</b> Fraunhofer Institute for Molecular Biology and Applied Ecology - IME</p> <p><b>Network members:</b>  Institute for Plan Biotechnology - University of Münster  Institute of molecular Biotechnology - Aachen University  Institute of Entomology - University of Giessen  Institute of Medical Pharmacology - Goethe University  Fraunhofer Food Chain Management Alliance  Fraunhofer Network for Sustainability</p>
Chilean Academia (Universities, Research centres)	<p><b>Founder:</b> No one</p> <p><b>Co-executing partners</b>  Fundación Chile  Universidad de Talca  Pontificia Universidad Católica de Valparaíso  Universidad Andrés Bello</p>
Private partners (firms)	<p><b>Founder:</b> No one</p>

Source: Fraunhofer Institutional Report 2011-2014 (Fraunhofer Chile Research 2015).  
Author's own elaboration.

On the other hand, [Table 10](#) describes the main features of the Peruvian centre in terms of its focus, partners and main research lines. This information has been obtained from the application to the second call for CoEs and public information.

The research lines of this CoE are related to the agricultural sector, particularly to the production and processing of cocoa beans, and the food industry based on chocolate and various by-products. Some projects included in the initial proposal relate to biotechnology and chemical analyses in order to create and offer solutions for improving crop yields and quality.

Moreover, among the international actors considered initially in the proposal was the Fraunhofer Society, which apparently did not participate in the set-up nor the operation of this centre.

*Table 10. Main characteristics of the Peruvian case*

Centro de Innovación del Cacao - CIC Innovation Cocoa Centre	
Country	Peru
Focus (field, sector, industry, etc.)	<p><b>Sectors:</b> Agriculture - Cocoa Food – Chocolate</p> <p><b>Research lines:</b> Identification. selection and improvement of promising varieties of cocoa. Products and services for crops management and post-harvest processing for promising varieties adapted to regional agro-ecological conditions. Characterisation, control and optimisation of cocoa organoleptic quality through chemical predictors.</p>
General Objective	To generate technological solutions to increase cocoa productivity and improve the added value according to demand.
Specific Objectives	<ol style="list-style-type: none"> <li>1. Identification, characterisation, selection and improvement of promising varieties of cocoa.</li> <li>2. Development of products and services to improve productivity and quality.</li> <li>3. Organoleptic quality accreditation through chemical analyses.</li> <li>4. Production of vegetal material free from pathogens.</li> <li>5. Training of human capital at the operational and post-graduate levels.</li> <li>6. Incubation of businesses derived from activities of the centre.</li> <li>7. Implementation of R&amp;D projects according the national and international demand.</li> </ol>

Reach (Founding members and network members)	
International research and technology institutions	<p><b>Founder:</b> Pennsylvania State University (PSU)</p> <p><b>Network members:</b> Fraunhofer - Gesellschaft GIZ - Pro Ambiente, Cooperación Alemana</p>
Peruvian academia (Universities, Research centres)	<p><b>Founders:</b> Universidad Peruana Cayetano Heredia (UPCH) Universidad Nacional Agraria La Molina (UNALM)</p> <p><b>Network members:</b> Instituto de Cultivos Tropicales Ministerio de Agricultura y Riego - MINAGRI Comisión Nacional para el Desarrollo y Vida Sin Drogas - DEVIDA</p>
Firms	<p><b>Founders:</b> Cafetalera Amazónica - Grupo ECOM Central Café y Cacao - Central de cooperativas de productores La Ibérica S.A.</p> <p><b>Network members:</b> Bioincuba - Sistema de Innovación y Transferencia Tecnológica de la Universidad Peruana Cayetano Heredia Exportadora ROMEX S.A.</p>

Author's own elaboration.

Bearing all these antecedents in mind, the following chapters will analyse empirically three aspects of CoEs: their internal organisation and UILs developed within them, the barriers to UILs, and the roles of international partners.

## CHAPTER 6. Organisation and activities of CoEs

### 6.1. Introduction

The overall objective of this study is to understand the interactions between universities, firms and international actors within Centres of Excellence (CoEs) in Chile and Peru. As a first step to achieve that aim, this chapter analyses empirically how CoEs have been working in both countries and how university-industry linkages (UILs) have developed within them. Understanding these aspects is important to contextualise the analysis of barriers to UILs and the roles of international actors in subsequent chapters.

As described in Section 2.3.4, CoEs have been promoted and studied since the 1970s in Canada and the US, having influenced similar initiatives in a number of countries such as South Korea (1989), Australia (1990), Finland and Canada (2007), the UK (2010), and Germany (2011). Latin America has most recently engaged with this area of policy, with Chile (2010) and Peru (2014) setting up their own initiatives. This trend means that CoEs have existed for almost four decades but nonetheless remain very much a contemporary phenomenon, which deserves academic and policy attention in contexts such as LACs.<sup>14</sup>

This chapter begins with an analysis of certain aspects of CoEs in Chile and Peru, including their internal organisation and activities. The results of this analysis demonstrate that centres have been set up as research partnerships that carry out boundary-spanning roles between universities, firms and international actors. Arriving at this conclusion for the Chilean case took a number of additional steps compared to the analysis of the Peruvian one, but they were worth pursuing because the resulting insights lend support to a conceptual distinction between *CRCs* and the so-called research and technology organisations (*RTOs*).

Then, we compare CoEs in Chile and Peru, based on certain patterns found in the literature. We conclude that the Chilean and Peruvian centres share most characteristics with *CRCs* in

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<sup>14</sup> These initiatives have taken various different names such as ‘cooperative research centres’, ‘public-private partnerships’ and so on. In this study, the term *cooperative research centres* (*CRCs*) and *centres of excellence* (*CoEs*) are used interchangeably.

the developed world. However, they also have some particularities regarding, for instance, the participation of firms in their governance and the scope of their pre-competitive research activities. Neither case can be categorised as a business-driven initiative, which is one of the features of CRCs in the international experience. Finally, we discuss our main findings.

## 6.2. Fraunhofer Chile Research - Centre for Systems Biotechnology (FCR – CSB)

As explained in [Chapter 4](#), the FCR-CSB is the selected case in Chile. This section is based on the interviews we conducted with various actors such as academics, intermediaries, the centre’s staff and civil servants. Moreover, it also draws on the perspective of German interviewees (seven in total) and secondary data.

### 6.2.1. Uncovering the actual nature of the centre

In seeking to understand how the Chilean CoE works, we set out to examine the aim of the centre and the relationships between international partners, local universities and firms. Regarding the CoE programme, most interviewees agreed that the main idea was to attract well-known organisations with experience in technology transfer and applied research. This view is consistent with the objective stated in the call for CoEs, which was *“to set up international centres of excellence to perform activities of research and development, technology transfer, and commercialisation in forefront technology areas, and strengthen national capabilities of R&D”* (Innova Chile 2012).

Some interviewees, among academics, centre staff, civil servants and intermediaries,<sup>15</sup> stated that the idea was to ‘import’ models that have been working in developed countries and implement them in Chile. Thus, the aim of attracting the Fraunhofer Society (Fraunhofer-Gesellschaft – FhG) was to set up a German-like institute.<sup>16</sup> However, the first aspect that emerged from our fieldwork activities was the lack of clarity about what the Chilean centre actually is. Confusion seems to stem from the call for CoEs, which required

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<sup>15</sup> Interviewees 2149, 2451, 2436, 2439, 2534, and 2633.

<sup>16</sup> The same idea was behind the attraction of other organisations such as Wageningen from the Netherlands, CSIRO from Australia, and INRIA from France.

these to be set up in '*co-execution*' with local actors, with little clarity about the exact relationship between local and international partners.

To this respect, we could identify three possible interpretations regarding the nature of the centre. These approaches emerged from our interviews and are as follows: i) the centre is a subsidiary of the Fraunhofer Society (FhG), ii) it is a unit within the subsidiary of FhG, or iii) it is a partnership between the international actor and local universities. In what follows, we will analyse each possible interpretation.

First, we found that the FhG did create a subsidiary called the Fraunhofer Chile Research Foundation (FCR), which has taken part in two CoE initiatives financed by the Chilean government, one being the Centre for Systems Biotechnology (FCR – CSB) and the second, the Centre for Solar Energy Technologies (FCR – CSET). Given this structure, we can conclude that the FhG subsidiary is different from the CoEs in which it is involved, suggesting we should discard the first possible interpretation.

The second interpretation – CoEs as units within the FCR – seems plausible, as in Germany with institutes coming under the Fraunhofer Society (FhG). However, we cannot arrive at this conclusion straightforwardly without knowing what the model in Germany looks like. In this regard, some authors have studied Fraunhofer institutes within the well-developed category of research and technology organisations (RTOs), alongside other institutes such as the Industrial Technology Research Institute (Taiwan), Electronics and Telecommunications Research Institute (South Korea), CSIRO (Australia) and so forth (Intarakumnerd and Goto 2018; Mina, Connell, and Hughes 2009; De Silva, Howells, and Meyer 2018).

Chilean and German interviewees agreed that the German model is based on independent institutes that interact with academic and industrial actors and have a budget with a balanced distribution of income sources: roughly one third as base funding coming from government, one third from industry (through contract research mainly), and one third from other sources such as competitive funds. This matches the description of FhG institutes in some studies (Intarakumnerd and Goto 2018; Mina et al. 2009). For the Chilean

case, staff members of the centre (interviewees 2445, 2451, and 249) highlighted that having such a balance was difficult but in the last few years it has been achieved. Therefore, at first glance, one might be tempted to assume that CoEs in Chile are like FhG institutes, while their *co-executing* contracts with local partners would represent their normal interactions with academic actors.

However, the budget scheme of the German model – with its balanced distribution of sources – is applied only for the institute’s operational budget. For large investments (e.g. facilities and laboratories), according to the director of a German institute (interviewee 5614), a FhG institute has to design investment projects and negotiate their financing with the government. This represents a big difference compared with the Chilean arrangements because Chilean centres have faced problems in building their own facilities and laboratories. As one civil servant (interviewee 2534) pointed out, centres had been assumed to build their own infrastructure and equipment, but that proved too expensive, so they ended up as networks of organisations.

A senior staff member of the CoE (interviewee 2436) noted that the *co-executing* contracts with local universities imply university researchers working as part of the centre within university facilities, while in Germany it is the other way around, with university researchers working in the institute’s facilities. In this regard, the Chilean arrangement brought certain management and financial consequences for the initiative; as two senior staff members of the centre (interviewees 249 and 2436) complained, university researchers could raise money for themselves instead of doing it for the centre, and monitoring university researchers was challenging. According to one academic (interviewee 2149), the German model was not possible to implement in Chile because of the participation of universities.<sup>17</sup>

These characteristics would lead us to reject the idea that the CoE is a unit within the FhG subsidiary and instead support the conclusion that it is a partnership between the FhG subsidiary and local universities (the third possible interpretation). The partnership nature

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<sup>17</sup> According to managers of two other CoEs (Interviewees 2439 and 2442), trying to implement foreign models in the Chilean context would have been a mistake; setting up a centre is not a matter of ‘copy and paste’.

of the centre was also noted by one senior professor of a local university (interviewee 2149), who stated that people from the international actor thought that university researchers were working ‘for’ them, when they have actually been working ‘with’ them, as partners.

Under this partnership organisation, firms do not take part in the centre, being mainly clients. They have not participated in either the creation or the governance of the centre. As clients, they can come from the entire value chain in sectors of the centre’s interest such as agriculture and aquaculture in the case of the FCR-CSB.<sup>18</sup>

Interviewees do not agree on whether the lack of firms’ involvement is positive or negative. For a senior staff member of the centre (interviewee 2436), incorporating firms in the initiative would have been complicated and could have prevented other firms from working with the centre later on. On the other hand, another staff member of the centre (interviewee 2453) stated that excluding firms was a fundamental mistake because there was then not enough information about their needs.

Based on the previous analysis, it was possible to identify the relationships between the relevant actors involved in CoEs. Figure 1 shows how partnerships between the international actor and local universities work. The FCR (FhG subsidiary in Chile) has a board of directors (the *board* henceforth) that steers two CoEs through the appointment of a director and the building of an internal structure (team) for each centre. Universities and research organisations participate through research groups. Interactions between the FCR and local actors are not limited to the CoEs, as they can develop other collaborative activities (thick blue arrows in Figure 1).

In summary, *CoEs are partnerships between the subsidiary of the international actor and local universities, while firms are merely clients*. In this regard, Hagedoorn, Link, and Vonortas (2000) noted that research partnerships can be studied in terms of their members, which could be firms, universities and public laboratories. However, these authors focused their study on private research partnerships (or industry consortia) and referred to public-

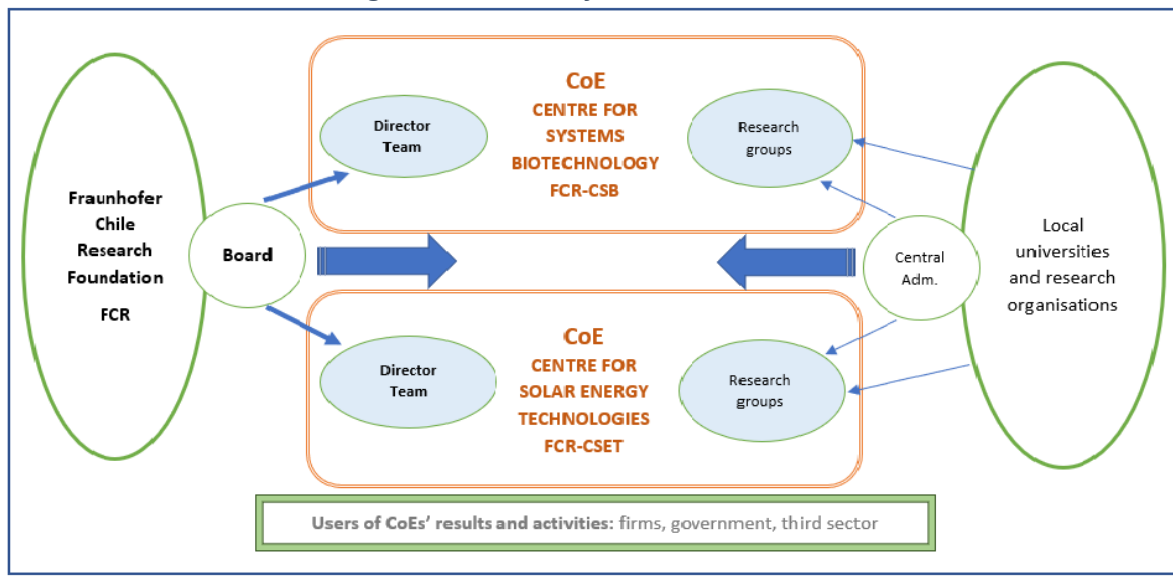
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<sup>18</sup> They are, for example, pharmaceutical laboratories, suppliers of services (designers of cages for the salmon industry, for instance) and government. Clients also include food suppliers and producers.



private partnerships when universities are included in the former, neglecting to some extent other actors such as RTOs. The Chilean case seems different from industry consortia because there are international actors collaborating with local universities, with no industrial partners.

*Figure 1. Centres of Excellence in Chile*



Author's own elaboration.

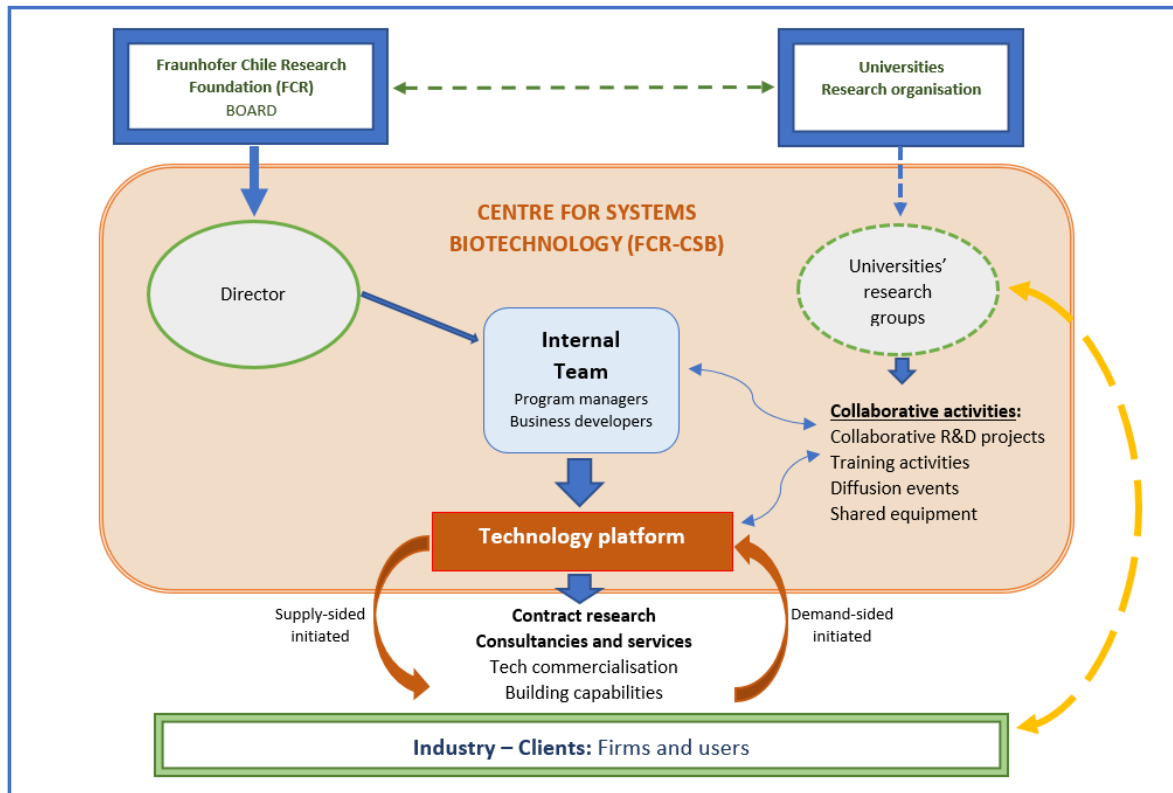
#### 6.2.2. Organisation of the CoE: decision making and activities

According to Gray, Boardman, and Rivers (2013), there are few studies about the structure and internal procedures of CRCs. Therefore, generating evidence about these aspects is a necessary first step to building a more comprehensive understanding of these initiatives. Figure 2 illustrates the organisation of this centre (the orange rectangle). The thickness and continuity/discontinuity of arrows and lines represent the level of influence and involvement of various actors. The leading organisation is the international partner operating through the *board* of its subsidiary (FCR), which appointed the director and the internal team to govern the centre. The influence of the international actor is represented with a continuous thick blue arrow.

Moreover, the centre takes developments from universities and research organisations to see whether they have the potential to link with the marketplace. This bridge between science and industry can be initiated through different mechanisms: from the *supply side*,

the CoE has built a portfolio of potential activities and services, based on its partners' capabilities and collaborative projects (the 'technology platform' in Figure 2). Then, the internal team contacts firms to develop certain activities together through different channels such as contract research. The technology platform (facilities, infrastructure, and capabilities) supports the centre's strategic business lines – agri-food and ingredients, aquaculture and marine systems, and industrial bio-sustainability.

Figure 2. Organisation of the Centre for Systems Biotechnology – FCR-CSB



Author's own elaboration.

On the *demand side*, firms approach the CoE with specific problems, some of which cannot be solved by the internal team, so it turns to a university to obtain the necessary complementary capabilities. According to a senior staff member of the centre (interviewee 249), good relations with universities are fundamental to providing a fast response to firms and implementing an open innovation model. When the participation of universities is required, activities take place in two separate spheres: on one side, the internal team has a

contract with a firm and, on the other side, it requires a separate and independent agreement with the university to acquire the necessary inputs.

The ability to speak both academic and business ‘languages’ is deemed to be one strength of the CoE’s internal team, which is composed of two types of profiles: *business developers* and *project managers*. Business developers have a combined scientific and business background and are in charge of talking to firms and selling them technology and solutions. According to one staff member of the centre (interviewee 2453), business developers perform several tasks such as negotiation with firms, dissemination of the CoE’s capabilities to attract firms, and implementation of technology.

*Project managers*, in turn, all have PhD degrees and act as consultants. In the process of responding to firms’ needs, *business developers* contact *project managers* to prepare a scientific or technological solution. Therefore, these two groups together carry out the business assessment of projects with firms in terms of budget, time and quality. When the solution cannot be developed internally, *project managers* have to turn to universities for complementary inputs.

The circle with the green discontinuous line in Figure 2 represents university research groups that can be changed according to the centre’s needs and with the agreement of the *co-executing* partners (universities). The flow of knowledge between universities and firms is always mediated by the internal team, while direct contact between them is exceptional (yellow discontinuous arrow). Finally, firms and users are outside the CoE (as reflected in the rectangle with green borders at the bottom of Figure 2).

Table 11 describes the main activities developed under the umbrella of the centre (detailed description in [Appendix D](#)).

Table 11. Activities developed within the Centre for Systems Biotechnology

Element/Activity	Description
Common agenda <sup>19</sup>	Most interviewees stated that the centre does not have a common agenda between partners. The centre has research lines and projects that respond to the interests of individual organisations and even individual research groups. However, one senior staff member (interviewee 249) pointed out that they are working on aligning partners' interests.
Collaborative projects	There are collaborative projects with both universities and firms, which can exhibit different forms. <sup>20</sup> For each project there is only one firm involved (a <i>one-firm-per-project</i> approach).
Contract research	The main channel of interaction with firms is contract research. However, most of them are publicly funded (by CORFO) so people used to speak of the 'corforisation' of innovation in Chile.
Consultancies and services	The centre provides consultancy and other services, but they are not its main business line. However, people recognise that it can be a short-term source of income.
Commercialisation of results: Licencing and spinoffs	In 2018, the first licencing contract was negotiated, and the first spin-off designed. This is happening after the centre has been operating for eight years and because it is a requirement from the funding agency.
Training of people and building capabilities	<ul style="list-style-type: none"> <li>• Training activities for the centre staff, but it does not provide training for firms.</li> <li>• Supervision of masters and PhD students, but this is still rather limited.</li> <li>• Mobility of students and researchers occurs at the national and international levels.</li> <li>• Diffusion events.</li> </ul>
Complementarity between activities	<ul style="list-style-type: none"> <li>• Diffusion activities are fundamental to building linkages with industry. They allow the CoE staff to meet people and show the centre's capabilities.</li> <li>• Small projects are necessary to build trust and later on may lead to larger contracts.</li> <li>• PhD students trained within the CoE are candidates to be hired by firms or will be able to produce technology and knowledge applicable to them.</li> </ul>

Author's own elaboration.

<sup>19</sup> An *agenda* is defined as a list of aims or possible future achievements (Cambridge Dictionary). Hence, a common agenda is a list of future achievements pursued jointly by the CoE partners, which have been approved by them; for example, its research and business lines. Hagedoorn, Link, and Vonortas (2000) have used the terms 'common cause' and 'shared objective' as a defining element of a research partnership.

<sup>20</sup> According to Katz and Martin (1997: p. 3), "Collaboration can take various forms ranging from offering general advice and insights to active participation in a specific piece of research. These collaborative contributions can also vary in level from the very substantial to the almost negligible."

Regarding complementarity between activities, previous studies have recognised that firms and universities can benefit from developing several interactions among themselves, particularly for building their capabilities (e.g. Cohen, Nelson, and Walsh 2002; D’Este and Patel 2007). For the Chilean centre, complementarity between different channels has been recognised (last row of [Table 11](#)), but one staff member of an intermediary (interviewee 2635) warned about developing activities that sometimes are undertaken just to fulfil the funding agency’s requirements, these being largely a waste of resources.

#### 6.2.3. What is new? Actors speaking of their previous experiences

In this section, we present the perception of interviewees regarding their current experience with the CoE and their previous collaborations. First, for people with previous academic experience, working for the centre represented a change in how interactions with firms work because it encompasses a technology platform that can be offered to firms to develop solutions. For university researchers, being involved in activities under the umbrella of the centre has meant a change in their focus, having moved from basic science towards application (interviewees 2141 and 2445). In universities, linkages with firms are not well structured, while in the CoE, they are much more standardised (interviewee 2445).

Second, unlike research projects, a CoE is a consortium with certain features such as the scale of resources and a particular form of organisation that allow partners to do things in a different way in terms of speed and efficiency (interviewees 2148 and 2633). Individual projects last for one or two years, while CoEs are mid- to long-term initiatives, with a focus on specific thematic areas and a multidisciplinary approach when needed (interviewee 2633). These features are consistent with the description of CoEs in other countries, which has been developed in Section 2.3.4.

#### 6.2.4. Concluding remarks: Do CoEs differ from RTOs?

Summarising the previous sections and moving the analysis of Chilean CoEs one step further, [Table 12](#) contains a comparison between them and FhG institutes in Germany. The criteria to compare them are their relationships with universities and firms, funding structure and roles.

Table 12. Comparing Fraunhofer institutes and CoEs

Feature	Fraunhofer (FhG) institutes	Centres of excellence (CoEs)
Relation with universities	<ul style="list-style-type: none"> <li>• The head of each FhG institute is a professor in the local university (strong institutional link).</li> <li>• Staff of FhG institutes are professors or lecturers at universities, while doctoral students work for FhG institutes.</li> <li>• There are projects with universities and, sometimes, with universities and firms together, but these are not too many (weak interactions).</li> <li>• The institute staff raise funds for the institute.</li> </ul>	<ul style="list-style-type: none"> <li>• The centre is a partnership between the international actor and local universities.</li> <li>• Universities could participate in defining some research lines of the CoE, while some projects are developed by and in universities.</li> <li>• University researchers can decide to raise funds outside the centre, for themselves.</li> <li>• Part of the grant for CoEs was allocated to strengthening facilities of universities.</li> </ul>
Funding structure	<ul style="list-style-type: none"> <li>• Budget model with three sources: roughly 1/3 basic funding from government, 1/3 from industry, and 1/3 from other sources.</li> <li>• Basic funding has been granted since the creation of FhG (1948) and seems to continue; however, it has been decreasing over time, forcing an increase of the other funding sources.</li> <li>• In addition, there is a specific mechanism for financing buildings, laboratories and facilities, which are also publicly funded.</li> </ul>	<ul style="list-style-type: none"> <li>• The CoE led by Fraunhofer in Chile achieved the same balance between the three sources of income.</li> <li>• A CoE receives a grant from the funding agency (CORFO) for 10 years, expecting them to become self-sustaining after that period (a feature of CRCs in other countries)</li> <li>• The grant was not enough for CoEs to build their own facilities, relying on the capabilities of their university partners.</li> </ul>
Relation with firms	<ul style="list-style-type: none"> <li>• Based on contract research, services and training.</li> <li>• The main source of funding is firms' own money. There is a large stock of firms willing to outsource research and mobilise part of their budgets instead of doing R&amp;D internally.</li> </ul>	<ul style="list-style-type: none"> <li>• Based on contract research and consultancies. Few services and no training activities.</li> <li>• The main source of funding is government (grants from the funding agency - CORFO). For that reason, people speak of the 'corforisation' of innovation in Chile.</li> </ul>
Roles	FhG institutes are intermediaries that can be categorised as RTOs, which take technologies at a certain degree of development and develop them further toward application to meet industrial needs.	CoEs are boundary-spanning research partnerships. Collaboration with universities are intended to generate new technology. They have a mid- to long-term perspective, but they also address short-term needs of firms.

Author's own elaboration.

Table 12, shows that FhG institutes and the Chilean CoEs have some similarities, but also sharp differences that, we argue, make them different types of intermediaries, with the former falling into the RTO category and the latter into the CRC category (Table 4. [Classification of intermediaries](#)). In this regard, FhG institutes have sometimes been studied in the same group as certain ‘cooperative research centres’ (CRCs) such as the Finnish Strategic Centres for Science, Technology and Innovation (SHOKs), the Catapult centres in the UK and the engineering research centres (ERCs) in the US (Andersen and Le Blanc 2013; Gray et al. 2013; Lal and Boardman 2013).

Our findings, however, provide evidence to make a conceptual distinction between *RTOs* and *CRCs*, the latter being inter-organisational structures that have been studied under a specific body of literature (Ankrah et al. 2013; Bozeman and Boardman 2004; Davis and Bryant 2010; Koschatzky 2017; Kroll 2016). The partnership nature of CRCs can explain why they exhibit certain differences with RTOs in regard to their interactions with universities and firms as well as their funding structure and roles. Moreover, Intarakumnerd and Goto (2018) found that RTOs in some countries (e.g. Australia, Germany and Japan) have become partners of CRCs, as is happening in Chile with the subsidiaries of RTOs taking part in CoEs, something which lends support to the above conceptual distinction.

### 6.3. Cocoa Innovation Centre (CIC)

This section analyses the Peruvian case and is based on interviews conducted with people from different sectors including academia, business, the funding agency, and international actors. We also used secondary information (reports and websites, for instance).

#### 6.3.1. The centre as a research partnership

The idea of creating the CoE started with the interest of a number of actors from the cocoa value chain (around 20 actors). However, the proposal for funding was submitted including only six partners: two local universities, three business actors and one foreign university. Core funding was granted, and the set-up process started with the decision to create a limited liability company (a *new firm*). Having this legal form brought various challenges such as defining the actual share of partners in the firm’s equity, given that they have been

contributing mainly in kind. A second challenge refers to certain limitations for the international partner and two local actors to take part in a for-profit organisation because of their internal regulations.

Despite those difficulties, the CIC began to operate in 2015, and all partners are represented in its decision-making bodies. The centre was expected to become a technology organisation, the aim of which is to generate new technologies to be commercialised (most interviewees support this view). However, to make the centre sustainable, partners considered a broader range of activities. According to some interviewees (1126, 146, 152, and 154), activities are expected to be developed with a long-term approach, which requires partners to agree an ambitious plan.

At this point, we would like to explore if the CoE is actually the *new firm* or it is something else. The first observation from business actors (interviewees 1213 and 1232) is that public-private partnerships, in which partners have to match public funding to develop a particular initiative, had not worked in previous instances and it is not working in the case of the CIC. Indeed, private partners have made token cash contributions compared to the size of the grant (around US\$ 4 million): one firm is investing US\$ 200,000, another just US\$ 10,000, while the third business actor has not contributed anything in cash.

As pointed out earlier, partners contribute mainly in kind through, for example, university researchers' time, access to laboratories, equipment and infrastructure, and particular logistical assets (vehicles, time of people in the field, etc.). Ownership of these assets is not transferred to the new firm, which implies that the centre's activities are basically supported by its partners' capabilities. Therefore, building on the concept provided by Hagedoorn, Link, and Vonortas (2000), we can conclude that the Peruvian CoE is a 'cooperative agreement' understood as a common interest between different organisations in which ownership is not the linking factor.<sup>21</sup>

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<sup>21</sup> According to Hagedoorn, Link, and Vonortas (2000: p. 576), "Cooperative agreements are defined as common interests between industrial partners that are not connected through ownership." In the Peruvian centre, partners are more diverse.



Moreover, the CIC might be considered as a platform to develop projects and other activities that would benefit the whole cocoa value chain. Under this organisation, university partners have been designing projects to be approved and funded by the internal structure of the CoE, when they are aligned with the centre's research lines.<sup>22</sup> Projects have been undertaken by university research groups, using the university's own facilities.

These characteristics lead us to conclude that the CIC is a research partnership, defined by Hagedoorn, Link, and Vonortas (2000: p. 567-568) as “an innovation-based relationship that involves, at least partly, a significant effort in research and development (R&D)”. It is a partnership between six actors who founded the *new firm*, the responsibility of which is to receive, manage and provide accountability for the grant. The new firm approves and funds certain activities and then coordinates their execution, fulfilling the role of what some authors have called the *intermediate administrative structure* in CRCs (e.g. Sinnewe, Charles, and Keast 2016; Turpin, Garrett-Jones, and Woolley 2011).

This partnership seems to facilitate the use of capabilities in different locations (partners' facilities), where projects are mainly undertaken individually by each partner. According to the literature on CRCs (Koschatzky et al. 2015) in some cases such as Finland and Canada, projects and activities are distributed across different locations, and can be developed unilateral or multilaterally. For that reason, we can conclude that the Peruvian centre is something broader than the *new firm* created to manage the grant; it is an inter-organisational structure that allows activities to be developed by different organisations under specific research and strategic lines.

### 6.3.2. Organisation of the CoE: decision making and activities

Previously, we called attention to the limited evidence about the structure and practices of CRCs, despite the fact that they have been in place for decades in several countries.

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<sup>22</sup> The CIC has three main research lines: the improvement of vegetal varieties of cocoa, the improvement of productivity, and improvement of the organoleptic properties of cocoa – e.g. flavour and aroma (see [Table 10. Main characteristics of the Peruvian case](#)). Moreover, the CoE has commercial projects such as the creation of a chocolate school for training people and developing capabilities for the production of chocolate and various by-products.

Moreover, as highlighted in [Chapter 2](#), evidence on CoEs in Latin America is still very limited. Addressing those gaps, this section analyses the structure and operation of the CIC.

The Peruvian centre has been structured with three levels of decision-making. The highest level rests with its *board*, composed of directors from all partners, including a seat for a representative of the funding agency (CONCYTEC). At the second level of decision-making, the centre has two committees, one scientific and another for business. These two committees are in charge of approving projects presented mainly by university researchers.

This arrangement gives an appearance of distributed power of decision-making among partners. However, most interviewees<sup>23</sup> recognised that the UPCH (Universidad Peruana Cayetano Heredia) has a leading role, which has materialised through certain aspects: the decision to create a new firm came from this university, which also has appointed and pays the salary of the scientific director (who heads the scientific committee).

Decisions on projects are made first by the *business committee*, which assesses their market potential. Then, the *scientific committee* evaluates projects in terms of methodology, experimental design, and other research considerations. The final decision on which projects would be funded and carried out rests with the CoE's *board*, which decides based on strategic criteria such as the alignment with the centre's objectives.

At the third level of decision-making, the *general manager* is responsible for following up the execution of activities in liaison with the scientific director, building working teams for commercial projects, and preparing reports for the *board* and the funding agency. The general manager's decision power is very limited, something which was criticised by one business actor (interviewee 1218) who argued that this is a weakness of the centre because the board decides almost everything while the general manager's hands are 'tied' (this business partner was interested in having more influence over the initiative, which might have skewed his/her opinion).

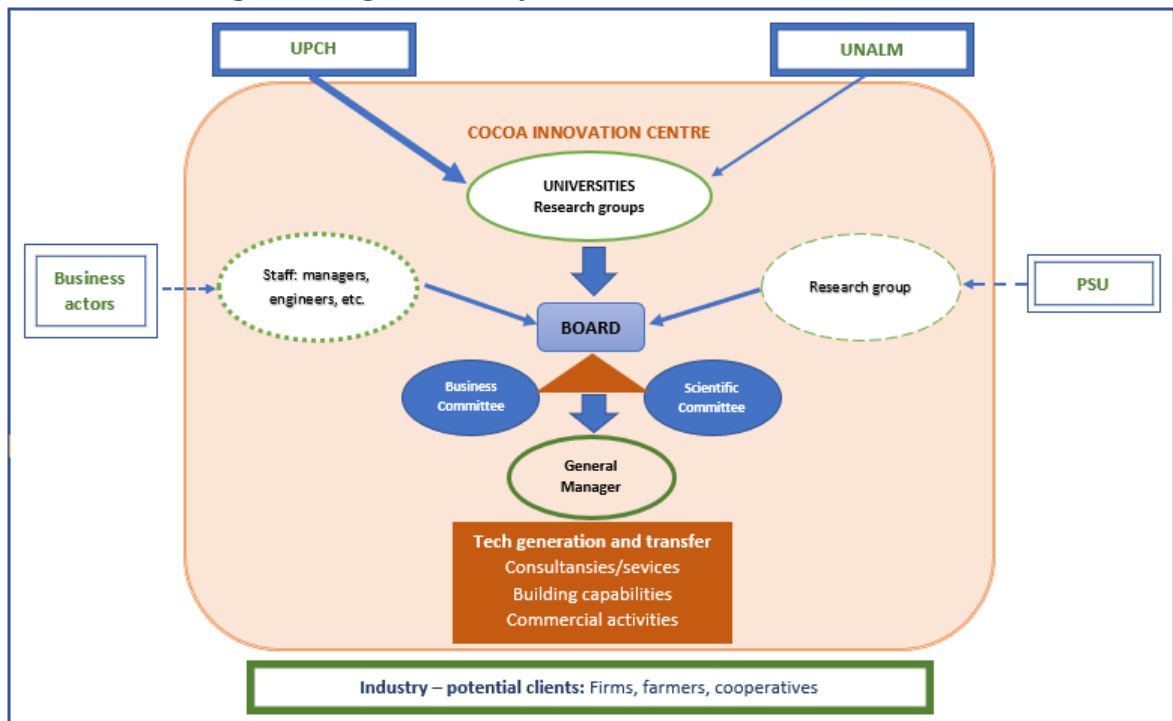
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<sup>23</sup> Academics, civil servants, business actors, international partners and intermediaries (interviewees 152, 154, 1617, 1116, 1128, 1213, 1331, 1120, and 1218).

Under this arrangement, the *board* seems to be the main sphere where academics and firms interact with each other. Firms in general do not have direct contact with universities outside the board. On the other hand, researchers undertaking some projects seldom have direct links with other partners because, according to one academic (interviewee 1127), everything is channelled through the centre's structure. The limited collaboration in the execution of projects seems to prevent partners from creating a better collaborative environment; as one business actor (interviewee 1218) stated, mutual understanding was supposed to be easier within the CoE but has actually been relatively hard.

Figure 3 shows the organisation of the CIC (the orange rectangle). The thickness and continuity/discontinuity of arrows represent the level of influence of the various actors. For example, universities have a stronger influence on the centre and UPCH, in particular, is deemed the leading organisation (its influence arrow has a thick continuous line). In general, firms and the international actor (PSU – Pennsylvania State University) participate in the board and both committees but their involvement in the centre is weaker (as shown by discontinuous arrows and circles); they neither propose nor lead projects, for instance.

Figure 3. Organisation of the Cocoa Innovation Centre - CIC



Author's own elaboration.

The brown triangle means that almost every decision depends on those units (the *board* and two committees), while the general manager coordinates the execution of those decisions. Moreover, firms from the whole cocoa value chain are expected to be clients or users of the knowledge and technology generated by the CIC.

Regarding the range of activities, international experience shows that CRCs are configured as platforms in which partners develop research projects and other activities, either unilaterally or jointly (Koschatzky 2017; Kroll 2016). Figure 3 shows that there is a kind of resource pooling, based on which partners undertake projects and other activities. In the same vein, [Table 13](#) summarises the activities performed within the CIC (more details can be found in [Appendix E](#)). In the Peruvian case, activities seem to be organised under a common agenda, which does not necessarily mean that mutual understanding between different actors always exists.

*Table 13. Activities developed within the Cocoa Innovation Centre*

Element/Activity	Description
<b>Common agenda</b>	The common agenda is approved by centre's board, where all partners are represented. However, mutual understanding between researchers and businesspeople has not been fully achieved.
<b>Collaborative projects</b>	Collaboration occurs at two levels: <ul style="list-style-type: none"> <li>• In the process of project approval, all partners are involved.</li> <li>• The second level occurs in the design and execution of projects, where it is still rather limited.</li> </ul>
<b>Contract research</b>	Contract research is not considered because this is not the centre's main objective.
<b>Consultancies and services</b>	<ul style="list-style-type: none"> <li>• The centre is not currently providing consultancy. Most interviewees consider this to be necessary, but without diverting attention from the main objective (technology development and commercialisation).</li> <li>• Services are provided to a very limited extent.</li> </ul>
<b>Commercialisation of results: Licencing and spinoffs</b>	<ul style="list-style-type: none"> <li>• The main objective of the CoE is to generate and commercialise technology. However, it is still at too early stage to assess this aspect.</li> <li>• Regarding spin-offs and business projects, for example, there is no clarity about whether a commercial project would be developed directly by the centre or by a new firm.</li> </ul>

Element/Activity	Description
<b>Training of people and building capabilities</b>	<ul style="list-style-type: none"> <li>• Training for firms, but still very limited.</li> <li>• Open events in which firms, academics and other actors can participate.</li> <li>• Supervision of students, but this is still limited.</li> <li>• Mobility of people is achieved through different mechanisms, at the national and international levels.</li> </ul>
<b>Complementarity between activities</b>	<ul style="list-style-type: none"> <li>• Diffusion events help to build connections at the national and international levels. Most linkages are developed during research events.</li> <li>• Training of human resources opens up opportunities for mobility.</li> </ul>

Author's own elaboration.

The range of activities developed by the centre allows us to conclude that it provides a platform that spans the boundaries between universities, firms, and international actors through different channels of interaction. Moreover, these channels complement each other to some extent.

Collaboration between partners and the level of involvement of firms have different forms. For instance, firms and the international partner are mainly involved at the decision-making level, providing advice and insights, which fits into the broad concept of collaboration given by Katz and Martin (1997). The role of international partners will be analysed in detail in [Chapter 8](#).

#### 6.3.3. What is new? Actors speaking of their previous experiences

The experience of creating and operating CoEs has prompted both positive and negative reactions in various actors, especially when comparing it with their previous experiences (e.g. individual projects). According to some university researchers (interviewees 1116, 1126, and 1127), their previous experience was largely based on specific projects with firms, which responded to specific needs. According to one of them (interviewee 1116), individual projects were negotiated directly by the researcher and one person in the firm; they had clear objectives, budgets and expected results. With the CoE, there is uncertainty instead.

According to the same academic, the CoE has several actors and different levels of decision-making, which make processes time-consuming and dependent on a more complex structure. As one civil servant (interviewee 152) added, actors in CoEs are ‘forced’ to set ambitious plans to develop long-lasting relationships among them and look for specialisation in certain research lines (i.e. a thematic approach).

Finally, one staff member of an intermediary (interviewee 1619) stated that building and operating a CoE is a unique experience because it is not only about linking with firms but also thinking of different aspects such as intellectual property regulations, contribution to and benefits from the initiative, and decision-making processes (governance). One civil servant (interviewee 152) pointed out that partners are expected not to think of the CoE as a larger fund for their own projects, but as a new dynamic of interacting.

Consequently, we can argue that CoEs represent a change in the way of promoting and managing interactions between universities, firms and international actors and, for that reason, they seem to be new for the Peruvian system. In the same vein, CoEs in Peru show very marked differences from project-based interactions, which has also been highlighted for experiences in other countries (e.g. Gray, Johnson, and Gidley 1986).

#### 6.4. How to compare CoEs in Chile and Peru?

In this chapter we have shown that CoEs in both Chile and Peru have been configured as partnerships. To understand how these two sets of experiences differ from each other, we turn to studies that have highlighted the main features of similar initiatives. These centres have received general labels such as ‘cooperative research centres’, ‘public-private partnerships for research and innovation’, and ‘strategic models of science-industry R&D collaboration’. However, each country has launched programmes with specific names and distinctive features.

Based on studies included in [Table 14](#), we identified the main patterns of CRCs to compare our cases and draw some conclusions.

*Table 14. International experiences of CoEs*

N°	Name	Country (starting year)	Source
1	Industry/University Cooperative Research Centres – I/UCRC	US 1970s - 1980s	Adams, Chiang, and Starkey (2001); Davis and Bryant (2010); Gray et al. (2011); Gray, Boardman, and Rivers (2013); Gray, Lindblad, and Rudolph (2001); Stone (2015)
2	Engineering Research Centres - ERC	US 1984	Bozeman and Boardman (2004); Feller, Ailes, and Roessner (2002); Gray, Boardman, and Rivers (2013); Gray, Johnson, and Gidley (1986); Kroll (2016)
3	Centres of Excellence	Canada 1987	Bell (1996)
4	Centres of excellence: - Science Research Centers (SRCs) - Engineering Research Centers (ERCs)	South Korea 1989	Soon (1995)
5	Cooperative Research Centres	Australia 1990	Harman (2005); Koschatzky et al. (2015); Sandall, Cooksey, and Wright (2011); Sinnewe, Charles, and Keast (2016); Turpin, Garrett-Jones, and Woolley (2011)
6	Faraday Partnerships	UK 1997	AIRTO (2001); Ankrah, Burgess, Grimshaw and Shaw (2013)
7	French Poles of Competitiveness – 'Pôle de Competitivité'	France 2005	Kroll (2016)
8	Norwegian Centres of Expertise - NCE Norwegian Global Centres of Expertise – GCE	Norway 2006 2013	Kroll (2016)
9	Business-Led-Network of Centres of Excellence – BL- NCE	Canada 2007	Performance Management Network INC. (2012)
10	Strategic Centres of Excellence - SHOKs	Finland 2007	Aksnes et al. (2012); Kroll (2016); Lähteenmäki-Smith et al. (2013)
11	Catapult Centres	UK 2010	Andersen and Le Blanc (2013); Hauser (2014); Kroll (2016)
12	Research Campus – 'Forschungscampus'	Germany 2011	Koschatzky (2017); Koschatzky et al. (2015); Kroll (2016)

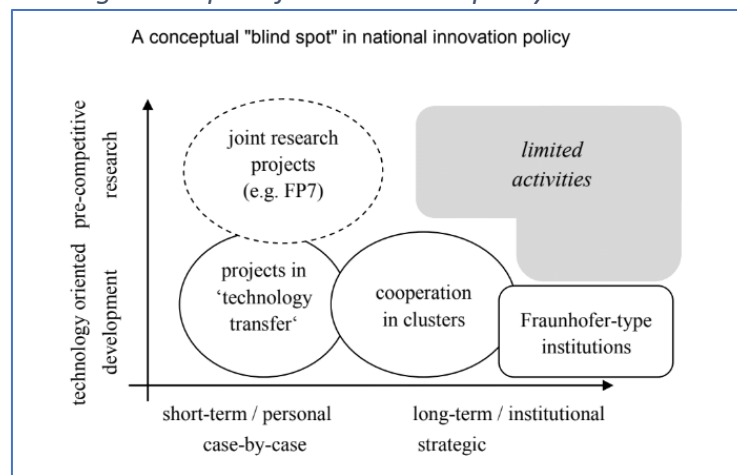
Author's own elaboration.

Experiences listed in Table 14 show that such centres have been implemented since the 1970s and received significant academic attention. Despite this, some authors have argued that little attempt has been made to provide a theoretical framework for explaining such initiatives (e.g. Bozeman 2013; Koschatzky 2017). Moreover, Gray, Boardman, and Rivers (2013: p. 8) argued that CRCs are only poorly understood because there is not a “widely agreed-upon definition.” Consequently, in order to compare our cases, we first build a conceptual framework with the main features of these inter-organisational structures.

#### 6.4.1. Patterns in the organisation of CRCs

As pointed out in Sections 6.2 and 6.3, our empirical analysis of CoEs in Chile and Peru strongly suggests that *RTOs* and *CRCs* are different types of intermediaries, as the former are individual organisations with intermediary roles, while the latter are boundary-spanning inter-organisational structures. This is consistent with Kroll's (2016) study of global experiences, which positioned CRCs in the broad picture of innovation policy and concluded that they address a specific gap, fulfilling different roles compared to clusters and RTOs (Figure 4). We argue, therefore, that CRCs have specific features that are not shared by RTOs. These features are outlined below.

Figure 4. Space for CRCs in the policy arena



Source: Kroll (2016)

First, these initiatives are **partnerships with a mid- to long-term approach**. Partners share a common interest (a sector or technology) and a common vision about future challenges and opportunities combined with current needs (urgency). Given the participation of actors



from science and industry, they perform ***boundary-spanning roles*** between these two *worlds*. According to AIRTO (2001), these centres in the UK meant a fundamental change in the infrastructure of collaboration between different actors. Centres also have ***standardised policies and procedures*** referring to several aspects such as membership, ownership of and access to intellectual property rights (IPRs).

Second, centres perform a ***range of activities***, but research seems to have a primary position. Activities are mainly based on strategic plans implemented through research programmes or project portfolios. Capabilities to fulfil their mission can be located ‘under one roof’ (Germany), within a region (France and Germany) or they can be deployed across different locations operating as a network (Finland, Canada, and US). Moreover, sometimes projects can be performed mainly by faculty and students from universities (US), while in other cases research is carried out by either universities, firms or other organisations (Canada, Finland, Germany). What is common, however, is the complementarity between partners’ capabilities in pursuing a jointly formulated agenda.

Third, a long-term vision drives centres to develop ***pre-competitive/pre-proprietary research***<sup>24</sup> agendas (one of the criteria to identify these policy initiatives in Figure 4). In this regard, Feller, Ailes, and Roessner (2002) found that firms participated in ERCs (in the US) in order to access pre-competitive research rather than to develop specific products or processes. However, short-term results should not be neglected because, as noted by some authors (AIRTO 2001; Andersen and Le Blanc 2013), a balance between ***short-term results and benefits with a long-term vision*** allows enthusiasm to be maintained and further support generated (something neglected in the framework presented in Figure 4).

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<sup>24</sup> Pre-competitive research is understood as “R&D which is distanced from the market, being focused on ‘generic’ or ‘enabling’ technologies rather than the development of final-use products targeted on specific markets. Here ‘enabling’ technologies are mainly process technologies (...) which enable a multiplicity of product markets to be satisfied downstream” (Quintas and Guy 1995).

Another definition is provided by Eckl and Engel (2011: p 297): “precompetitiveness is also accepted whenever results are available to all interested firms in the same or other industries and therefore have a “public good” character”.

The fourth feature refers to the ***role of the private sector***, which is closely involved in the design and execution of research, thereby ensuring more effective use of results. For that reason, some authors have stated that CRCs should be defined as ***business-driven/user-driven*** initiatives (e.g. Aksnes et al. 2012; Koschatzky et al. 2015; Kroll 2016). This implies that industrial participation is not limited to the co-execution of projects, but is also fulfilled through decision-making functions. Therefore, according to Gray et al. (2011), firms require the necessary absorptive capacity to assess and decide on the strategic lines of the centre as well as to exploit the results.

Taking these patterns as a reference, we will compare the Chilean and Peruvian centres in the following section.

#### 6.4.2. Comparing CoEs in Chile and Peru: How different are they?

CoEs in both countries have been configured as ***boundary-spanning partnerships*** that have a mid- to long-term vision and operate through different mechanisms to foster interactions between their partners. In *Chile*, the centre's structure spans boundaries between universities and firms, but firms have not been involved in either the creation or the governance of the centre (Figure 2). Meanwhile, the boundary-spanning function in the *Peruvian centre* is fulfilled through the participation of all actors on the *board* and the internal organisation of the centre; unlike the Chilean case, Peruvian firms have been involved in the centre's governance by participating in certain decisions such as the approval of strategic lines and projects (Figure 3).

Moreover, CoEs in Chile and Peru are ***platforms for developing a range of activities***, unilaterally or in collaboration, supported by standardised policies and procedures, but they exhibit marked differences in their focus. The *Chilean centre* relies on collaborative projects with academic organisations and contract research with firms, while engaging in limited activities involving commercialisation of technology. The *Peruvian centre*, in contrast, does not focus on contract research but on developing projects intended to produce new technology that can be commercialised later on.

In both countries, centres have very limited activities providing consultancy, services and training for firms. Even though some interviewees stated that these activities are important for generating short-term income, no interviewee referred to these short-term results as mechanisms for building trust, maintaining enthusiasm and gaining further support – as highlighted in other experiences. This is probably one of the most important weaknesses of Chilean and Peruvian centres.

In terms of ***pre-competitive/pre-proprietary research***, the *Chilean centre* does not develop it with private funding because of its *one-firm-per-project* approach (explained in [Table 11](#)). Nonetheless, it does have publicly-funded collaborative projects with local academia, which aim to improve the technology platform offered to any firm to draw upon and create a solution. In the *Peruvian case*, pre-competitive projects are neither designed, developed nor funded by firms. However, projects currently funded by the centre can be considered as pre-competitive ones given that they are expected to create solutions for the whole cocoa value chain and not for a firm or a group of firms participating in the CIC.

We also found that CoEs in both countries cannot be labelled as ***business/user-driven initiatives***. In the *Chile* case, firms have not been involved in either the creation or the operation of the CoE. Even though the board of the Fraunhofer Chile Research Foundation (FCR) has representatives from the private sector, they are neither users nor funders of the CoE activities. In *Peru*, business actors have been involved in the creation and operation of the centre through their participation in its *board* and *business committee*, which makes a difference compared with the Chilean experience because firms can inform the centre's decisions. However, it does not mean that the centre is driven by business partners because the leading organisation is a local university, while private actors cannot exercise that much negotiation power.

Unlike CRCs in developed countries, large firms do not play a major role in either the Chilean or the Peruvian case. However, the business composition of the Peruvian centre is interesting because there are a large international trader, a local chocolate producer and a union of cooperatives of small farmers (La Central) all involved.

*Table 15. Comparing Chilean and Peruvian Cases*

Characteristic	Chile	Peru
Partnership nature	Yes Between the international partner and universities	Yes Between the three types of actors
Boundary-spanning role	Yes	Yes
Mid- to long-term vision	Yes	Yes
Standardised policies and procedures	Yes	Yes
Broad range of activities	Yes, but limited Centred on collaborative R&D and contract research	Yes, but limited Centred on generation of new technology and commercialisation
Pre-competitive/ pre-proprietary research	Yes, but limited Publicly funded	Yes, but limited Publicly funded
Balance between long-term and short results	No Limited short-term activities	No Limited short-term activities
Business-driven/user-driven initiatives	No Leading actor: International partner	No Leading actor: A local university but with participation of firms in its governance
Centred/distributed locations	Distributed	Distributed

Author's own elaboration.

Finally, the participation of SMEs is uncommon in CRCs in the developed world, while the CIC does have a representative of a number of small farmers, which gives the centre a specific potential to apply its research results to this type of actors. It also means that there is an effort to incorporate SMEs, but under a different approach: through their intermediaries rather than individual firms/farmers.

## 6.5. Conclusions and discussion

The first conclusion of this chapter is that the Chilean and Peruvian CoEs exhibit certain similarities but also a number of differences (Table 15). In both countries, centres are mid- to long-term partnerships, with boundary-spanning roles between academia and industry. However, we also found quite marked differences in some respects such as firms' participation in the decision-making process and the role of leading organisations. These

differences have a strong influence on the operation of centres and the organisation of interactions between universities, firms and international actors.

In Chile, the inter-organisation, boundary-spanning structure of the centre was not obvious in the beginning because the CoE programme was intended to attract RTOs from developed countries. However, based on our empirical comparison between Fraunhofer institutes and the Chilean centre (Section 6.2.4) and the main characteristics of CRCs (Section 6.4.1), we have been able to conclude that CoEs in Chile fit better into the category of *CRCs* rather than into that of *RTOs*. This finding provides important insights to delineate a conceptual distinction between these two intermediaries, addressing a literature gap relating to the lack of a uniform definition of CRCs, as highlighted by Gray, Boardman, and Rivers (2013).

By integrating the comparison between Chilean and Peruvian CoEs with the main features of CRCs, we found that the Chilean and Peruvian cases are boundary-spanning structures consisting of a technology platform available to perform a range of activities in different locations (a network of facilities). This supports our argument that CoEs, rather than being specific *channels* of interaction, encompass *contexts* that support UIs through different channels.

Moreover, both the Chilean and Peruvian centres are engaged to some extent in pre-competitive research, which is a characteristic of CRCs compared to other initiatives such as clusters and RTOs (Kroll 2016). However, and here the differences with the international experience begin, pre-competitive research is not funded by firms but by competitive funds (grants). Second, neither case is a business-driven initiative because either firms do not take part in the centre or they play very much a secondary role.

We can thus conclude that in the empirical comparison, the Chilean and Peruvian centres seem quite different from each other, but not too much in the broader context of a theoretical comparison with CRCs (based on patterns drawn on the literature). This is somewhat unexpected because we intended to compare the Chilean centres with the Peruvian ones – something we have achieved to some extent – but ended up broadening the study to compare them with CRCs in developed countries. This extended approach has

provided insights to help understand certain characteristics of this institution when analysing Latin American experiences.

In this regard, Kroll (2016) has pointed out that all leading economies have implemented CRC initiatives regardless of their political culture, meaning that there is latent interest in building these centres. Chile and Peru are developing countries, and their CoEs seem to fit very well into what Kroll (2016) has called the 'blind spot' in national innovation policy (Figure 4. Space for CRCs in the policy arena) in that they fulfil the condition of being mid- to long-term initiatives developing pre-competitive research, albeit with some particularities.

Then, the question is how to explain the differences between CRC initiatives. In this regard some authors have argued that participation of firms and other actors in research partnerships can be explained under some theories or conceptual frameworks such as transaction cost theory, game theory, the open innovation approach, strategic management approaches and so on (Gray et al. 2013; Hagedoorn et al. 2000; Koschatzky 2017). However, these authors have also recognised that a unified analytical framework is still missing.

The limitation of those approaches is their focus on individual actors involved in centres and inter-firm interactions. CoEs, as delineated in this study, are partnerships that include not only firms but also universities, intermediaries and international partners, each with their own motivations and strategies. Moreover, centres are the result of public programmes and are embedded in the specific context of each country. For that reason, they require a broader approach to be explained and analysed.

In this regard, the NSI framework seems better suited to explain why CoEs exhibit differences across countries. The first insight here is that depending on the characteristics of NSIs such as their higher education system and the level of technological development, linkages between universities and firms will exhibit different patterns (Perkmann et al. 2013; Schiller and Lee 2015). Therefore, differences between the Chilean and Peruvian centres and CRCs in other countries could be explained in terms of differences in their NSIs.

For instance, centres in the US are university-based organisations sponsored by a consortium of firms, particularly large private laboratories. This could be explained by the long-standing tradition of American universities in providing scientific and technological capabilities, and the strong participation of large firms in supporting public R&D (Mazzoleni 2008; Mazzoleni and Nelson 2007; Mowery 1992). Moreover, the US agency promoting these centres, the National Science Foundation, has established the leadership of universities in such initiatives.

In Germany, large firms are used to collaborating with the public research sector and have enough absorptive capability to do so; for that reason, according to some authors (Koschatzky 2017; Kroll 2016), promoting *Research Campuses* – the specific name of CRCs in Germany – did not face particular challenges. Moreover, rules for setting up the centre ‘under one roof’ was a requirement of the programme launched by the Federal Ministry of Research and Education (BMBF).

As can be observed from the American and German examples, the configuration of centres depends not only on firms’ decisions but also on the characteristics of NSIs in those countries. In the Chilean case, the funding agency (CORFO) required international actors to lead CoEs in partnership with local universities, while in Peru participants were left to decide which actors would lead the initiatives, ending up with them being in university hands.

Moreover, the limited involvement of firms in the Chilean and Peruvian centres could also be explained by certain characteristics of their respective NSIs. It is important to note that this limitation was highlighted not only for the studied cases but also for other CoEs in Chile and Peru. At the system level, firms are still investing relatively little in R&D and innovation, compared to developed countries, as highlighted by various studies on Latin America (e.g. Alcorta and Peres 1998; Sargent and Matthews 2014). Moreover, firms seem to have a low absorptive capacity, and experience in building UILs seems to be very limited. Such features would have constrained firms from leading or driving these initiatives.

These aspects, among others, will be analysed in the following chapter, which focuses on barriers to UILs in the context of CoEs.

## CHAPTER 7. Barriers to university-industry linkages (UILs)

### 7.1. Introduction

In the previous chapter, we concluded that centres of excellence (CoEs) in Chile and Peru have been working as boundary-spanning structures that have turned into specific contexts for UILs. Following the research inquiry of this study, this chapter explores and explains the main obstacles faced by universities, firms and international partners in their interactions in the context of CoEs.

As highlighted earlier, certain aspects relating to UILs in Latin America have only been studied to a limited extent, barriers being one of them. For that reason, we built a tentative conceptual framework with three categories: *orientation-related*, *transaction-related* and *capacity-related* barriers (Section 3.2). In this chapter, we explore these barriers and highlight differences and similarities between Chilean and Peruvian centres.

We will see, for instance, that *orientation-related* barriers are not limited to the characteristics of the science system. They relate to a broad set of interaction channels and are intertwined with the balanced – or unbalanced – relations between the three missions of universities (teaching, research and linking with society and the economy). Findings on *transaction-related* barriers show that the organisation of each centre has brought specific challenges with regard to reaching agreements and solving certain intellectual property (IP) issues as well as how easy/difficult it is to find partners.

This chapter also shows that few firms have staff able to communicate effectively with academics, which may be a sign of their limited absorptive capacity. Universities, on the other hand, exhibit limitations in certain aspects such as knowledge and technology transfer skills and conflicting internal incentives. Overall, we found some connections between the three types of barriers. Finally, we discuss our findings and draw a number of conclusions.

The analysis of the patterns found empirically is not necessarily presented in the same order as the theoretical patterns set out in our preliminary conceptual framework for examining barriers to UILs (Table 3). For instance, the theoretical divide between basic and applied research appeared in the first row of the Table 3, while its empirical analysis is developed at the end of the section because it does not seem to be a particularly



relevant barrier to the participants of CoEs. Instead, different understandings of innovation and research emerged as one important divide between university and business actors, so we developed that at the beginning. We adopted this writing perspective to highlight the most relevant findings and to make the account flow more smoothly.

## 7.2. Orientation-related barriers

According to our preliminary conceptual framework, *orientation-related* barriers include various aspects such as different research orientation (basic versus applied research) and time scales, lack of interest, and lack of mutual understanding. This section analyses the configuration of this type of barrier in each country.

### 7.2.1. The Chilean case

Regarding *the academic side*, according to most interviewees (from academia, civil servants, intermediaries and CoE staff), researchers think that innovation comes from research or they may even believe that they are already innovating by doing research and producing something scientifically valuable or disruptive. Moreover, four people from university intermediaries (interviewees 2640, 2644, 2633, and 2635) pointed out that universities are focused on technological innovation, that coming from research.

A second aspect about universities is the tension between their three missions: teaching, research and linking with external actors. Chilean universities seem to consider teaching as their primary objective, with research in second place and linkages very much in third, and they have set incentives accordingly, in terms of workload and career progression. One staff member of a university intermediary (interviewee 2644) stated that the importance of teaching and research derives from policies set by government and funding agencies such as CONICYT.<sup>25</sup> For instance, researchers' career progression and access to funding are dependent on their publication trajectory.<sup>26</sup>

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<sup>25</sup> For instance, the accreditation system of higher education institutions in Chile is voluntary and focuses mainly on teaching, while research and linkages with external factors are optional areas (Cancino and Schmal 2014). Moreover, one of the most important instruments for promoting research (the FONDECYT programme) evaluates research proposals according to the scientific production of researchers alongside other criteria. Source: <https://www.conicyt.cl/fondecyt/files/2019/05/Bases-Concurso-FONDECYT-Regular-2020.pdf>

<sup>26</sup> Various interviewees (249, 2534, 2640, 2442, and 2445) supported this view.

The resulting incentive scheme can thus explain why researchers are generally overloaded with teaching, research and even administrative tasks, leaving little room for interactions with firms. One researcher (interviewee 2141) stated that *“in Chile one should work up to 44 hours a week (...) which is unrealistic (...) so I do not declare my activities for Fraunhofer [the CoE] because my working time already exceeds 44 hours. This situation of ‘magic numbers’, which depends basically on a bureaucrat, does not facilitate interactions”*. Therefore, it seems that time devoted to work with external actors lies outside the formal accounts of universities, making it largely invisible and thereby preventing decision-makers, in the university and government, from appreciating the time and effort these activities demand.

At the individual level, we found some academics interested in developing UILs for different reasons such as curiosity and access to funding, something that has been highlighted by previous studies (e.g. Ankrah et al. 2013; Arza 2010; Dutrénit and Arza 2010; Lockett, Kerr, and Robinson 2008; Muscio and Vallanti 2014; Perkmann et al. 2013). At the same time, there is another group of academics uninterested in working with firms; one external intermediary (interviewee 2652) added that when scientists were approached to talk about the creation of CoEs, *“they stared at me so frightened; it was as though they were saying ‘how I could bring such an evil into the system, it is something horrific’. That has changed a lot (...) but is still imperfect.”* The position of the last group seems to fit into the so-called ‘ivory tower’ mentality (Etzkowitz et al. 2000; Lockett et al. 2008).

On the other hand, *firms* want a finished, fast and feasible solution (interviewees 2640, 2453, and 2450). According to some interviewees from universities and the centres,<sup>27</sup> firms do not even know how innovation actually works and talk of it as if it were something related to marketing, the marketplace, production and organisation. This view about firms comes from university actors and the centre staff but not from firms

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<sup>27</sup> Interviewees 249, 2640, 2644, 2633, and 2635.

themselves,<sup>28</sup> so it could have been influenced by their understanding of innovation as a result of R&D.

Regarding the focus of Chilean CoEs – doing research and generating new technology – most interviewees stated that firms do not understand how much developing a technology costs and how much uncertainty it implies. When uncertainty is discussed with firms, they either lose interest or decide to start with a small project, despite having sufficient public financial incentives to collaborate with universities and CoEs.<sup>29</sup> One senior staff member of the centre (interviewee 249) highlighted that there are several promoting instruments such that many people now talk of the ‘*corforisation*’ of innovation in Chile.

Despite those incentives, firms seem to be reluctant to invest their own money, often losing interest in collaborative projects when they have to contribute in cash (interviewees 2148, 2445, and 2442). According to staff members of the centre (interviewees 2445, 2450, and 2453), Chilean and more generally Latin American firms do not want to invest in R&D because they have a short-term approach (*cortoplacistas*)<sup>30</sup>. This characteristic of firms has been highlighted not only for Latin America (Alcorta and Peres 1998; Dutrénit and Arza 2010) but also for Asian countries, where most UILs seem to be limited to short-term solving problem activities save some cases that required proper R&D projects, as in the Korean context (Schiller and Lee 2015).

Investment in R&D and innovation can also be explained in terms of sectoral characteristics and the innovation strategies of firms. For example, some interviewees (2453 and 249) believe that the centre works with industries in which firms tend to have a comfortable competitive position, so innovation is not their top priority.<sup>31</sup> Moreover,

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<sup>28</sup> As explained earlier ([Chapter 4](#)), we could not conduct interviews in Chilean firms, which represents one of the main limitations of this study.

<sup>29</sup> For example, subsidies for collaborative research or technology projects as well as the application of the R&D Law, which offers tax benefits for firms investing in R&D.

<sup>30</sup> ‘Cortoplacista’ is a Spanish word, an adjective meaning “that pursue short-term results or effects”. Source: <https://dle.rae.es/>.

<sup>31</sup> For example, in the Chilean fresh fruit sector – the third most important economic sector of the country – 70% of cultivated areas are in the hands of medium-size and large growers, while more than 40% of

when innovation and R&D is carried out by firms, according to two centre staff members (interviewees 2450 and 2439), they still think in terms of developing everything internally, retaining ownership of the results. Whatever the reason, Chile seems to differ significantly from Germany, where a large proportion of firms are willing to outsource research and share knowledge, according to German interviewees (5613 and 5614) and to some studies (Koschatzky 2017; Kroll 2016).

### *Summarising orientation-related barriers in Chile*

Regarding *orientation-related* barriers, we found that academics and businesspeople have different understandings of innovation, which could be the first barrier to develop UIs. Academics think of technological/disruptive innovations based on R&D, with a long-term approach, while firms seem to embrace incremental and organisational innovations and require short-term solutions. In this regard, one staff member of the centre (interviewee 2450) stated that *“it is very hard to reconcile the expectations of researchers, who want to do something unique and move towards the forefront of research (...) with the very mundane and actual needs of industry, which also has little money and wants results as cheaply as possible”*.

At this point, it is necessary to introduce some comments. First, university actors' view of innovation seems to fit into the science-driven or technology-push linear model, described and criticised by Kline and Rosenberg (1986), who have argued that this model distorts the reality of innovation. Moreover, some authors have highlighted that one of the effects of innovation research was that linear models, either science-driven or demand-pull ones, have been replaced by a more complex and multi-actor understanding of innovation (e.g. Cohen, Nelson, and Walsh 2002; Freeman 1994).<sup>32</sup>

Therefore, the question is why university actors still hold such a perspective. One possible explanation is university incentive schemes, which prioritise teaching and

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exports are concentrated in just 10 firms. Moreover, the industry has a high level of vertical integration (Bain 2007).

<sup>32</sup> Rothwell (1994) has set out the historical evolution in models of the innovation process and concluded that all types of innovation process co-exist, with particular features depending on sectoral characteristics. In this regard, Pavitt (1984) has explained that patterns of production and use of innovation differ across sectors, so the simple demand-pull and technology-push approaches of innovation are misleading.

research, leading researchers to embrace the linear concept of innovation as a strategy to defend their interests and current activities (Fagerberg 2011). Another explanation is their lack of capabilities and experience to understand innovation processes, something which will be analysed later on in this chapter.

Second, interviewees from university and CoEs criticised firms' focus on short-term solutions and on marketing, production and organisation, neglecting the fact that innovation requires a combination of knowledge, capabilities and resources such those for production, marketing, distribution and so forth (Fagerberg 2011; Martin and Tang 2006; Teece 1986). Consequently, such a criticism seems to neglect non-technological innovation and the diffusion of innovations, the importance of which has been highlighted by Freeman (1995).

From the conceptual point of view, academics and businesspeople seem to prefer different types of innovations and activities related to innovation, which tends to create a divide between them. Moreover, contrary to previous studies that found the divide between basic and applied research to be part of the *orientation-related* barriers (e.g. Bruneel, D'Este and Salter 2010; Fontana, Geuna and Matt 2006; Schiller and Lee 2015), no interviewee in Chile specifically mentioned this.

Finally, the mismatch seems to relate to interactions at the institutional level, with some interviewees (2439 and 2436) noting that university professors provide consultancy and services to firms outside the control of universities and centres. This would reflect the richness of UILs but, at the same time, it brings challenges regarding the alignment of interests and the lack of information on academics' activities. In this respect, Bodas Freitas, Geuna and Rossi (2013) have distinguished between individual and institutional arrangements of UILs and argued that focusing on the latter could overlook at least 50% of interactions.

#### 7.2.2. The Peruvian case

As described in Section 6.3, the CIC has all its partners represented in its decision-making bodies and was therefore expected to have a balanced agenda between universities and firms. However, this has not been achieved because, as one centre staff member (interviewee 146) highlighted, "*each partner, to tell the truth, had different ideas of what*

*a centre should be and different priorities, which is natural given their characteristics”.*

One businessperson and one external intermediary (interviewees 1218 and 1643) added that the problem within the centre is a lack of integration of the scientific agenda with commercial needs.

On the one hand, *university actors* seem to conceive of innovation as a linear process (the science-push linear model)<sup>33</sup> like their Chilean counterparts do. In this regard, one researcher (interviewee 1126) pointed out: *“we generally think of scientific innovation, (...) of new knowledge (...) developed from research, and from that a new potential application can emerge, which is technological innovation, based on which a product can be created”*. This understanding of innovation drives academics to work at their own pace with a long-term perspective (typically 5 to 10 years) or even without any fixed time-horizon (interviewees 146, 153, 1624 and 1218).

In terms of incentives, the Peruvian university system shows marked differences between public and private universities. Academics in public universities have time to do research in collaboration with firms, but they cannot increase their income as a result of it. Meanwhile, private universities do permit an income increase to their researchers, but these generally do not have enough time to do research and link with firms.<sup>34</sup> Such a difference is important because previous studies (e.g. Link and Siegel 2005) have found that universities with strong and clear economic incentives tend to be more efficient in technology transfer activities.

Notwithstanding, both types of universities seem to face similar challenges regarding UILs. For instance, linkages are not normalised or institutionalised within universities, so there is no clarity on how linkages can affect teaching and research nor on how researchers should be paid for collaboration (academics 1116 and 1128). One staff member of a university intermediary (interviewee 1619) added: *“I would tell academics ‘I can allow you to stop teaching [to work with firms], but (...) if firms do not pay enough, you do not leave teaching and you want to develop a project; you end up working 12 -*

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<sup>33</sup> Confirmed by academics, intermediaries and civil servants (interviewees 1120, 1126, 1617, 146, 1624, 1625, 153 and 154)

<sup>34</sup> This view about the differences is supported by actors in both private and public universities (interviewees 1116, 1120, 1411 and 1617).

*20 hours a day,' (...) so one would expect to have delays and some problems". Professors' time is committed to many activities, so they do not pay much attention to firms, hiring students to attend firms or running late in their deliverables (interviewees 1624, 1619, 1127 and 1218).*

Lack of clarity in incentives could also promote what one staff member of an intermediary (interviewee 1619) labelled as *"the culture of doing research as a 'cachuelo'<sup>35</sup>,"* which is a kind of informal, badly paid job. One researcher (interviewee 1128) highlighted: *"my colleagues think that those who have linkages with firms are doing 'cachuelos' ... so researchers have to 'camouflage' their activities with firms".* The result of this would be organisations without a clear idea of researchers' work, overloading them with several tasks – research and UILs being largely invisible to decision makers (interviewee 1126), as happens in Chile.

At the individual level, there are academics willing to interact with firms because they are curious and want to access funding to do research and improve their capabilities (interviewees 1116, 1214 and 1126). On the other side, there are researchers who like to develop their activities free of influence from outside academia, at their own pace, without feeling that they owe anything to anybody (interviewees 1617 and 1619). These two groups have also been found in Chile.

Regarding *the private sector*, the centre has three types of actors – an international trader, a chocolate producer and a union of small cocoa farmers – each with its own priorities and perspectives on innovation. For example, two businesspeople (interviewee 1214 and 1218) stated that their firms carried out a number of innovation projects aiming at selling basically the same product but with a different characteristic – chocolates without sugar additives, for example. Meanwhile, representatives of a union of small farmers expected the centre to provide evidence for overcoming various trade restrictions in the global value chain, such as the level of cadmium in chocolate products (interviewees 1213 and 1232).

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<sup>35</sup> 'Cachuelo' is a Peruvian slang term, which is recognised by the Royal Spanish Academy, and means "occasional, badly-paid job". Source: <https://dle.rae.es/>

The perspective of firms seems to fit into the concept of incremental innovation, both in process and product, but it does not necessarily match the CIC focus – namely R&D and the generation of new technology. Moreover, like their Chilean counterparts, Peruvian firms seem to be risk-averse and do not recognise how much research costs and how long it takes, preferring sometimes to acquire something that is already fully developed.<sup>36</sup>

Firms' interest in collaboration with universities, particularly to do R&D, seem to be conditioned by the availability of external funding. The best sign of their "interest" without making an investment commitment is their participation in the centre, but with a minimal cash contribution (Section 6.3). According to one researcher (interviewee 1127), firms tend to be interested when they do not have to finance the project, otherwise that "interest" quickly disappears. One external intermediary (interviewee 1643) added: *"it is not the case that growers or their cooperative organisations have to pay with their own resources; governmental organisations are always there to fund things for them"*. This mind-set represents a challenge for decision makers in their efforts to promote private investment less dependent on public subsidies.

Firms' approach to research and technology could be explained by a number of factors. First, firms – particularly small farmers – do not seem to be convinced of the importance of technology; according to one researcher (interviewee 1128), even though the government gives farmers some technology inputs for their crops, they do not apply them. Second, farmers and their cooperatives tend to think that government should solve everything and, therefore, they do not have to fund initiatives themselves (interviewees 1128 and 1643). And third, some firms still try to do everything in-house (interviewee 1214).

Finally, Peruvian actors did mention the dichotomy between basic and applied research as a dividing point for UILs, which has been highlighted by previous studies as an *orientation-related barrier* (e.g. Bruneel, D'Este and Salter 2010; Fontana, Geuna and Matt 2006; Schiller and Lee 2015). According to one senior staff member of the centre

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<sup>36</sup> This is the perspective of academics, centres staff and university intermediaries' staff (interviewees 1116, 1127, 1120, 146, 1411, 154, 1619 and 1625).



(interviewee 146), that divide still remains: researchers are open to doing both basic and applied research, while firms simply do not want basic research.

### *Summarising orientation-related barriers in Peru*

Academics and businesspeople seem to have a different understanding of innovation and research. Moreover, the linear model of innovation is prevalent and dominant among Peruvian university actors, which might be due to either their incentives and interests or their limited capabilities, something we suggested for the Chilean case as well. On the other side, businesspeople highlighted the importance of incremental and organisational innovation as well as their need for supporting evidence to face regulatory aspects.

These differences between universities and firms in terms of their understanding of innovation and R&D, their incentives and interests, would cause differences regarding their time scales (something highlighted by 12 interviewees). However, time-scale differences within the centre seem to be relatively low mainly because firms do not develop projects nor invest in them, letting university researchers lead R&D projects (Section 6.3). Therefore, one would expect more conflicts on time-scale issues either if firms were more involved in R&D or if the centre developed more short-term activities such as consultancy and services.

This does not imply, however, that university actors are not engaging in short-term activities with firms, given that academics provide consultancy and services as individuals (like their Chilean counterparts). One staff member of an intermediary (interviewee 1625) warned that individual activities of academics can promote an 'informal' system of UILs where universities may miss opportunities because firms would see them primarily as providers of human resources rather than as providers of technology and knowledge. However, this is not a unique feature of the Chilean and Peruvian systems, with some authors having studied 'informal' university technology transfer mechanisms such as consultancy and technical assistance in other countries such as the US (e.g. Grimpe and Fier 2010; Link, Siegel, and Bozeman 2007).

### 7.2.3. Concluding remarks: broadening the scope of orientation-related barriers

In both countries, university and business actors have a different understanding of innovation and research, and they respond to different interests and incentives. These findings alongside the conclusions from the previous chapter (on the organisation and activities of CoEs) allow us to broaden the analysis of *orientation-related* barriers by including not only R&D and commercialisation activities but also other channels of interaction such as training for firms, consultancy and services.

Broadening the scope of *orientation-related* barriers address us to conclude that the analysis of UILs should not be detached from the tension found between the three missions of universities and unclear incentive schemes within them. Incorporating this tension into the analysis may help explain, for instance, why differences in timescales relate not only to the usual long-term approach of R&D in Chilean and Peruvian universities and the short-term approach of firms in those countries, but also to the multiple activities of academics and universities' incentives. The analysis should not be detached from the actual innovation needs of firms either, given that they require not only R&D inputs in their innovation processes.

This approach might have implications for redefining the analytical framework of barriers to UILs, understanding these as interactions between the university subsystem and the business subsystem within NSIs. The frameworks currently used consider UILs as relations between science and business systems (Kaufmann and Tödtling 2001) or between different communities producing knowledge in the science system (Dasgupta and David 1994; Meyer-Krahmer and Schmoch 1998), an approach which neglects to some extent the range of UIL channels and the tensions within universities. Such approaches may be suitable for developed countries and high-tech industries, where there is a high participation of firms in R&D (funding and developing it), but not for developing countries and low-tech industries with different needs and patterns of innovation.

Regarding actors' interest, we found two groups of university researchers, those with an interest in interacting with firms and those without such an interest. Even though previous work has highlighted the benefits of UILs for academics (e.g. Ankrah et al. 2013; Arza 2010; Dutrénit and Arza 2010; Lockett, Kerr, and Robinson 2008; Muscio and

Vallanti 2014; Perkmann et al. 2013), the lack of interest of some researchers should not be considered necessarily as a barrier to UILs because from the policy standpoint, as Lundvall and Borrás (2011) have argued, keeping both groups of academics working in parallel within the science system might be desirable.

Moreover, we found that the interest of university researchers in linking with firms refers not only to R&D collaboration but also to other activities such as consultancy, technical assistance and services, activities which are sometimes developed individually and outside the administrative structure of universities and CoEs. Those linkages have been labelled as *informal* interactions and research on this topic for Latin America would certainly be worth pursuing, but this lies outside the scope of the present study.

Our findings have also shown that firms are interested in innovating, but not necessarily the type of innovation that requires R&D as a main component. In the ‘worst’ case, as we showed for the Peruvian case, some firms are not actually interested in applying technology in their production processes even when it is available, something which might also merit further research.

Finally, the low participation of firms in R&D in Chilean and Peruvian CoEs seems to be related to sectoral characteristics. Some studies have highlighted that public investment in the agriculture sector is important around the globe, particularly in developing countries, where less than 7% of the total expenditure on R&D is private (Dutrénit et al. 2012; Klerkx and Leeuwis 2008; Pardey, Alston, and Ruttan 2010; Wright and Shih 2010).

Table 16 summarises the different configuration of *orientation-related* barriers in Peru and Chile.

*Table 16. Orientation-related barriers in Chile and Peru*

Sources of orientation related barriers	Chile	Peru
Academics think/affirm that innovation come from R&D (linear model of innovation)	Yes	Yes
Incentives within universities focus on teaching and research/unclear incentives about UILs Limited time for UILs, which would fall outside formal accounts (‘cachuelos’)	Yes	Yes
Researchers’ lack of interest in linking with firms – ‘Ivory tower’	Yes, but it is not a barrier	Yes, but it is not a barrier

Firms' focus on incremental and organisational innovation – lack of interest in investing in R&D.	Yes	Yes
Firms' lack of understanding of research (times and uncertainty)	Yes	Yes
Lack of economic incentives for firms to link with universities	No	Limited
Basic research versus applied research	No	Yes

Author's own elaboration.

### 7.3. Transaction-related barriers

This section focuses in the second type of barrier of our conceptual framework, the so-called *transaction-related* barriers. This type includes conflict about costs of interactions, disagreements over IP, and problems in identifying potential partners.

#### 7.3.1. The Chilean case

##### *Disagreement concerning interaction costs*

Given the model of operation of CoEs in Chile (Section 6.2), interactions between the centre and academics tend to develop independently from interactions with firms. Regarding the costs of interactions between the centre and universities, we found that agreeing on this aspect was not as hard as defining how much partners will contribute to projects and how public grants would be distributed among them. This conflict emerges because universities and the centre's internal team have different cost structures.<sup>37</sup> Universities have already covered certain costs such as equipment and professors' time, so researchers try to use public subsidies to strengthen their R&D capabilities by training post-graduate students and buying new equipment, for instance. On the other side, the internal team of the centre has to cover its full operation costs including human resource expenses.

Regarding interactions with firms, the main concern is firms' perception that R&D is costly. Managers of two CoEs (interviewees 2436, 2442) stated that firms always complain, saying that projects require 'a lot of money'. These interviewees recognised that interactions could indeed take up a lot of money but that is the actual cost of

<sup>37</sup> A view supported by the centre staff and university actors (interviewees 2450, 249, 2644, 2635 and 2633).

projects. Negotiations in this arena are not so easy and sometimes there is no agreement.

#### *Conflicts over intellectual property (IP)*

Most interviewees stated that there were not conflicts regarding IP between universities and the centre because clear rules were settled from the very beginning and their regulations were quite compatible.<sup>38</sup> However, not all universities in the Chilean system have the same approach; for example, one staff member from a non-participating university (interviewee 2635) complained, saying that international actors arrived in Chile with a somewhat 'imperialistic approach', in that they wanted to retain ownership of the resulting IP, so the university decided not to participate in the CoE.

With firms, negotiation on IP issues was not hard because firms are clients and rules are established right from the beginning.<sup>39</sup> Even though some firms expected to retain ownership of the results or to have an exclusive licence, one centre manager (interviewee 2442) stated that the position of the centre has been *"you pay, and you have access, but it is not yours. Knowledge belongs to the centre"*. This position seems to match with the so-called *knowledge capitalisation* practices of intermediaries, identified by De Silva et al (2018), which is essential for building their internal capabilities and creating value for their clients.

Although IP issues did not cause too much trouble when setting up the centre, discussions on this matter seem to reflect a misleading standpoint because it is focused on ownership of IPR rather than on its exploitation. This approach could explain why some actors seem to have unrealistic expectations on IP (six interviewees expressed this concern). For instance, one researcher (interviewee 2141) stated that people think that they will earn a lot of money from a patent, but the probability of finding something huge to become a big business is very low; indeed, it is almost a 'fantasy'.

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<sup>38</sup> According to the centre's regulations, IP in the beginning is co-owned by the centre and its university partners; then, the university transfers its rights to the centre while the benefits – the royalties – are distributed 50-50.

<sup>39</sup> The distribution of IP depends on the maturity of the technology (interviewees 2450 and 2644): if it is something the centre has been working on, it retains the ownership and licenses the technology. However, if a firm contracts the centre and finances 100% of the project, the firm retains ownership of the resulting IP.

Unrealistic expectations come not only from firms and researchers, but also from staff of university TTOs and civil servants. A staff member of the centre (interviewee 2450) stated that TTOs in some universities were very ‘mean’ because they wanted to keep everything, but they have gradually adjusted their expectations over time. Government expectations about IP, according to one manager of a centre (interviewee 2439), tended to be unrealistic, particularly in a country where there is not a strong food industry or other sectors, such as biotechnology or high-tech industries, where patents are more likely to pay back.

#### *Difficulties in identifying partners*

Most interviewees (among academics, centre staff, and intermediaries) stated that finding potential partners is not hard because Chile is a small country and relevant people are relatively easy to identify. One potential explanation may be that industries working with the centre are highly concentrated in a few firms, as described in Section 7.2.1. The challenge, according to the centre staff (interviewees 2450 and 2442), is to gain their commitment and to convince them to do research, something that connects with what we found in Section 7.2.1 regarding firms’ lack of interest in outsourcing R&D (an *orientation-related* barrier).

According to some interviewees,<sup>40</sup> the centre has to work on demonstrating that its activities are useful for firms; it is still difficult because the centre staff have to talk to 15-20 firms on average in order to get just one contract, and negotiations can take more than a year.

#### *7.3.2. The Peruvian case*

##### *Disagreement concerning interaction costs*

According to the model of the CIC, projects and activities are evaluated by two committees (the scientific and business committees), and the centre’s board then makes the final decision (Section 6.3). As projects are developed mainly by researchers, disagreements arise in the process of approving individual projects. One potential explanation for conflicts over costs is that partners contribute mainly in kind (researchers’ time, equipment, and infrastructure), which is difficult to value and

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<sup>40</sup> Mainly centre staff and civil servants (interviewees 2453, 2445, 2436, 2534 and 2442).

incorporate in project budgets. For example, in the project for a chocolate school, as described by a business actor (interviewee 1214), discussion focused on which costs would be covered by the centre and which by its partners.

Disagreement also relates to the financing of certain items of projects (11 interviewees highlighted this aspect). Firms push to reduce costs by proposing to eliminate the acquisition of equipment, travel costs, and training activities (interviewees 1116, 1120, 1214 and 146), while researchers see those activities as something positive (interviewees 146 and 1619). These different approaches are linked with the different priorities and needs of universities and of firms (*orientation-related* barriers). As in Chile, firms think of reducing costs and achieving returns in the short term, while academics are thinking in the long run, through their attempt to build up their capabilities.

#### *Conflicts over intellectual property (IP)*

According to most Peruvian interviewees, there have been no conflicts regarding IP because the CoEs are just starting and there are no results yet. The CIC is now in the process of approving its internal IP regulations and in this process certain conflicts did arise. The first disagreement, according to one centre staff member (interviewee 146), relates to how ownership and royalties will be distributed between partners, given that some of them are not shareholders of the new firm and therefore cannot receive benefits directly. The second conflict relates to the compensation of university researchers because in universities, according to one staff member of an intermediary (interviewee 1619), researchers receive 50-60% of patent profits, while in the CoE they do not have such a share.

Finally, Peruvian interviewees did not put forward critical views about unrealistic expectations regarding patents and IP, unlike some Chilean participants who did. What is more, according to most interviewees, the focus of the centre is on the production of new technology to be transferred, which means they expect IP exploitation to be the main source of income of the centre.

#### *Difficulties in identifying partners*

Despite the fact that many actors were interested in participating in the set-up of the centre, it ended up with just six partners. Some interviewees (1617, 1127 and 1619)

noted that it is not easy to find large firms willing to invest and committed to supporting the centre as a whole. One potential explanation is that firms do not want to risk their own resources and instead expect public resources to be used to fund UILs. As in Chile, the main problem therefore does not seem to be difficulties in identifying potential partners but in getting their commitment in terms of investment. Another possible explanation, at least for small farmers and chocolate producers in Peru, might be their limited resources to invest in these initiatives.

### 7.3.3. Concluding remarks: where do transaction-related barriers come from?

Differences regarding costs of interactions depend on the organisation of CoEs in different countries. Chilean firms, as *clients* of the centre, complain about the amount of money interactions require, while Peruvian ones, as *partners* of the centre, discuss project budgets, particularly when they include the acquisition of equipment or the training of researchers. The commonality in both countries is universities being focused on using available resources to strengthen their capabilities to keep on doing R&D, which relates to their long-term vision.

We also found that conflicts over IP seem to stem from different understandings of innovation and research across different actors (an *orientation-related* barrier). For university actors in both countries, innovation involves something disruptive, yielding R&D results or patents (Section 7.2) and, for that reason, it would be understandable for them to try to retain ownership of IPRs to obtain the resulting income (an unrealistic expectation, according to some Chilean interviewees). However, the university position may reflect a misunderstanding of innovation and research results (patents, for instance), because research is just one of the inputs required for some innovations, alongside non-technical aspects such as marketing and organisational improvements, as explained earlier.

Moreover, in terms of returns, the literature on university TTOs and CoEs has shown that promises about making money with IP are normally unrealistic. Only a very small proportion of TTOs in American universities are self-sustaining (Abrams, Leung and Stevens 2009), while patents and their benefits in universities are highly concentrated in just a few universities and fields (Mowery et al. 2001; Perkins and Tierney 2014). In the same vein, no more than 10% of the income of CRCs and RTOs comes from IP



exploitation (Andersen and Le Blanc 2013). The unrealistic expectation about the benefits from IP exploitation seems to be more embedded in the Peruvian case.

*Table 17. Transaction-related barriers in Chile and Peru*

Barriers	Chile	Peru
Conflicts regarding costs of interactions and distribution of funds	<ul style="list-style-type: none"> <li>• Universities want to strengthen their capabilities.</li> <li>• Internal team of the centre needs to cover its full budget.</li> <li>• Firms deem that R&amp;D is costly.</li> </ul>	<ul style="list-style-type: none"> <li>• Universities want to strengthen their capabilities, while firms criticise that approach.</li> <li>• Conflicts over the value of in-kind contributions.</li> </ul>
Conflicts over IP	<ul style="list-style-type: none"> <li>• Not too high – rules settled from the beginning.</li> <li>• Unrealistic expectation on IP and misleading focus on ownership instead of exploitation.</li> </ul>	<ul style="list-style-type: none"> <li>• Not too high – there are not results yet.</li> <li>• Discussions on sharing ownership and royalties.</li> <li>• Concerns about compensation to university researchers.</li> </ul>
Difficulties in identifying partners	<ul style="list-style-type: none"> <li>• No</li> <li>• Commitment to invest is the big challenge</li> </ul>	<ul style="list-style-type: none"> <li>• Yes</li> <li>• Commitment to invest is the big challenge</li> </ul>

Author's own elaboration.

Finally, while finding potential partners in Chile seems to be easier than in Peru, we found that this is not a barrier to building UILs. What is actually limiting these linkages is the lack of interest on both sides and the lack of commitment in firms to invest in and outsource R&D activities (*orientation-related barriers*). Besides that, another potential explanation for firms' limited involvement in UILs may be their limited capabilities and resources, something that will be studied in the following section.

#### 7.4. Capacity-related barriers

In this section, we focus on actors' capabilities to initiate and develop linkages with one another as well as on certain conditions of the collaborative environment in Chile and Peru.

##### 7.4.1. Chilean case

###### *Firms*

According to most interviews, Chilean firms in general do not possess the capabilities to undertake research and technology projects. Firms may have innovation units but many of these are actually marketing units, and most firms do not have staff able to communicate with academia and become a 'valid counterpart' (this is supported by six

participants). One centre staff member (interviewee 2453) noted: *“I often see myself without a counterpart on the other side; you simply sit down at the table and they do not understand you. So, it is complicated.”* Moreover, most interviewees considered that Chilean firms also lack the skills to exploit technology and do not even understand aspects regarding investment and business models linked to technology and innovation.

Therefore, capabilities to develop UIs do not depend necessarily on firms having an R&D unit, but on the skills of their staff and their ability to communicate with other actors such academics (Brundenius et al. 2009; De Silva and Rossi 2018; Tether and Tajar 2008; Vaaland and Ishengoma 2016). Moreover, some authors have argued that effective communication with academics often reveals an enhanced absorptive capacity in firms (e.g. De Silva and Rossi 2018; Sutz 2000).

One staff member of an intermediary (interviewee 2640) stated that some Chilean firms try to collaborate with universities or research centres because of their limitations. This statement could imply a degree of substitution of R&D capabilities between firms and the academic sector, such as that found by Brehm and Lundin (2012) for commercialisation channels in China. However, even for these activities, firms require a certain minimum level of capabilities to understand R&D and technology transfer and to communicate with academics, as highlighted by various authors (Arza 2010; De Fuentes and Dutrénit 2017; De Silva and Rossi 2018).

Besides human resources to understand R&D and technology, capabilities in firms also refer to the availability of internal financial resources. In this regard, most interviewees stated that many firms do not have enough resources to invest in R&D and innovation. However, for three interviewees (one centre staff member, one civil servant and one intermediary), there are still a number of firms with the necessary financial resources, the problem being the lack of decisiveness (something found in section 7.2.1 as an *orientation-related barrier*).

### *Universities*

Capabilities can vary across universities because there are both strong universities (i.e. with very strong capabilities) and weak ones. Most interviewees highlighted that Chilean universities have sufficient capabilities to do basic research and interact with

international partners, but they lack capabilities relating to applied research and the translation of research results into technology. According to one centre staff member (interviewee 2451), universities in particular lack the capability to understand, speak, and act with the speed needed to interact with firms.

There have been policy efforts, for example, to create TTOs and strengthen their capabilities,<sup>41</sup> but few of these offices have the necessary capabilities, experience and inputs to fulfil their function. One centre staff member (interviewee 2445) stated that universities are still in ‘nappies’ in this respect because TTOs have personnel who do not understand R&D, while scientists are still reluctant to disclose their findings. One staff member of the TTO at one of the strongest Chilean universities (interviewee 2635) added, the university *“is still in the adolescence phase: too much activity and lack of systematisation”* because of an absence of standardised processes and systematised information regarding research and UILs.

Moreover, according to six interviewees, universities have resources neither to do research nor to develop linkages with firms, depending mainly on external sources. One staff member of an intermediary (interviewee 2644) stated that resources for doing research come mainly from government, and one university researcher (interviewee 2148) added that interactions with firms depend 99% on external funding. This means the lack of a constant flow of resources to allow academics to develop interactions with firms, so they have to apply for grants with all the administrative burden and uncertainty that this implies.

#### *Conditions of the collaborative infrastructure*

One of the most serious problems is the limited resources for UILs, because either actors do not have them, or they are not sufficiently interested in investing in such interactions. Regarding public funding, according to one centre manager (interviewee 249), the problem is not the type of instruments launched by government but the level of funds, which are not large enough to attract attention from international partners, for

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<sup>41</sup> For example, the CORFO Programme for Strengthening Technology and Licensing Offices in Universities. [https://www.corfo.cl/sites/cpp/convocatorias/consolidacion\\_de\\_oficinas\\_de\\_transferencia\\_y\\_licenciamiento](https://www.corfo.cl/sites/cpp/convocatorias/consolidacion_de_oficinas_de_transferencia_y_licenciamiento).

instance. German interviewees (568 and 5610-5611) also highlighted the problem of limited resources in developing countries.

Another condition in Chile, for most interviewees, is actors without enough experience in interacting with one another. According to one external intermediary (interviewee 2652), firms in Chile do not have a history of active cooperation with the scientific sector. Moreover, four staff members of the centre (2436, 2445, 2451 and 2453) recognised that there are few successful models of value created from R&D and, because of that, people have limited information about the costs and benefits of interactions. Lack of experience may also hamper interactions among firms. As mentioned in Section 6.2, there was just one firm involved in each project developed by CoEs and when the centre staff tried to bring firms together, it proved almost impossible (interviewees 2453 and 2439). This problem might explain why the centre is not developing pre-competitive research funded by a pool of firms.

In the policy domain in Chile, a strategic long-term vision promoting R&D and innovation is missing. According to one external intermediary (interviewee 2652), *“a solid central line of promoting applied R&D is lacking; rather with each new government and their new ideas, one new instrument emerges over here, then another one over there. The country’s long-term strategy is missing”*. The lack of continuity in policies, according to one centre manager (interviewee 2436), *“would be the biggest mistake for the long-term survival of this kind of initiative [CoEs]”*.

#### 7.4.2. Peruvian case

##### *Firms*

Peruvian firms, like their Chilean counterparts, face certain problems regarding their capabilities to undertake research, technology or innovation projects (most Peruvian interviewees highlighted this), and therefore one would expect their absorptive capacity to be relatively limited. For example, small farmers and their cooperatives lack the capabilities needed to implement technology and innovation (interviewees 1213 and 1232 and 1617). One researcher (interviewee 1128) illustrated the situation as follows: a research team and a cooperative of small farmers had developed an activity benefiting

a few farmers, and the cooperative was then expected to diffuse it to the remaining associates, but that never happened.

Chocolate manufacturers may have production capabilities, but not the capabilities for doing research (interviewees 1331 and 1214), while the largest business partner, the international trader, only manages the commercial aspects of innovation (interviewee 146). Occasionally, there are firms that have certain capabilities, but their problem is a lack of conviction to develop interactions with universities (interviewee 1625) as they prefer to develop their projects internally, as highlighted earlier (Section 7.2.2).

According to one researcher (interviewee 1126), R&D capabilities in firms are not critical because *“the university or the centre of excellence, through its researchers, can replace them (...) The centre of excellence can serve as those firms’ R&D unit”*. This perception involves a form of substitution rather than complementarity between the firms’ and academics’ capabilities. However, as argued for the Chilean case, while firms may not need to have their own researchers and R&D laboratories, they should have a minimum of capabilities to understand research, technology and innovation in order to develop UILs.

In terms of internal financial resources to develop UILs, seven interviewees stated that firms do not possess such resources. One business actor (interviewee 1218) stated that industry does not have the time to develop interactions with academia because they do not have personnel and resources for those activities. Regarding cooperatives of small farmers, another business actor (interviewee 1213) stated that they do not generate profits, as firms do, so they might contribute with equipment, office space, or personnel time, but not monetary resources.

### *Universities*

A large number of interviewees (fifteen) pointed out that most universities lack certain capabilities, while few are actually doing R&D. As mentioned earlier, Peru has public and private universities, each with their own characteristics. The public university participating in the centre has certain R&D capabilities and is specialised in agriculture but still lacks equipment and trained personnel in technology management. According to one staff member of the intermediary unit of that university (interviewee 1617), *“we*

*are far from the best research capabilities; that is the origin of distrust in firms because they can acquire technology that we do not even know about*". On the other hand, the private university has more capabilities than its public counterpart, but it is not specialised in agriculture and still faces challenges regarding certain quality aspects such as the certification and calibration of equipment (interviewee 1619).

Moreover, one civil servant and two business actors (interviewees 154, 1213 and 1232) argued that there are few specialised researchers on cocoa in the country, distributed across a few universities or other organisations. One civil servant (interviewee 153) reinforced this point, stating that firms sometimes have better capabilities than universities and have more information about technology. In this regard, some authors have found universities to be lagging behind industry in terms of industrial developments, which may be a deterrent for developing UILs (e.g. Fontana, Geuna, and Matt 2006).

In terms of capabilities of management and building linkages with external actors, most interviewees highlighted that universities have certain shortcomings. Researchers and universities do not have a business approach in their activities; for example, they lack a portfolio of services and information on researchers who might be interested in interacting with firms. According to researchers from two different universities (interviewees 1116 and 1127), diffusion of information on what universities can do for firms is largely missing. This would make it difficult to find potential partners (a *transaction-related* barrier).

Moreover, bureaucracy is another problem faced particularly by public universities in Peru (eight interviewees mentioned it) because when projects pass through their administrative structure, one can expect delays in their execution. This tends to discourage both researchers and firms from developing interactions (interviewees 1127 and 1411), and it could explain why researchers and firms prefer to interact with each other outside of university procedures (i.e. through 'informal' interactions).

Finally, universities also face budget limitations in order to perform different activities such as carrying out research, interacting with firms, and building an internal infrastructure for supporting linkages (TTOs, for example). Thus, research and

interactions with firms seem to depend on external funding, as in Chile. The effect is actors relying on public competitive grants, with all the associated administrative burden and uncertainty, which may prevent them from developing UILs as a systematic activity.

#### *Conditions of the collaborative infrastructure*

The first aspect is the limited resources for building UILs in Peru. As highlighted earlier, both economic incentives from government and private investment in R&D are relatively low.<sup>42</sup> According to an international actor (interviewee 1331), the Peruvian agency's efforts are interesting but *"resources are very limited; even with the funding for the centre of excellence, there is not enough money to do as much work as is needed (...) The size of the project is still very small"*. And that is the perception about one of the most ambitious programmes in terms of funding in this country.

Moreover, most interviewees recognised that there is not much experience in developing interactions and exploiting research results. According to one staff member of an intermediary (interviewee 1624), *"the lack of successful cases of linkages does not allow us to have a model to follow"*. As in Chile, a lack of experience in collaboration seems to affect both the business and the academic *worlds*. In the business sector, however, we found ECOM and La Central participating in the CIC even though they are competitors and have experienced some conflicts. On the university side, the situation was depicted by one centre manager (interviewee 1411) as follows: *"Peru is a country of divided and isolated capabilities"* because even within the same school of the same university, research groups are like small dominions with nobody sharing information. This may explain the lack of information about what universities can offer to firms (a *transaction-related barrier*).

In the policy area, a strategic vision promoting collaboration is missing. According to one civil servant (interviewee 152), the problem is not so much a lack of funding – because there are far more resources than in the past – but a lack of organisation within government in order to have a strategic approach to provide funding and support.

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<sup>42</sup> This has been highlighted by academics, centres staff and intermediaries (interviewees 1120, 146, 153, 1617, 1619 and 1411).

According to one centre manager (interviewee 146), there is duplication of governmental initiatives aiming to support the cocoa sector, which may dilute efforts and generate unnecessary competition. For example, CONCYTEC is promoting the CIC while the National Congress has created the National Institute of Peruvian Cocoa.

#### 7.4.3. Concluding remarks: How much do capacity-related barriers matter?

In both countries, firms seem to have limited capabilities to develop R&D and technology projects by themselves and to build UILs, since most of them do not have researchers and laboratories. Moreover, what is more important for this study is that they do not have staff able to communicate effectively with academics. As argued earlier, firms require a certain minimum level of capabilities to communicate with academics (Arza 2010; De Fuentes and Dutrénit 2017; De Silva and Rossi 2018).

On the other hand, Chilean and Peruvian universities seem to have different capabilities to develop R&D, the former having better conditions than the latter. However, in terms of their capacity for transferring R&D results to firms and managing linkages, universities in both countries seem to be dealing with similar difficulties such a lack of experience and capabilities, limited information about their own capabilities and opportunities, and a lack of standardised procedures. In Peru, university actors recognised that they sometimes lag behind firms in terms of certain technologies, while Chilean actors highlighted the fact that they do not have much information about the ‘pains’ of firms (i.e. their needs).

Previous work on technology transfer and TTOs has highlighted the importance of certain factors in promoting researchers to become involved in technology transfer (e.g. Ho et al. 2014; Link and Siegel 2005; Link, Siegel, and Bozeman 2007). Those factors refer to TTOs’ experience and capabilities, clear rules about economic benefits (incentives), and academics’ willingness to disclose their discoveries; Chilean and Peruvian universities face certain limitations with regard to most of these factors.

*Table 18. Capacity-related barriers in Chile and Peru*

Barriers	Chile	Peru
Firms lack the capabilities to develop R&D (scientists and labs)	Yes	Yes
Note: Not always necessary for developing UILs		
Firms lack staff able to communicate with academia	Yes	Yes



Firms lack Innovation management skills	Limited	Limited
Firms' limited financial resources, combined with lack of interest in R&D	Yes	Yes
Universities lack of capabilities to do R&D Note: In Peru, there are differences between public and private universities	No	Yes
Universities lack the capabilities to do applied research and translate R&D into technology; weak TTOs Note: differences across universities	Yes	Yes
Universities lack internal financial resources UILs depend on competitive public grants	Yes	Yes
Not enough resources in the system	Yes	Yes
Lack of experience in developing collaboration and UILs Lack of successful models	Yes	Yes
Incoherence and discontinuity in policy	Yes	Yes

Author's own elaboration.

Despite some people in universities and centres in Chile and Peru believing that they could substitute for firms' capabilities, we found that firms require a certain minimum level of skills in order to communicate effectively with academics, and these skills are part of their absorptive capacity (De Silva and Rossi 2018; Sutz 2000). In this regard, firms' absorptive capacity has been identified as a success factor for the role of intermediaries in general (Kodama 2008; Yusuf 2008) and boundary-spanning structures such as CoEs in particular (Gray et al. 2011).

Moreover, capabilities relating to UILs also refer to the region, sector and country levels (Mazzoleni 2008; Mowery and Oxley 1995; Qiu, Liu, and Gao 2017; Soete 1985). These capabilities encompass, for example, experience in promoting and building UILs, something which is missing in Chile and Peru. They also include the availability of financial resources to develop UILs, which are limited; in this regard, Sagasti (2013) has pointed out that there has been a historical lack of resources for R&D in LACs, both from public and private sources.

Finally, in the policy domain, we found incoherence – several initiatives addressing similar objectives – and discontinuity – a new government coming with new ideas – which might weaken UILs. However, these problems are not exclusive to Latin America,

in that Klerkx and Leeuwis (2008) found similar problems for innovation policy in The Netherlands, particularly in promoting technology intermediaries.

### 7.5. Final discussion on barriers to UILs

Our findings with regard to barriers to UILs, in the context of CoEs in Chile and Peru, provide insights relating to two relevant aspects: the analytical framework for barriers to UILs and the role of universities and CoEs in countries like Chile and Peru. On the first matter, current approaches used to study the origin of these barriers seem to provide only a partial explanation for our findings because they are focused on R&D. For Latin America, analysing barriers to UILs should encompass a range of channels of interaction, going beyond just contract research and commercialisation channels.

The detailed description and explanation of each type of barriers (developed in this chapter) allow us to identify certain relationships between barriers. For example, timescale differences relate not only to different understandings of innovation but also to unclear incentives within universities, which seem to privilege teaching and research, leaving limited time for academics to link up with firms. A different understanding of innovation between universities and firms, or even a misunderstanding of the nature of innovation and research (*orientation-related* barriers) would, for instance, explain the unrealistic expectations about IP and certain disagreements over costs (*transaction-related* barriers).

Moreover, various *capacity-related* barriers could help explain the other types of barriers. For instance, the lack of capabilities and experience in universities (a *capacity-related* barrier) can reinforce the linear conception of innovation among university actors (an *orientation-related* barrier) and their unrealistic expectations regarding IP, thereby worsening conflicts over this matter (a *transaction-related* barrier). Thus, understanding innovation as a linear process may not only be related to researchers' strategic desire to protect their current activities, as suggested by Fagerberg (2011), but also to certain limitations in their capabilities.

On the other hand, firms' lack of experience and their limited capabilities to build UILs (*capacity-related* barriers) may reinforce certain misunderstandings about R&D (an *orientation-related* barrier) and generate disagreements over costs (a *transaction-*

*related* barrier). In the same vein, a lack of resources in universities, firms and the system as a whole, alongside incoherent and discontinuous policy measures (*capacity-related* barriers), does not allow actors to develop UILs systematically, as they depend on accessing public grants that come with a degree of administrative burden and uncertainty that may discourage actors from developing UILs.

Relations between these three types of barriers do not necessarily imply cause-and-effect relationships; these relationships seem to be much more complex. For instance, academics' assumption that innovation comes from disruptive scientific findings could explain why universities set up incentives privileging basic research and neglecting interactions with firms. However, we also could argue the opposite, that incentive schemes privileging basic research may explain why academics embrace a linear conception of innovation, as a strategy to protect their own interests. A similar bidirectional relation may be found between firms' lack of resources and successful experiences with their interest in investing in R&D. Therefore, we can only conclude that those barriers are interlinked with one another.

The second contribution of this chapter refers to certain insights in analysing the role of universities and CoEs in developing countries. Actors in universities and CoEs still think that their mission is to do R&D and to replace firms' capacities as well as to 'educate' or 'enlighten' firms to become more involved in R&D. We argue that more than merely 'educating' firms, they might need to understand firms' needs better, show that they are able to support them, and re-orientate their activities if needed.

Some authors have already called for new roles of universities, such as supporting firms according to their technological capabilities (Schiller and Lee 2015) and backing the development of countries and regions (Brundenius et al. 2009), through differentiated functions, with some universities being involved in international connections and others relying on domestic collaborations to support innovation at the national and regional levels (Bramwell and Wolfe 2008; Qiu et al. 2017). Under these new approaches, the challenge is how to organise their missions and provide appropriate incentive schemes (e.g. funding, time, and career progression criteria) to foster different activities with firms (research, training, consultancy and services).

In the same vein, our findings lead us to question the roles of CoEs, calling for more than the generation and commercialisation of new technology, to promote their involvement in capacity-building activities. In a context of limited capabilities, it is appealing for CoEs to broaden their scope to internal training (as the FCR-CSB does) and training for firms and academics, which is very limited in both countries. Even in developed countries, such as the UK with its Catapult initiatives, enhancing firms' absorptive capacity has been recognised as a key role of CRCs (Hauser 2014). Short-term results, therefore, could offer a feasible means to develop capabilities in firms alongside building legitimacy to maintain stakeholders' support.

In terms of incentives, there seem to be good financial instruments in Chile and increasing resources in Peru, but both countries still face certain challenges – for example, how to promote private investment less dependent of public subsidies, and how to increase the participation of the private sector in R&D and innovation activities. A second challenge is how to make public support more accessible by, for example, increasing public resources – only 6% of firms in Latin America countries accesses public support, while in OECD the figure is 18% (Crespi et al. 2014) – and promoting more stable and coherent programmes.

## CHAPTER 8. Intermediary roles in the context of Centres of Excellence

### 8.1. Introduction

In Section 2.3, we argued that intermediaries play an important role not only within innovation systems but also in fostering university-industry linkages (UILs). We also highlighted the range of intermediaries and the activities they perform (Section 3.3). Moreover, CoE programmes in Chile and Peru have required the participation of international actors, expecting them to connect local actors with international sources of knowledge and technology and to help them build their capabilities. Therefore, this chapter critically analyses the role of intermediaries and international partners.

The first part of the chapter explores the range of actors performing intermediary roles during the set-up of CoEs and shows that some of them have not usually been included in previous studies, while the set of activities they perform are particular to the context of CoEs. We find, for instance, that some external actors and senior university authorities played essential roles in this domain, while some ‘traditional’ university intermediaries such as technology transfer offices (TTOs) had a much more limited involvement. Our findings also show, particularly for the Peruvian case, that some university researchers have been the main promoters of CoEs, fulfilling a kind of ‘gatekeeper’ role.

The second part of this chapter focuses on the role of international actors. To examine this aspect, we turn to intermediary roles identified in previous studies (Section 3.3.2), which include support to universities and firms in aspects relating to R&D and technology transfer capabilities, the broadening of their international networking, access to laboratories, and so forth. We found that in our study international partners have been playing a very limited intermediary role and elaborate some potential explanations for this finding.

The analysis of intermediary roles in this chapter should be distinguished from the roles of CoEs as boundary-spanning organisations (something that has been studied in detail in [Chapter 6](#)). As we showed in that chapter, CoEs in Chile and Peru have emerged as structures within which actors develop a range of interactions, providing a platform that allows them to collaborate at different levels.

## 8.2. Actors supporting the set-up of CoEs

The process of setting up CoEs in Chile and Peru was quite complex because of the participation of several actors, each with different priorities and understandings about research and innovation, as shown in [Chapter 6](#) and [Chapter 7](#). CoEs have demanded complex structures and different levels of coordination that distinguish them from individual collaborative R&D projects. In this context, Chilean and Peruvian interviewees acknowledged the important role played by some actors in facilitating dialogue and striking agreements.

In the phase of setting-up CoEs, these actors did not participate directly in any specific innovation process – understood as the introduction of a new product or process at the firm level, as defined by Nelson and Rosenberg (1993); instead, they were involved in the building of organisations aimed at supporting UILs and innovation projects. The creation of these CoEs involved the definition of research and innovation agendas and the design of a structure to support their implementation. In both countries, we identified organisations and individuals promoting those initiatives.

The first question we then address is whether the activities performed by these actors can be regarded as intermediary roles, given that they are not directly linked to the introduction of new products or processes at the firm level. We are inclined to a positive answer because CoEs, according to some authors (e.g. Gray, Johnson and Gidley 1986; Kroll 2016), generate institutional proximity<sup>43</sup> between universities and firms and, therefore, create the environment to support the bridging of those two *worlds*. Therefore, the process of setting up CoEs fits into the broad concept of NSI that, according to Lundvall (2016), includes the institutional set-up of the learning process.

In the Chilean case, for instance, three senior actors stated that the Chilean-German Chamber of Commerce (CAMCHAL is the Spanish acronym) had played a fundamental role in linking partners, particularly regarding cultural differences between people coming from

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<sup>43</sup> Institutional proximity in the field of UILs can be understood, following Schiller and Lee (2015: p. 59), in terms of similarity in “institutional background, incentives and aims of both parties [universities and firms].”

different countries (interviewees 2436, 249 and 2652). In the literature, intermediary roles of industrial associations have been highlighted in both developed and developing countries (e.g. Brimble and Doner 2007; Dossou-Yovo and Tremblay 2012; Kodama 2008; Sutz 2000; Watkins et al. 2015). The distinctive feature of CAMCHAL is that it does not respond to a specific sector or industry, but to firms and investment coming from a specific country (Germany).<sup>44</sup>

Other important facilitators were public organisations such as the funding agency (CORFO) and the Ministry of Agriculture. According to one civil servant (interviewee 2534), the Chilean funding agency performed a kind of intermediary role in the set-up of CoEs by accompanying partners in building networks with academia and industry. Moreover, a senior manager of a CoE (interviewee 2442) stated that government officials from the Chilean Ministry of Agriculture and the Foundation for Agrarian Innovation (FIA in the Spanish acronym) were assigned to support the setting-up of CoEs. Despite certain limitations such as insufficient information about firms' needs, the funding agency did play a fundamental role by not only providing subsidies but also building bridges between different actors.

The other group of intermediaries are university actors such as TTOs or the like. However, in the process of setting up CoEs in Chile, other university units participated, particularly those at a more senior level in the hierarchy such as pro vice-chancellors and senior authorities. Again, their function in the set-up phase of CoEs did not relate to specific innovation or R&D projects but to the building of centres, which required the involvement of universities at two levels, high-level authorities to sign the consortium agreement and researchers in charge of defining the R&D agenda in coordination with the international actor. Moreover, university authorities provided CoEs with stability in the long run by looking for new research groups to replace groups leaving the initiative (interviewees 249 and 2640)

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<sup>44</sup> <https://chile.ahk.de/es/acerca-de-camchal/>

Regarding TTOs, we found that in some universities, they played a certain role in facilitating negotiations, while in others they were not involved at all. For instance, a manager of a CoE (interviewee 2442) stated that *“technology transfer offices in universities do not have influence; it [the centre set-up] was negotiated with pro vice-chancellors or heads of departments.”* Meanwhile, one staff member of a TTO (interviewee 2633) stated *“Our researchers participate in the formulation process; we as an office do not formulate the proposal, but we oversee, guide, support, sometimes finance the hiring of some formulators (...) and oversee all the legal aspects and fulfilment of regulations”*. Differences in TTO roles can be explained by their different capabilities (discussed in Section 7.4).

In Peru, the involvement of intermediaries was quite similar. For instance, there was a non-governmental organisation, a development body (Pro-Ambiente) coming from the German International Cooperation Agency, which articulated efforts and actors around certain unifying threads (six interviewees mentioned this). Moreover, four interviewees recognised the intermediary roles of the funding agency (CONCYTEC), despite certain limitations that civil servants themselves recognised. One difference with the Chilean experience is that partners of the centre hired an external facilitator to support coordination and to elaborate a unified proposal (eleven interviewees mentioned this).

Regarding university actors, their participation in the setting-up process varied across universities. In one university, the Director of Research and the TTO played a leading role by bringing actors together within the university and negotiating with external actors (interviewees 1116, 146, 152, 153, 1619, and 1625). In another university, researchers were involved in the formulation of the proposal, while the Pro Vice-Chancellor of Research and the TTO participated at the end of the process just to organise the signature of agreements (interviewees 146, 1617, and 1624). As in Chile, the participation of senior university authorities allowed the centre to change researchers when some of them stepped aside or to incorporate new ones for new projects (interviewee 1617).

Moreover, Peruvian interviewees (1116, 146, 1619, 1625, and 1617) highlighted that initially some university researchers were involved in the set-up of CoEs. Those individuals



developed their activities with both an inward and an outward orientation. Through their inward orientation, they contacted other researchers within the same university to organise the formulation of a CoE and liaised with high-level authorities to obtain institutional support. Their outward activities included the invitation to firms to take part in the proposal of CoEs and linking up with international actors to support the initiative.

Table 19 summarises the type of actors with intermediary roles we have identified in the context of CoEs in Chile and Peru.

*Table 19. Actors and their intermediary roles in CoEs*

Actors	Chile	Peru
<b>External actors</b>	CAMCHAL – Trade organisation <ul style="list-style-type: none"> <li>• Brokering agreements between partners</li> </ul>	Pro-Ambiente – Development agency <ul style="list-style-type: none"> <li>• Fostering the joint definition of an innovation agenda in the cocoa sector</li> </ul>
	Funding agency <ul style="list-style-type: none"> <li>• Providing information and organising linking events</li> <li>• Limited information on firms' needs</li> </ul>	Funding agency <ul style="list-style-type: none"> <li>• Providing information and organising linking events</li> <li>• Limited information on firms' needs</li> </ul>
	Ministries <ul style="list-style-type: none"> <li>• Accompanying the process</li> </ul>	None
	None	External facilitator <ul style="list-style-type: none"> <li>• Coordination and elaboration of the proposal</li> </ul>
<b>Internal actors</b>	TTOs <ul style="list-style-type: none"> <li>• Their role varies across universities</li> </ul>	TTOs <ul style="list-style-type: none"> <li>• Their role varies across universities</li> </ul>
	Vice chancellors and high-level authorities <ul style="list-style-type: none"> <li>• Institutional support</li> <li>• Stability to CoEs</li> </ul>	Vice chancellors and high-level authorities <ul style="list-style-type: none"> <li>• Institutional support</li> <li>• Stability to CoEs</li> </ul>
	None	University gatekeepers <ul style="list-style-type: none"> <li>• Promoters of CoEs</li> <li>• Power and control of information flows</li> </ul>

Author's own elaboration.

As can be observed in both countries, alongside 'traditional' intermediaries – e.g. TTOs – there were other actors facilitating negotiations and giving stability to CoEs. They include trade organisations, public agencies, and even international cooperation development

agencies, all entities that did not have a direct mission of enhancing innovation at the firm level, but which have nevertheless facilitated the setting up and operation of CoEs. In this regard, some studies have argued for opening up the concept of intermediaries to include not only actors bridging the research sector with industry at the firm level, but also other individuals and organisations that stimulate, for instance, the innovative capacity of regions, countries or sectors (Dalziel 2010; Frietsch and Schubert 2012; Warnke et al. 2015).

Finally, we should highlight the importance of engaging the most senior authorities in universities. These units have not been ‘traditionally’ included as internal intermediaries by the literature, but they seem to have been playing a very important supporting role in CoEs, which require a mid- to long-term vision and institutional support. According to international experiences (e.g. with I/UCRCs and ERCs in the US), initiatives of this kind can fail or succeed depending on the level of institutional support they receive from their host university (Gray et al. 2011; Stone 2015).

### 8.3. The limited intermediary role of international actors

CoE programmes in Chile and Peru have required the participation of international partners, expecting them to connect local actors with international sources of knowledge and technology and to help them in building their capabilities. In [Chapter 6](#), we described how international partners fit into the structure and governance of the Chilean and Peruvian CoEs. Complementing that analysis, this section studies the benefits for local actors from interacting with international partners and, in order to do so, we take intermediary roles as a reference framework (see Section 3.3).

In Chile, CoEs ended up being led by subsidiaries of foreign RTOs, with foreign names but local capabilities, as shown in Section 6.2. Unlike Chilean centres, the role of international partners in Peruvian centres was secondary, as described in Section 6.3. Nonetheless, the roles of international actors with regard to their direct connection with local actors seem to exhibit similar patterns in both countries. For instance, Chilean and Peruvian actors recognised that the main contribution of foreign partners has been their ***names and prestige***.

In Chile, two senior managers of CoEs highlighted that international actors bring an illustrious reputation with them, which opened many doors. According to one of them (interviewee 2436), *“it was an amazing opportunity to work with such a well-recognised innovation brand”*.<sup>45</sup> In Peru, at least five interviewees<sup>46</sup> recognised that the prestige of the international partner helps to build a positive image of the initiative. As one senior manager of the Peruvian centre (interviewee 146) stated, *“as a brand, it helps a lot ... if I wanted to deliver a service, it is like saying ‘hey, these are the centre partners and we have one of the best universities from the US”*. Therefore, international actors in both countries seem to help local actors in signalling their capabilities because they are working with well-recognised and prestigious organisations.

However, that does not necessarily mean that they are playing important roles in ***supporting dialogue between partners and building UILs***. For instance, in Chile most interviewees criticised international partners because they do not usually foster direct linkages between partners. We found two potential reasons for this limited role: first, the organisation of Chilean centres requires their internal teams to be involved and to lead all interactions between universities and firms (as described in Section 6.2). Second, promoting direct connections between different actors is not their responsibility according to the CoE programme, as was made clear by a civil servant (interviewee 2534).

In Peru, most interviewees pointed out that international partners limit their roles to participation on the centre’s *board* and involvement in specific research activities. Moreover, the international actor (interviewee 1331) recognised that they do not play an important function in facilitating dialogue between actors. Expectations about international partners were well described by one civil servant (interviewee 154), who complained saying *“they [international actors] are more focused on research projects; however, it [facilitation*

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<sup>45</sup> The general manager of another CoE (interviewee 2442) stated that rather than financial backing, the international actor supported the initiative with its name and prestige, providing evidence that an experienced organisation which had successfully carried out projects with firms in many places was involved.

<sup>46</sup> Among them academics, business actors and the international partner (interviewees 1218, 1331, 146, 1123, and 1412).

*of interactions] would have been important because they have a lot of experience in this type of linkages and in negotiations on technology”.*

Regarding other intermediary roles, the literature has identified activities such as supporting actors in several aspects of R&D, improving networking, laboratory sharing, finding specialist personnel and so forth (Andersen and Le Blanc 2013; Dutrénit et al. 2012; Howells 2006; Kodama 2008; Mina et al. 2009). In terms of **R&D and commercialisation**, international centres were attracted to Chile to fill a gap in the system relating to capabilities in applied R&D, technology transfer and commercialisation of research results. Therefore, we might have expected international partners to strongly support local actors in these aspects but, according to most Chilean interviewees, that did not happen.

A senior manager of Chilean centre (interviewee 2436) stated that there was not too much collaboration to strengthen universities' R&D capabilities, for example. This interviewee stressed: *“to some extent, I was very sad they [universities] did not come to us to either work together or take our advice. We did actually provide lots of advice for many, many organisations ... but our involvement with universities was not as close as it should have been or could have been”*. Moreover, a staff member of a university intermediary (interviewee 2635) stated: *“whether they [international actors] brought technology or encouraged the participation of specialists with advanced knowledge from their headquarters, in projects developed in Chile, that did not happen”*.

In Peru, as mentioned earlier, the participation of the international partner was limited to attending meetings of the centre's board and supporting the scientific committee. For that reason, several interviewees (1617, 1624, 1127, 1120, and 1126) labelled its role as a 'consulting' or 'advisory' function.

Regarding the strengthening of local actors' **capabilities in knowledge and technology transfer**, Chilean interviewees recognised that international actors brought some capabilities into the country, for instance, procedures for laboratory management, confidentiality, and technology transfer. However, six interviewees complained that universities, particularly TTOs within these, did not benefit from the process. Two persons

from university intermediaries (interviewees 2640 and 2633) stated that in this aspect *“there is a debt”* and one of them added: *“if I had to highlight a weak point of this programme of attraction of centres of excellence, it would be that they did not install those capabilities sufficiently”*. In Peru, this role was almost negligible; as one civil servant (interviewee 152) pointed out, the international centre focused on research, so *“it was hard for us to incorporate other topics of interest such as technology transfer”*.

In this regard, according to some interviewees from Germany, the main objective of internationalisation of intermediaries such as the Fraunhofer Society is to gain access to funding and knowledge, which has been highlighted in previous studies (e.g. Berger and Hofer 2011; Jonkers and Cruz-Castro 2010). Considering the other side of international collaboration, German actors (interviewees 5610-5611) stated that they expect their counterpart to access knowledge and technology useful for their needs and to benefit from German organisations’ experience in building UILs and carrying out technology transfer. However, based on our findings in Peru and Chile, it seems that those benefits are still very limited.

Regarding other potential benefits, most Chilean interviewees stated that ***accessing laboratories and equipment of the parent centre*** is possible, but its realisation has been very limited for various reasons. The first difficulty comes from the business model of Fraunhofer institutes, which are financially independent from each other and, therefore, using their facilities comes with associated costs. Second, one member of an intermediary unit (interviewee 2633) stated that laboratory sharing is possible but did not happen because international actors do not have large equipment based in Chile, while there is little connection with their overseas headquarters. A few exceptions can be found in collaborative projects, where some activities are carried out in Germany and the results are then sent to Chile (interviewees 249 and 2644). A similar situation has been highlighted by Peruvian actors involved in the CoE.

In terms of **networking**, Chilean actors, among centres staff and intermediaries,<sup>47</sup> highlighted that the contact with the international partner allowed firms to link directly with Fraunhofer institutes in Germany. Moreover, there is a lot of mobility (internships and visits) between the internal team of the Chilean centre and Fraunhofer institutes. However, Chilean university actors (interviewees 2148, 2149, 2633, and 2635) perceived that they did not benefit greatly from those international linkages. For instance, a person working for a university intermediary (interviewee 2635) complained, *“they have not opened up opportunities for us, such as those of Horizon 2020<sup>48</sup> (...) there was not this kind of collaboration outside the established activities of the CoE”*.

In Peru, half of our interviewees stated that international actors did not promote those connections because either local partners did not ask for that or they have nothing to show internationally yet. The other half acknowledged that there had been some actions to strengthen networks, but they are still relatively limited. Those actions include, for example, the participation of Peruvian actors in international academic events, internships and visits.

Finally, intermediary roles also refer to **supporting actors to create new firms, linking them with investors and incubators, to identify and hire specialist personnel as well as to promote internationally the products of local partners** (Kodama 2008; Mina et al. 2009). Most interviewees in Chile and Peru did not recognise these functions in international partners. For instance, a senior manager of the Chilean CoE (interviewee 2436) highlighted that it did not play the role of linking firms with investors because “the system has not been that much developed, and the centre of excellence did not have that much experience to offer backing to start-up companies”.

Summarising, we can conclude that international partners of CoEs in Chile and Peru have been performing certain roles, some of which are considered as intermediary ones in section 3.3.2, with certain characteristics. As we argued in Chapter 3, the taxonomy

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<sup>47</sup> Interviewees 2450, 2451, 249, 2644, 2652, and 2442.

<sup>48</sup> Horizon 2020 is a European research and innovation programme that provides subsidies for projects that can involve the participation of non-EU partners.

presented in Table 5 was just a point of reference to analyse empirically the roles of international actors and was used with an open perspective about what these roles would be like in the context of CoEs in Chile and Peru. For that reason, the resulting taxonomy set out in Table 20, which does not match precisely with Table 5, can be regarded as a new analytical framework suitable for studying the contribution of those actors in partnerships aimed at fostering developing countries' capabilities in areas such as technology transfer, university-industry linkages, and innovation.

*Table 20. Roles of international partners in the Chilean and Peruvian systems*

Activities	Chile International RTO	Peru International University
Reputational benefit Opportunities to broaden networks Signalling of local actors' capabilities	Yes	Yes
Facilitating dialogue and interactions between local actors	Very limited	None
Support to universities and firms in R&D aspects	None	None
Support to universities in knowledge and technology transfer management	Very limited	None
Accessing laboratories	Very limited	Very limited
Broadening networking and mobility	limited	limited
Support entrepreneurship Linking with investors Identifying specialist personnel	None	None

Author's own elaboration.

In this regard, international partners in both Chile and Peru do not seem to be fulfilling, to the expected degree, an intermediary role among local partners and between the local system and the international sphere. The limited role of international partners can be explained by certain conditions and capabilities in the Chilean and Peruvian systems, such as the lack of resources. Interviewees from Chile and Germany highlighted that one of the most important factors hampering the building of international connections is the lack of resources (a *capacity-related* barrier identified in Section 7.4). In the Peruvian case, the

international partner (interview 1331) stated: *“resources are very limited; even with the funding for the centre of excellence, there is not enough money to do as much work as is needed, but the centre is doing really amazing stuff. The size of the project is still very small.”*

A second potential explanation, particularly for the lack of knowledge or technology brought from abroad, is that foreign technologies do not necessarily fit the needs and capabilities of receiving countries, as highlighted by some German actors (interviewees 564, 568 and 5613). In Section 7.4, we found that Chilean and Peruvian actors, both university and business ones, face certain limitations regarding capacities in regard to R&D, technology transfer and experience in developing UILs (i.e. *capacity-related* barriers) that could limit also their international connections. This is consistent with some studies that pointed out the mismatch between foreign technology and local capabilities and conditions in developing countries (e.g. Acemoglu 2002; Freeman 1995; Fu, Pietrobelli, and Soete 2011; Lundvall 2016).

These two potential explanations – lack of resources and limited capabilities – complement each other to some extent. According to one German interviewee (568), technology developed in Germany needs to be adapted to local conditions in other countries, and that requires financial resources, which are often missing in developing countries.

Finally, on a related note, we found that the level of involvement of international partners in CoEs – a leading function in Chile but only a secondary role in Peru – makes local actors perceive them differently. In Chile, for example, one staff member of an intermediary (interviewee 2644) criticised international partners because these only collaborate with local organisations if they do not have another option and, unfortunately, they are actually more competitors in the system than collaborators. In Peru, nobody mentioned this tension, which could be explained by the ancillary role of international partners in Peruvian CoEs.

In the Chilean context, characterised by UILs mainly built upon public subsidies (Section 6.2), it may be understandable for universities to perceive international actors as competitors for funding, as they are new actors in the system. However, in some mature



systems, different actors have specialised in different aspects, so they sometimes compete and sometimes cooperate (Frietsch and Schubert 2012). An example is the German system where, according to Harding (2001), there is competition between technology transfer institutes – including universities – for public and private money alongside cooperation and interdependence between them. As Lundvall and Borrás (2011) have argued, a systemic approach to innovation implies both competition and cooperation between different agents.

## 8.4. Conclusions and discussion

### *Regarding the range of actors and intermediary roles*

The experiences of Chile and Peru show the diversity of actors and intermediary roles in the context of CoEs. First, we have identified a range of significant actors including pro vice-chancellors of universities, individual academics, public organisations (including funding agencies), trade organisations and even development agencies. Some of these actors are not always included as intermediaries with regard to innovation in the existing literature, as can be seen in [Table 4](#) (Section 3.3.1). One explanation is that they are not directly involved in specific innovation processes at the firm level but in the creation of CoEs, which somehow requires from them certain knowledge about innovation and the ability to build connections between two different worlds – firms and universities.

In Chile and Peru, we found some universities in which researchers promoted CoE initiatives and then looked for institutional support from pro vice-chancellors, overlooking the university TTO. In other universities, TTOs did play a major role in facilitating the interaction between different actors, both within and outside the university. However, in the context of CoEs, even strong TTOs needed institutional support from more senior authorities. Such support was translated into coordination within the university, to find research groups willing to participate in the centre's activities, and outside it by representing the university on the centre board. In both countries, senior authorities have given centres a certain degree of stability by allowing changes among the researchers and the research groups participating in the centre, without dissolving the partnership.

In Peru, there were individuals who can be categorised as ‘gatekeepers’ because they liaised internally with research groups interested in the initiative and then with senior authorities to obtain the necessary institutional support (inward orientation) as well as with external actors (other universities, firms and international partners) to elaborate the CoE proposals. These inward and outward gatekeeper functions have been highlighted by the literature on management (Brion et al. 2012; Haas 2015; Paul and Whittam 2010; Tushman and Katz 1980) and innovation (Chau et al. 2017; Howells 2006; Sutz 2000).

There is a substantial difference between the role of gatekeepers identified in previous studies and that found in this chapter. The former refers to the involvement of particular individuals in the innovation process of firms and in managing sources of knowledge and technology, while the latter refers to university researchers managing information and relations in order to create CoEs. However, these *university gatekeepers* have commonalities with firms’ gatekeepers in two important aspects: first, they perform what Brion et al. (2012) call ‘obtaining political support’ within universities because they look for the support of high-level authorities to implement initiatives.

Second, besides their positive role in facilitating activities, they can also use their position to gain power and to control the flow of information (e.g. Haas 2015; Paul and Whittam 2010). We found this effect in the Peruvian case, where two academics who had been promoting the creation of a centre, had to step aside from the initiative, leaving other people in their organisations without information regarding previous agreements with external actors. Despite all that, most interviewees recognised that those individuals initiated the creation of CoEs, having played a fundamental role in the set-up phase.

In the case of public agencies in both Chile and Peru, we found that they not only facilitate UILs by granting subsidies such as that given to CoEs, but they also organise different kinds of events and perform activities linking different actors. However, they still have some limitations that prevent them from playing more relevant roles. Regarding other external intermediaries, in both countries we found organisations that acted as brokers and facilitators to create CoEs, something that is different compared to the intermediary roles

identified for industrial associations (Arocena and Sutz 2000; Brimble and Doner 2007; Dalziel 2006; Dossou-Yovo and Tremblay 2012; Kodama 2008; Watkins et al. 2015).

As stated earlier, the function of all these actors was not directly related to innovation processes at the firm level but to the creation of a specific context to organise UILs and foster innovation (i.e. the creation of centres of excellence). Considering their activities as intermediary roles is consistent with the broad concept of interactive learning and the systemic view of innovation. As Lundvall and Borrás (2011: p. 613) have stated, *“one fundamental distinction in innovation policy lies between initiatives aiming at promoting innovation within the institutional context and those aiming at changing the institutional context in order to promote innovation.”* The design and operation CoEs lay within the second type of policies because CoEs involve an institutional change in how UILs are promoted, organised and developed.

#### *Regarding the role of international partners*

CoE programmes were expected to contribute to innovation in firms and the competitiveness of the country through different mechanisms such as access to and the generation of technology, technology-transfer activities, and the training of highly qualified human capital as well as promoting entrepreneurship and new business opportunities (see [Table 8](#)). These programmes in Chile and Peru required the involvement of international partners, which were supposed to play an important role in helping to achieve those objectives. Moreover, CoEs can be seen as part of the trend, identified by Pfothenauer et al. (2016), of countries promoting large-scale international partnerships to build domestic capabilities with the help of foreign partners.

We found research and technology organisations (RTOs) and universities from developed countries participating in Chilean and Peruvian CoEs. In this regard, the extant literature on the internationalisation of these actors has been focused on their motivations (Altbach and Knight 2007; Frølich 2006; Georghiou 1998; Knight 1999; Zacharewicz et al. 2017), their overseas activities and partnership forms (Bennell and Pearce 2003; Cruz-Castro, Jonkers, and Sanz-Menéndez 2015; Jonkers and Cruz-Castro 2010; Pfothenauer et al. 2016; Youtie

et al. 2017). However, the benefits for the *host* organisations and countries, particularly for developing countries and in terms of technology transfer and innovation, has previously had limited attention. Some authors (e.g. Youtie et al. 2017) have mentioned that host countries would expect scientific, technological or reputational benefits from being engaged with recognised international organisations, but there is not much evidence on this.

To analyse the potential benefits from foreign organisations, we have used intermediary roles (Section 3.3.2) as a point of reference, given the objectives of the CoE programmes in Chile and Peru, but we found that they have actually played a very limited role in supporting STI capabilities in local actors. In the Chilean case, the German Fraunhofer Society led the initiative and set up a subsidiary as a platform to create two CoEs. Its strategy for internationalisation is based on the principle of *“creating scientific value for Fraunhofer and generating positive effects both for Germany, Europe and the partner country in question”* (Fraunhofer 2017: p.29). German interviewees (interviewees 564 and 5610-5611) backed this idea by stating that international connections can allow their counterparts to access knowledge and technology generated in Germany, broader networks (academia, firms, clusters) and new business opportunities. They also mentioned that host countries can benefit and learn from the long-lasting experience of Germany, and in particular of the Fraunhofer Society, in linking university and basic science with industry needs.

However, benefits for the Chilean system have not been achieved to the degree expected by local actors; the international partner in Chile did not play an extensive intermediary role between the local innovation system and the international sphere. In the Peruvian case, the international actor did not play a leading role, so expectations were not particularly high, while its intermediary role has been very limited. In both countries, local actors perceive that international partners have a certain ‘debt’ in this aspect.

As the internationalisation process involves home and host countries and organisations, explanations for the limited role of international partners may come from both sides. From the *host* country perspective, the most plausible reasons are the following: i) the lack of

resources devoted to innovation and R&D not only by private actors but also by the public sector (a *capacity-related* barrier); ii) regulations regarding the CoE programme that promoted the generation of indigenous technology rather than the import of foreign technology; and iii) according to our findings and some authors, foreign technology may not necessarily match local needs and capabilities (Acemoglu 2002; Freeman 1995; Fu, Pietrobelli, and Soete 2011; Lundvall 2016), something which may have discouraged firms from searching for foreign solutions.

From the *home* country perspective, certain patterns in the internationalisation of universities and RTOs may help us understand their limited involvement with Chilean and Peruvian actors, in terms of technology transfer and innovation aspects. According to some authors (Altbach and Knight 2007; Berger and Hofer 2011; Loikkanen, Hyytinen, and Pelkonen 2015; Youtie et al. 2017) and our interviewees, the most relevant motivations for universities and RTOs to become involved in international activities are funding opportunities (economic interest) and access to new and complementary sources of knowledge (academic interest). Regarding the economic motivation, international cooperation usually requires partners to share costs and, as explained earlier, developing countries and CoE programmes have limited resources to finance interactions national and internationally.

From the academic point of view, universities and RTOs search for new sources of knowledge that can be useful for them and their activities in their home countries. For that reason, international relationships are expected to be developed between researchers with similar capabilities but with complementary strengths, as argued by Youtie et al. (2017). The academic orientations would, for instance, explain why German organisations focus their internationalisation more on basic research than on applied research and other activities (Berger and Hofer 2011). The academic focus of internationalisation would also explain why it is mainly concentrated on the developed world, while interactions with the Chilean and Peruvian systems would be expected to be relatively limited.

Despite this ‘negative’ perception of the role of international partners, their participation – albeit limited – can be an important source of certain benefits. First, in both countries, local actors recognised that working with international partners brought opportunities to signal their capabilities locally and internationally, and hence the chance to broaden their networks and develop new interactions. As Youtie et al. (2017) recognised, reputational benefit is one of the drivers for host organisations to become engaged with recognised international organisations, and Chilean and Peruvian actors seem to have achieved this to some extent.

Second, one of the most frequently mentioned activities was international mobility (visits and internships). In Chile, these activities were limited to the internal team of CoEs, while in the Peru they included the staff of the centre’s partners. In this regard, there is some evidence of the benefits from international mobility on the probability of scientists becoming involved in knowledge and technology transfer activities in both the host and the home country (Edler, Fier, and Grimpe 2011). Mobility under CoEs not only refers to scientists but also to other staff members of centres, which might have improved local capabilities regarding managing knowledge and technology transfer. However, this topic would need further research to arrive at a more reliable conclusion.

Therefore, international partners did bring certain benefits as shown in [Table 20](#) - probably not to the degree expected by policy makers and local actors, but they nevertheless brought them. The taxonomy presented in [Table 20](#) would then seem to offer an appropriate analytical framework for studying the contribution of these actors in international partnerships aimed at strengthening developing countries’ capabilities in technology transfer, UILs and innovation.

## CHAPTER 9. Conclusions and Discussion

In the last decade, Chile and Peru each launched CoE programmes with high expectations. Centres were expected to contribute to the competitiveness of the country through various mechanisms such as access to and the generation of technology, training highly qualified human capital, and promoting entrepreneurship and new business opportunities. The size and timescale of public funding for these initiatives were unprecedented, and the programmes were designed with the idea of centres becoming self-sustaining through a gradual increase of private funding.

Chile and Peru launched broadly similar programmes following initiatives implemented in other countries, mostly from the developed world, where they represented a substantial change in the promotion and organisation of interactions between universities, firms and even other actors in the innovation system such as intermediaries. One marked feature of the centres in Chile and Peru is the participation of international partners – research and technology organisations (RTOs) or universities from Australia, the US and certain European countries.

Chilean and Peruvian centres are quite recent initiatives, so their eventual outcomes and impacts would probably be more appropriately studied in the years to come. In the meantime, my attention has focused on three aspects of the setting-up and operation of such centres: their internal organisation supporting university-industry linkages (UILs), the barriers to UILs, and the role of international partners.

Having carried out a preliminary exploration of the CoE programmes in Chile and Peru, I realised that there was not sufficient clarity about the nature of the centres; in particular, it was not clear whether they were individual organisations or multi-organisation structures. For that reason, I decided to start the empirical study by characterising these initiatives and the interactions developed within them. This approach allowed me to compare the Chilean and Peruvian experiences as well as to understand certain differences between centres and other policy instruments such as RTOs. At the same time, this work

provided an in-depth understanding of the context in which barriers to UILs and the role of international partners could then be better studied.

Therefore, I developed three empirical chapters. [Chapter 6](#) set out the organisation of CoEs in terms of structure and interactions. [Chapter 7](#) presented the configuration of barriers to UILs specifically in the context of CoEs, and [Chapter 8](#) analysed the empirical results regarding the role of intermediaries and international partners. Each chapter addressed one specific research question (defined in Section 4.2) and together they addressed the overall question of this study: how do universities, firms and international partners develop interactions within the context of CoEs?

In what follows, I first discuss the main empirical and conceptual conclusions and the contributions with regard to the three chapters mentioned earlier, and I end with a discussion of the overall contributions of the thesis, the new insights it offers and its limitations.

## 9.1. Main findings and discussion

### 9.1.1. CoEs in the developing world: What can be learnt from them?

This section summarises and discusses the findings of [Chapter 6](#) by highlighting the main contributions with regard to CoEs in terms of their structure and organisation, thereby contextualising the subsequent study of barriers to UILs and the role of international partners.

Historically, CoE initiatives can be traced back to the 1970s and 1980s in Canada and the US, where they emerged with names such as ‘industry/university cooperative research centres’, ‘engineering research centres’ and ‘centres of excellence’. Their influence grew in the late 1980s and early 1990s with South Korea, Australia and the UK all launching similar programmes. In the last decade, Norway and Germany have also been engaged in this endeavour, which demonstrates the importance and contemporaneity of this policy



instrument.<sup>49</sup> Latin American countries (LACs) have not been indifferent to this trend, with Chile and Peru launching CoE programmes in 2010 and 2014, respectively.

Findings relating to the organisation of CoEs in Chile and Peru have yielded the following lessons and conceptual contributions:

- I. CoEs are partnerships configured as boundary-spanning structures within which UILs are developed. This feature provides a relevant conceptual clarification because previous studies have considered CRCs as a type of *channel* of interaction between universities and firms (e.g. D’Este and Patel 2007; Hughes and Kitson 2012; Perkmann and Walsh 2007). Here, the conclusion is that CRCs should be seen as *contexts* that can encompass several UIL channels. CRCs are a mechanism to promote and organise UILs with certain characteristics such as a mid- to long-term perspective and the development of pre-competitive research alongside certain short-term results.

This conceptual distinction is important because studying *contexts* refers to the analysis of aspects that may condition the phenomena under study – UILs in this case. For instance, CoE programmes and the leadership of certain actors – international partners and universities – may explain why these centres focus on carrying out research and generating new technology, while partially neglecting short-term activities such as consultancy, providing training to firms, and offering services. Moreover, the goals set by centres may explain, for instance, why they have been developing several complementary UIL channels such as diffusion events and personnel mobility alongside contract research and joint technology projects.

Therefore, the organisation of CoEs will probably have an influence on certain patterns of UILs. In this regard, this study provides a relative clear differentiation between CoEs and channels of interactions. Adapting the concept of *context* provided by Autio et al. (2014), I would argue that “*the context [centres of excellence] must play a central role*

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<sup>49</sup> In this study, the terms *centres of excellence (CoEs)* and *cooperative research centres (CRCs)* are used interchangeably.

*in our understanding of the origins, forms, functioning, and diverse outcomes of [university-industry linkages]”.*<sup>50</sup>

Moreover, this study adds to the literature on CoEs by providing information on how actors build interactions between them and how centres organise themselves internally. In this way, I address a particular gap in the literature because there has been limited research done on the structure and practices within CRCs in general (Gray et al. 2013) and in Latin America in particular. Studies on these initiatives in developed countries have mostly focused on their origin and design (Aksnes et al. 2012; Bozeman and Boardman 2004; Gray et al. 2013; Soon 1995), their results and impacts (Allen Consulting Group 2012; Feller et al. 2002; Lähteenmäki-Smith et al. 2013; Performance Management Network INC. 2012), and the determinants of firms’ participation (Gray et al. 2001; Stone 2015).

- II. The second conceptual contribution is the distinction between *CoEs* and *RTOs*, both having been sometimes treated as part of the same category of intermediaries (Andersen and Le Blanc 2013; Gray et al. 2013; Lal and Boardman 2013). Such a distinction is relevant not only for conceptual purposes but also with regard to policy implications. On the conceptual side, I conclude that CoEs are university-industry consortia and therefore several organisations are involved in their design, set-up and operation, with each organisation having its own priorities, interests and perspectives.

This study has shown differences between *CoEs* and *RTOs* in terms of their structure and the patterns of interactions with universities and firms. As an example, RTOs staff need to strike a balance between the freedom to interact with third parties while at the same time their behaviour has to be aligned to the organisation’s interests and they must respond to the centralised control of the RTO (De Silva et al. 2018). Meanwhile,

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<sup>50</sup> In discussing entrepreneurship, Autio et al. (2014: p. 1099) stated that “all human action occurs in contexts: it is the context that regulates what individuals and teams get to see, what choices they are likely to make, and what the outcomes of those choices are likely to be. For this reason, *context must play a central role in our understanding of the origins, forms, micro-processes, functioning, and diverse outcomes of entrepreneurial activities.*” (Italics are mine)

Chilean and Peruvian CoEs work with university researchers, who can commit to specific projects under the umbrella of the centre but who can also decide to work individually outside the centre, a potential source of tension that has also been observed in Australian CRCs, for example (Garrett-Jones, Turpin, and Diment 2013).

The characteristics of CoEs and RTOs shown in Table 12 may explain why their interactions with universities and firms work differently and confirms my preliminary classification of intermediaries (Table 4). That classification has a specific category of ‘*inter-organisational intermediary structures*’ that includes CRCs, and a different category of ‘*institutional intermediaries*’ that encompasses RTOs.

In the policy arena, it is important to distinguish the roles of different actors in the innovation system and to identify complementarities between them. As Fagerberg (2011) has noted, strong complementarities between different components is a defining feature of systems. In this regard, some authors have analysed the role of and interactions between universities, RTOs and KIBS (Giannopoulou et al. 2019; Lee and Miozzo 2019; Pinto et al. 2015), while differences and complementarities between RTOs and CRCs have been studied to a lesser extent.

Among the few studies in this field, Kroll (2016) has distinguished the role of CRCs and RTOs in the innovation policy arena (Figure 4), while a couple of studies have pointed out the potential contribution of RTOs, alongside universities and industrial partners, to R&D partnerships such as CoEs (Giannopoulou et al. 2019; Intarakumnerd and Goto 2018). However, they did not study the interactions and functions of these two types of intermediaries. A conceptual distinction between them seem to be the key starting point for such a research endeavour.

- III. Third, this study has shown that CRCs have different configurations across countries. I found that centres in Latin America and developed countries share certain commonalities in their main characteristics such as developing pre-competitive research with a long-term perspective. However, they also exhibit sharp differences

such as the limited involvement of firms in Latin America, which translates into a low private investment commitment.

In the Chilean case, projects with firms are mostly subsidised by public sources and are developed under a *one-firm-per-project* mechanism, which prevents the centre from developing pre-competitive research with funding from, and the involvement of, many firms. In Peru, university researchers design and undertake projects, while firms participate in their evaluation and approval, but their involvement in terms of investment and carrying out of R&D is almost negligible. Thus, pre-competitive research is primarily funded by public resources in both countries.

Moreover, in both countries, centres develop very limited short-term activities such as training for firms, consultancy or services. There are some voices calling for centres to become engaged in those activities, for they are a potential source of income in the short run. In developed countries, short-term activities have been seen as a means to leverage further support from stakeholders (AIRTO 2001; Andersen and Le Blanc 2013) and to strengthen firms' absorptive capability (Hauser 2014). The design and operation of CoEs in Latin America has neglected this aspect to a significant extent.

A particular feature of CoEs in Chile and Peru is the involvement of international actors (RTOs or universities in their home countries). In Chile, these actors played a leading role in setting up CoEs, while in Peru they only have a secondary role. Because of this, centres in Peru and Chile exhibit certain differences in their structure and the way universities and international actors interact with each other, but they have maintained their character in terms of being boundary-spanning structures. In this regard, international partners participate in CoEs alongside universities and firms, as is the case with some RTOs participating in CRCs in Australia and Japan (Intarakumnerd and Goto 2018).

- IV. Finally, the mode of organisation of CoEs has created a complex dynamic between them and universities. In Chile, international actors set up subsidiaries and internal teams to work with local partners. They did not, however, bring capabilities from abroad

(researchers, for instance) but relied more on local capabilities. Moreover, centres have applied for public funding to develop projects with firms, in the form of grants to which universities also apply, so they view each other as competitors. In Peru, the perception of competition between centres and universities was not raised, but university researchers are quite free to decide if they want to become involved in particular activities of the centre or apply for funding outside it.

The most plausible explanation is that in both countries, university researchers working in projects under the umbrella of one centre have neither a hierarchical relationship with, nor sole responsibility to, the centre, so they can apply for funding independently. Therefore, the effect of university researchers' position in both countries is the same:<sup>51</sup> universities and centres have to find a balance between competition and cooperation regarding access to funding and working with firms.

The relationship between competition and cooperation has been studied for firms using the concept of *co-opetition* (Bouncken et al. 2015; Martin 2016), implying a balance that has not been achieved so far among firms involved in the Chilean and Peruvian centres. In a different arena, the competition-cooperation relationship has also been highlighted in the technology transfer sphere, in which different actors compete for public funding and private contracts (Harding 2001). Achieving such a balance between CoEs and universities in Chile and Peru is particularly important because centres are expected to be self-sustaining while universities are incentivised to work with the private sector directly.

From a systemic point of view, the existence of different sources of knowledge and technology should be welcome because diversity or variety is often important in finding better or more suitable technological alternatives (Malerba 2002; Mazzoleni 2008;

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<sup>51</sup> The position of researchers seems to be consistent with the concept of autonomy in the university subsystem. The autonomy of individual scientists is defined as the ability to shape their own research agenda (Nelson and Rosenberg 1993), while that of universities, particularly in the Humboldt model, refers to both individuals and institutions (Martin 2003). In Latin America, the idea of universities teaching and doing research with autonomy was the result of the so-called University Reform of 1918 that started in Córdoba, Argentina, and later spread to other countries such as Chile and Peru (Brunner 2014).

Nelson 2006; Nill and Kemp 2009). Under the NSI approach and in a globalised world, Freeman (1995) has recognised that policies promoting the diffusion of standard generic technologies are as important as promoting local originality and diversity. A systemic perspective might therefore encourage researchers and decision-makers in government, universities and centres to search for a ‘healthy’ balance between cooperation and competition.

#### 9.1.2. Configuration of barriers to UILs: contributions from CoEs in Latin America

The methodological approach of this study allowed me to capture different perspectives and achieve an integrated understanding of barriers to UILs in developing countries. Moreover, the empirical analysis of barriers has drawn upon a preliminary conceptual framework incorporating three types: *orientation-related*, *transaction-related* and *capacity-related* barriers. Most studies on UILs have recognised the first two types, while capacity-related barriers have been included in only a few studies (particularly Schiller and Lee 2015 for Asian countries). This does not mean that capacity-related barriers do not exist in developed countries, since they have been studied partially.

These are the main contributions of this study with regard to barriers:

- I. First, the *orientation-related* barriers observed in this study show a particular configuration that differs from most previous studies in this field. Some authors (e.g. Bruneel, D’Este, and Salter 2010; Hewitt-Dundas, Gkypali, and Roper 2019; Meyer-Krahmer and Schmoch 1998) have linked this type of barrier to the divide between two different communities in the science system (scientists and technologists) (Dasgupta and David 1994; Sauermann and Stephan 2013) or to the relations between two systems (the science system and the business system) (Kaufmann and Tödtling 2001). According to this previous work, *orientation-related* barriers can be explained by researchers working under the different regimes of academia and business, which translates into different objectives of research (basic versus applied), different practices regarding research results (disclosure versus secrecy) and different reward schemes.

Against this background, I found that the divide between universities and business actors arises from different understandings, and even misunderstanding, of innovation and research. In Chile and Peru, the discussion about basic versus applied research as well as the issue of disclosure versus secrecy has been hardly raised by participants in this study. Therefore, differences arise from actors' differing perceptions about innovation, their incentives and interests, which provide a particular configuration of *orientation-related* barriers.

This new configuration contributes to the debate on the theoretical foundations of barriers to UILs. In this regard, limiting UILs and their barriers to the science system and R&D would neglect a broader set of interactions, some of which do not even come under the administrative structure of universities and centres. It would obscure the importance of the conflicting relationship between the three missions of universities and their internal incentive schemes. Such an approach would also overlook the actual needs of both university researchers and businesspeople.

For that reason, the most suitable framework for understanding UILs in developing countries is the relationship between the university subsystem and the business subsystem.<sup>52</sup> The former encompasses the complex relations among university missions, while the latter comprises various types of firms and even their cooperatives, all with different needs relating to innovation. In this domain, a recent study has provided insights on the interactions between teaching and the third mission of universities, and highlighted the importance of *teaching-focused collaboration* between universities and firms in emerging countries, where engineers often do not receive the required training to work in R&D positions in firms (Borah et al. 2019).

- II. The second contribution is the analysis of *capacity-related* barriers as a new category, which includes the capabilities of universities and firms as well as conditions in the

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<sup>52</sup> According to Lundvall (2016), the broad concept of NSI includes several subsystems that affect learning, searching and exploring, and one must remain flexible in deciding which subsystems should be considered and which processes studied.

collaborative infrastructure affecting interactions. In this regard, Chilean universities show some strengths in terms of R&D capabilities compared to their Peruvian counterparts, while in Peru there are various differences between public and private universities in terms of R&D capabilities, incentives and resources. However, in both countries, universities still have rather limited capabilities with regard to technology transfer and management of R&D.

For firms, the literature on UILs has highlighted the complementary relationship between firms' absorptive capacity and UILs (Section 2.3). Moreover, some studies have linked firms' absorptive capacity with their internal R&D activities (Cohen and Levinthal 1989; Giannopoulou et al. 2019). However, some authors (Brehm and Lundin 2012; Rosenberg and Nelson 1994) have shown that universities can sometimes substitute firms' R&D capabilities, a point which has also been made by a number of Chilean and Peruvian interviewees in this study.

In this regard, I found that firms involved in CoEs lack certain capabilities to develop UILs and I have argued that neither universities nor centres would be able to substitute firms' absorptive capacity totally. Business actors require a certain minimum level of understanding of research and technology to engage in UILs and to link with other actors in the system. Firms' absorptive capacity is relevant because it encompasses not only the capacity for identifying, acquiring and using external sources of knowledge and technology but also includes identifying and incorporating new customers' needs, as suggested by Schweisfurth and Raasch (2018).

Moreover, the required capabilities would probably depend on the specific channel of interactions (acquisition versus co-production, for instance), as highlighted by some authors (De Fuentes and Dutrénit 2017; De Silva and Rossi 2018). Under this approach, even though CoEs could develop R&D and technology focused on firms' needs, firms would require communication capabilities to interact with them to acquire and implement the technology. In case firms became more involved in financing, designing and developing R&D projects within CoEs (co-production of knowledge), they would



need the capabilities to co-define preliminary goals, monitor the fulfilment of commitments, and absorb the results.

Finally, this type of barrier should include capabilities not only at the individual level but also at the level of the collaborative infrastructure. These barriers include a lack of collaborative experience between actors as well as discontinuous and non-coherent policies, about which I have also presented some insights in Section 7.4.

- III. The third contribution with regard to barriers is the integration of the three types of barriers into a single conceptual framework, in which they are intertwined with one another. This dynamic of barriers adds a certain complexity to their analysis and the implementation of policies, particularly because the relationship between barriers does not seem to be always unidirectional. It means, for example, that *capacity-related* barriers could explain partially certain *orientation-related* barriers, and vice versa.

However, the clear message of this thesis is that *capacity-related* barriers matter. Then, if the limited capability of some actors could, at least partially, explain the misunderstanding of innovation and research (an *orientation-related* barrier), which at the same time may explain some *transaction-related* barriers (conflicts over costs of research and IP issues), then it would be worth considering policies and management strategies encompassing capability-building goals.

- IV. Integrating the findings about barriers ([Chapter 7](#)) and CoEs ([Chapter 6](#)), I can attempt to provide a better understanding of how the design and operation of centres can have an influence on barriers and their configuration. As pointed out earlier, CoEs are *contexts* that can shape UIL patterns. For example, the leading role of academics within centres combined with their particular perspective about innovation (an *orientation-related* barrier) could have driven centres to focus on R&D and the generation of new technology, originating conflicts over IP issues (a *transaction-related* barrier).

Therefore, an integrated understanding of centres' organisation and the barriers to UILs provides a basis for two management considerations. First, for CoEs to respond to firms' needs, a better balance in decision power between partners should be promoted

because firms have been playing no role or only an ancillary function in the centres' governance. Second, centres should reconsider their scope to include more short-term and capability-building activities in order to build trust and further support from their stakeholders. Such an integrated view also provides the basis to rethink the role of universities and their complementarity with centres and other intermediaries.

#### 9.1.3. Findings with regard to intermediaries and international partners in CoEs

The domain of innovation intermediaries is very diverse and complex because there is not always a clear dividing line between different categories of intermediaries (Table 4). This study has analysed just part of the broad area of intermediaries: actors performing intermediary roles during the establishment of centres, and the role of international actors.

The following are the main conclusions and contributions in this domain:

- I. Perhaps one of the surprising findings was the limited, and in some cases negligible, involvement of university TTOs in the design and operation of CoEs, in contrast to the common understanding of them as the most relevant internal intermediary in the university subsystem. Although some studies have highlighted the importance and limitations of TTOs (Carlsson and Fridh 2002; Kergroach, Meissner, and Vonortas 2018; Mowery et al. 2001; Perkins and Tierney 2014), there have been other university units facilitating the creation and operation of CoEs. For instance, high-level authorities such as pro vice-chancellors have played specific intermediary roles, even though it was not part of their mission. Therefore, one can label them as '*non-dedicated*'<sup>53</sup> intermediaries.

One plausible explanation is that CoEs require institutional support from universities, as highlighted for CRCs in the US (Gray et al. 2011). The findings of this study have shown that the involvement of high-level authorities proved to be essential for the stability of centres in Chile and Peru (Section 8.2). Another potential explanation is TTOs' limited capabilities to fulfil their intended function, as shown in Section 7.4. They

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<sup>53</sup> The term 'dedicated' is an adjective meaning "designed to be used for a particular purpose" (Cambridge Dictionary).

are relatively young entities and still face many challenges, such as a lack of trained and experienced personnel, a lack of standardised procedures, and researchers' reluctance to disclose their findings (a *capacity-related* barrier).

The range of external intermediaries was also diverse, encompassing trade associations, international development agencies, and funding agencies. These actors can also be labelled as '*non-dedicated*' intermediaries given that their main function refers to different activities, but they have been recognised as key players in bringing together academics, international actors and firms. For public funding agencies, they not only provided financial support to CoEs – which is their 'natural' function – but they also diffused information and organised events to facilitate the formation of alliances that could then become the basis of CoEs.

In consequence, the specific context of CoEs has shown particular patterns in intermediary roles, bringing about the involvement of actors that had not been intended to promote UILs. One could discuss whether they can be categorised as 'intermediaries' or not, but what I have found is that they did fulfil an intermediary function in the context of CoEs. A few studies have already recognised the intermediary role of industrial associations and public agencies, in both developed and developing countries (Section 3.3), so more research is needed to understand how and why they play such a role, and how they can complement the roles of other actors.

- II. A second contribution refers to the limited role of international partners, usually coming from developed countries. Previous work on the internationalisation of RTOs and universities has focused on the strategies, rationale (potential benefits) and impacts of internationalisation (Altbach and Knight 2007; Frølich 2006; Georghiou 1998; Knight 1999; Pfothenhauer et al. 2016; Youtie et al. 2017; Zacharewicz et al. 2017). However, little has been investigated about the benefits that *host* developing countries may have obtained from their cooperation with those organisations, particularly in terms of technology transfer and innovation.

To analyse the roles performed by these actors in the context of CoEs, I did not start with a defined conceptual framework, but rather with certain preliminary insights, as presented in [Table 5](#). The result of my empirical analysis is a new taxonomy which is particular to the context of CoE programmes in developing countries ([Table 20](#)); programmes intended to foster local capabilities in terms of technology transfer and innovation through international partnerships. This new taxonomy can be applied in future studies to analyse the benefits brought by international partners in similar programmes (i.e. with a *host-country* perspective).

In this regard, local actors in Chile and Peru agreed that one of the main contributions of international partners was their names and reputation, which allowed them to signal their capacities to other actors in their local system and even internationally. A second space for benefits opens up with the mobility of the researchers and personnel of centres and universities, which can bring certain advantages such as greater involvement in technology transfer and innovation activities. However, in areas such as fostering international networking and providing access to their laboratories, the role of international actors was quite limited. Moreover, regarding support to local actors in R&D aspects and UIs outside the centres, their role was almost negligible.

Another aspect regarding international actors is their limited role in bringing in foreign technology to be adopted in Chile and Peru. In this regard, this study has identified certain barriers that may help to understand this aspect. For example, the limited resources of actors (a *capacity-related* barrier) would have made foreign solutions and assets – whether researchers or access to equipment – unaffordable. Moreover, I found that private sector actors are generally unwilling to develop and outsource R&D activities (an *orientation-related* barrier) and universities and firms still have limited capabilities (*capacity-related* barriers), which may have made it difficult to understand, adopt and master foreign technology.

My findings are consistent with studies on internationalisation of NSIs. For instance, internationalisation of corporate R&D and international technology transfer are

concentrated in the developed world (Carlsson 2006; Mowery and Oxley 1995). Previous work (Berger and Hofer 2011; Jonkers and Cruz-Castro 2010; Loikkanen et al. 2015; Zacharewicz et al. 2017) has highlighted that the main motivation of RTOs to collaborate internationally is to gain access to funding and new knowledge, something which I also found in my interviews with international actors. Moreover, international operations of RTOs seem to depend on finding suitable partners in terms of their capabilities and resources as well as having market opportunities. It is unsurprising, then, that they tend to concentrate on developed countries.<sup>54</sup>

One potential explanation was given by Chen, Zhang, and Fu (2019), who have argued that international technological collaboration would tend to be more limited by national boundaries as leading countries would make some effort to prevent developing countries from benefiting from their investment in R&D. However, according to Ponds (2009), fears of ‘unwanted knowledge spillovers’ stemming from research collaboration are unfounded. Therefore, in Chile and Peru, the limited international technology collaboration seems to stem from different reasons: specifically, limited capabilities and a mismatch of interests.

For those reasons, the fact that CoEs focus on the generation of indigenous technology might make sense, given the conditions of the Chilean and Peruvian innovation systems. This is consistent with the prevailing theory of technical change that suggests that to foster technological development, there must be a combination of importing foreign technology and developing indigenous technology and capabilities (Acemoglu 2002; Alcorta and Peres 1998; Arocena and Sutz 2010; Bell and Pavitt 1993; Fu, Pietrobelli, and Soete 2011; Mazzoleni and Nelson 2007; Mowery and Oxley 1995).

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<sup>54</sup> According to one German interviewee (564), FhG focuses on ‘Germany, Europe and then the rest of the world’. This was corroborated by revenue figures for FhG in 2017: “some 30 percent of international revenue came from EU funds, 35 percent from customers and partners in Europe, and 35 percent from those outside Europe” (Fraunhofer 2017: p. 30). Despite the geographical diversity of the international activities of FhG, one can see a relatively high concentration: for example, North and South America in 2017 generated revenue of €55 million, mainly concentrated on the US (€48 million), followed a long way behind by Chile, which accounted for just €2.1 million (Fraunhofer 2017).

Consequently, following the experiences of Asian countries such as South Korea, Singapore and Malaysia, centres and policy makers promoting this kind of initiatives should consider broadening the scope of centres to get them engaged in capability-building activities. They should also look for complementarity with other actors in their innovation system who may help carry out capability-building activities, so the centres do not need to do this on their own. In this context, the remaining question is what kind of role international partners should play within schemes such as CoEs.

## 9.2. Overall contribution and generalisability

In previous sections we have set out the main contributions of the thesis in terms of empirical findings and conceptual distinctions. From the empirical perspective, the thesis has provided evidence on several aspects of CoEs in Latin American countries such as their organisation, the barriers to UILs and the role of international partners. Moreover, various conceptual distinctions and theoretical clarifications have been developed. In what follows, I will explain how these contributions fit in the broader picture of innovation studies and to what extent they can be generalised.

These two aspects are analysed together because generalisability of results from case studies, as noted by some authors (e.g. Verschuren 2003; Yin 2013), works at the analytical level through theoretical propositions. In this regard, Creswell (2007) has argued that qualitative researchers do not tend to generalise from one case to the universe of cases (i.e. a statistical approach) because the contexts may vary case by case. Even though the generalisability of my findings to the universe of cases is very limited, there are two factors – the empirical approach and the characteristics of CoE programmes – that provide grounds for generalising the findings, at least, to most cases (centres of excellence) in Chile and Peru.

The first factor is that interviews were conducted not only with people involved in the studied cases but also with high-profile individuals (managers and promoters) from three additional centres in Chile and two in Peru (details in [Table 6](#)). In general, these interviewees corroborated our findings and provided consistent views, which lends support to the generalisation of my findings. The second factor is the limited number of centres that come

under the same funding programmes (i.e. similar regulations about objectives, leading organisation, partners and contributions), seven in Chile and three in Peru. These two aspects, therefore, allows me to conclude that findings of this study can be extended to most CoEs in both countries and centres developed under similar conditions (i.e. a limited generalisability).

From a theoretical standpoint, the arena in which case studies can be generalised better, this work has contributed to a debate in certain subfields of innovation studies, characterised by Martin (2012, 2016) and Fagerberg and Verspagen (2009). These subfields refer to the NSI literature and three particular strands of studies: UILs and their barriers, intermediaries, and the internationalisation of NSIs. In general, some authors have highlighted the increasing importance of the research carried out on UILs within the NSI literature over the last decade (Albuquerque et al. 2015; Cassiolato et al. 2012; Rakas and Hain 2019; Teixeira 2014), and this study contributes to this trend by providing evidence on certain aspects of UILs in Latin American countries.

Contributions to innovation studies will be translated into analytical frameworks relating to CoEs and UILs (theoretical generalisation), which hopefully can be used to study these phenomena in other countries. The first contribution then is the analysis and development of a conceptual distinction between the *context* for UILs – Centres of Excellence (CoEs) – and the various UIL *channels*. As pointed out earlier, this distinction is important because understanding the context in which a phenomenon occurs may help scholars to understand and explain it, just as I could explain how UILs are developed, how they complement each other, and what barriers partners face within CoEs.

Moreover, to provide an in-depth understanding of CoEs (including their structure and decision-making processes), I drew upon studies of *research partnerships* (Hagedoorn et al. 2000; Koschatzky 2017) and empirical studies on CRCs and RTOs from around the globe. Integrating these bodies of literature and my empirical findings, I have characterised CoEs and UILs within them and delineated a conceptual distinction between *CoEs* and *RTOs*, enriching our understanding of intermediaries in the broad context of NSIs. This conceptual

distinction reinforces the previous conclusion that CoEs are *contexts* for UILs rather than *channels*.

These two conceptual distinctions help to address a gap in the literature on CRCs, highlighted by Gray, Boardman, and Rivers (2013), in terms of a lack of clarity about the concept of CRCs. These clarifications can have substantial theoretical and policy implications as explained earlier.

Regarding barriers to UILs, I have attempted to integrate several strands of literature to explain the configuration of these barriers in developing countries: UIL studies (Cohen, Nelson, and Walsh 2002; D’Este and Patel 2007; Meyer-Krahmer and Schmoch 1998; Perkmann et al. 2013), economics of science (Dasgupta and David 1994; Nelson 1959, 2006), economics of innovation (Fagerberg 2011; Freeman 1994; Teece 1986), and the missions of universities (Etzkowitz et al. 2000; Martin 2003). The result of this attempt is an analytical framework with three types of barriers to UILs, which could be useful to analyse these aspects in other developing countries and low-tech sectors, where there are relatively low levels of R&D activities.<sup>55</sup>

The framework implies a redefinition of the two *worlds* interacting when UILs are studied, which contributes to the debate on the theoretical foundations of barriers to UILs, as pointed out in Section 7.2. One of those *worlds* goes beyond the science system and R&D, to encompass the whole university subsystem, with all its complexities. The other ‘world’ is the business subsystem that incorporates a wide range of actors and their innovation needs that relate to a variety of sources of innovations. Recognising the scope of these two subsystems would help to understand the particular configurations of *orientation-related* and *transaction-related* barriers.

However, the framework would be incomplete without the category of *capacity-related* barriers. These refer to limitations of both university and business actors as well as

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<sup>55</sup> In developing countries and low-tech sectors, there is a relatively low level of R&D activities. For Chile and Peru, I provided some insights on this (Section 5.2). For low-tech sectors, Fagerberg (2011) and Smith (2011) have explained that low-tech refers mainly to sectors with a low R&D intensity.



conditions around the development of UILs (i.e. the collaborative infrastructure). As explained earlier, *capacity-related* barriers could at least partially explain some *orientation-related* and *transaction-related* barriers in the context of CoEs in Chile and Peru.

Finally, this study contributes to the literature on intermediaries and their specific roles in the context of CoEs as well as on the internationalisation of RTOs and universities. Regarding the former, I identified *non-dedicated* intermediaries that were involved in the set-up of CoEs and found that their roles did not seem to be linked directly with innovation processes at the firm level. Their roles are instead framed in the creation and operation of partnerships that have a mid- to long-term perspective and are intended to change the way in which UILs are promoted, organised and developed (i.e. an institutional change).

These findings have two implications. First, they lend support to some authors' claim that the concept of NSIs should be opened up to include new actors (Dalziel 2010; Frietsch and Schubert 2012; Warnke et al. 2015), in this case, those *non-dedicated* intermediaries. Second, they also reinforce the distinction drawn by Lundvall and Borrás (2011) between policy instruments aimed at promoting innovation within a given institutional setting and policy instruments aimed at changing the institutional setting to promote innovation, with CoEs falling into the latter.

In terms of international partners, this study has revealed certain differences between the expectations and actual benefits from their participation in CoEs in Chile and Peru. I have presented an alternative explanation for these findings, based on the limited capabilities of developing countries and the literature on technical change, which contributes to the ongoing debate about the internationalisation of NSIs. Moreover, I developed a new taxonomy of the potential roles of international partners in programmes intended to foster domestic capabilities in developing countries (Table 20) through what Pfotenhauer et al. (2016) calls large-scale international partnerships.

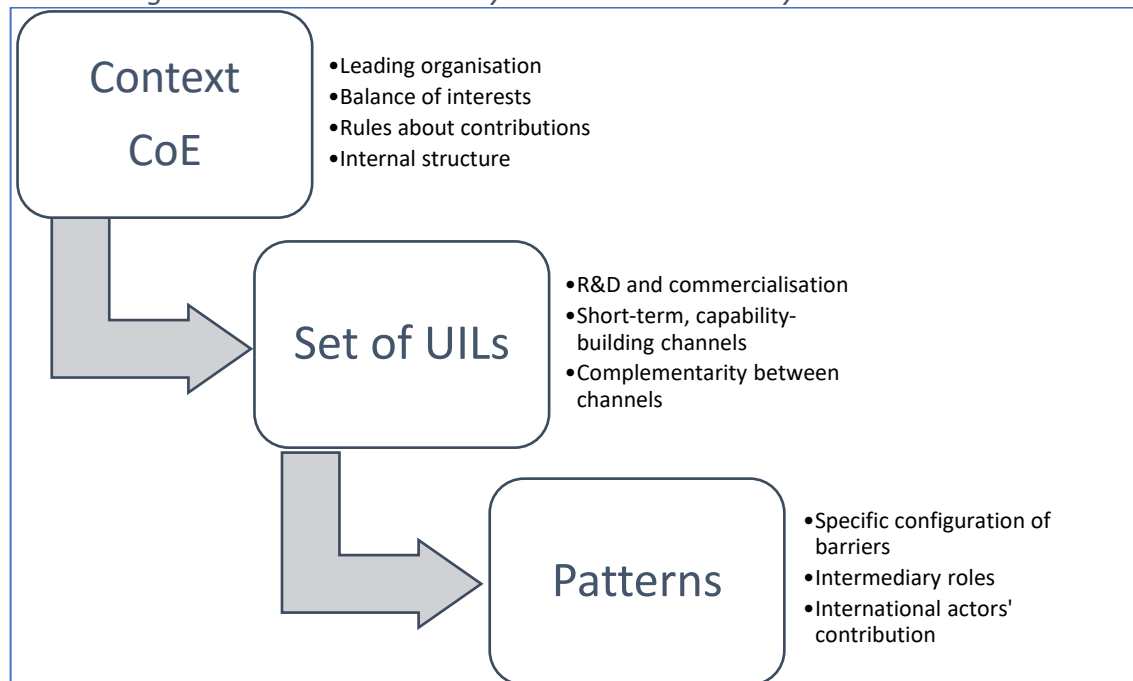
### 9.3. Promising insights to frame future research

As a result of the analysis of CoEs, barriers to UILs, intermediaries, and international actors, the need for an integrative, structured series of analytical steps to study these phenomena

emerged. Therefore, I can advance the following preliminary framework, with three consecutive steps: the characterisation of centres' organisation, the identification of UILs and their complementarities, and the characterisation of the specific configuration of barriers and intermediary roles (Figure 5).

Following these steps might bring a better understanding of relationships between the context for UILs – in this case CoEs –, how UILs developed in such a context, and how barriers to UILs and intermediary roles may be configured. Such an analysis seems worth pursuing in future research.

*Figure 5. Framework to study UILs and intermediary roles within CoEs*



Author's own elaboration.

The second promising insight derived from this study relates to the dynamics that would exist between the three types of barriers: orientation-related, transaction-related, and capacity-related barriers. We could identify certain relationships between barriers. For example, timescale differences relate not only to different understandings of innovation but also to unclear incentives regarding the three missions of universities, which seem to privilege teaching and research, leaving limited time for academics to link with firms. A different understanding of innovation between universities and firms, or even a

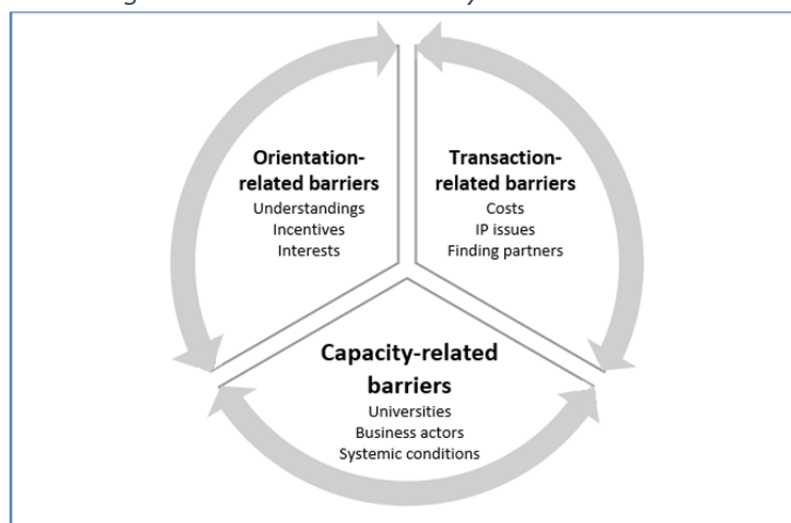
misunderstanding of the nature of innovation and research (*orientation-related* barriers) would, for instance, explain the unrealistic expectations about IP and some disagreements on costs and IP issues (*transaction-related* barriers).

Moreover, some *capacity-related* barriers could help explain the other types of barriers. For instance, the lack of capabilities and experience in universities (a *capacity-related* barrier) can reinforce the linear conception of innovation in university actors (an *orientation-related* barrier) and their unrealistic expectations about IP, worsening conflicts over this matter (a *transaction-related* barrier). Thus, the understanding of innovation as a linear process could not only be related to researchers' strategic position to protect their interests and current activities, as suggested by Fagerberg (2011), but also to certain limitations in their capabilities. I found several indications of similar relationships between different types of barriers.

Relations between barriers do not seem to imply simple cause-and-effect relationships; instead these seem to be much more complex. For instance, academics' assumption that innovation comes from disruptive scientific findings could explain why universities set up incentives privileging basic research and neglecting interactions with firms. However, we also could argue the opposite, that incentive schemes privileging basic research may explain why academics embrace a linear conception of innovation, as a strategy to protect their interests. In the same vein, I could mention other complex relationships between barriers, but this would go beyond the scope of this study.

At this point, I can only argue that the conceptual framework developed in this study, with its three types of barriers, could be greatly complemented by future studies on the dynamics and relationships among them. Therefore, let me propose a preliminary framework in which the relationships between barriers are represented by the bidirectional arrows in Figure 6.

Figure 6. Framework to analyse barriers to UILs



Author's own elaboration.

#### 9.4. Policy and management implications<sup>56</sup>

This study provides evidence about the organisation of CoEs, the barriers to UILs and the role of international partners. For both policy makers and managers of CoEs, it is essential to understand the limitations of the centres' stakeholders, so they can create a suitable environment to help actors understand what innovation really is, what kind of innovation is required in specific contexts, and how research and universities can actually contribute to innovation. A policy approach to addressing these concerns may then be in a better position to help overcome *capacity-related* and *orientation-related* barriers.

It is also important for policy makers and managers of centres to realise that these initiatives are partnerships, configured as boundary-spanning structures, which not only link university actors and the business sector but also connect up with international partners, the public sector, and potentially some intermediaries. Each actor bringing their own interests poses challenges with regard to the alignment of their interests. However, centres

<sup>56</sup> The conclusions and recommendations of this thesis seem to contain an implicit assumption about the need for CoEs in the Chilean and Peruvian innovation systems. Questioning their necessity in these countries and for the agriculture sector is valid but responding to it is not the aim of this study. However, my findings have shed some light on this matter, so some reflections are provided in [Appendix F](#).

are also intended to support innovation in specific sectors so their activities should be aligned with this aim.

This study has provided some insights that may help achieve such a complex alignment. First, more information about firms' innovation needs and capabilities as well as universities' capabilities is required to implement a feasible agenda (often called a 'business plan' in other contexts). This information should be required during the application for funding or in the beginning of the establishment of the centre. As the promoter of the Engineering Research Centres (ERCs) in the US stated, "*If you don't have a good plan, the work and commitment don't matter. You will fail*" (Bozeman and Boardman 2004: p. 373).

Second, the balance of decision power between partners is important but seems to have been neglected both in the design of the CoE programmes as well as in the decision-making structure in each centre. A better-balanced negotiation power between university and business actors may be necessary to agree a common agenda tailored to firms' needs (i.e. the main goal of CoE programmes in Chile and Peru). Like in other countries, such an agenda should encompass more than R&D activities (the current focus of Chilean and Peruvian centres).

Third, according to international experience, CoEs tend to have a *mid- to long-term approach* while, in some countries at least, *short-term results* are essential to maintain the interest and commitment of their stakeholders as well as to build capabilities in firms. An appropriate balance in this regard seems to be relevant in countries with weak innovation systems, where actors still have limited capabilities and little experience in developing interactions. Through short-term activities such as consultancy, training for firms and services, the required capabilities and experience could be built, while a long-term vision can provide the direction for developing knowledge and the indigenous technology that firms will need in the future.

Fourth, the role of international partners should be reconsidered. Given the patterns of the internationalisation of RTOs and universities – focused on academic and economic interests – and certain limitations in developing countries, their role in CoEs needs to be clarified. If

the attraction of foreign personnel, equipment and technology is expected, the actual cost of this and the required capabilities should be considered. If that is not feasible, other collaborative activities could be promoted to strengthen local capabilities, particularly in terms of knowledge and technology transfer and innovation (e.g. mobility of personnel, experience exchange activities, or advisory function).

Finally, initiatives such as CoEs requires a minimum level of certainty regarding policy because they have a mid- to long-term perspective. Chilean and Peruvian actors as well as international ones ask for coherent and long-term policy approaches. This is still a challenge in both countries despite various efforts made by governments. People involved in the CoEs do not know what is going to happen to them in the near future because, as governments change, so priorities and support for these initiatives may also change.

#### 9.5. Limitations of the study and future research

This study faced a couple of drawbacks in terms of sources of information. The first restriction was the limited availability of administrative and public data about CoEs in both countries. I could only access the calls for proposals and information on the basic characteristics of all the centres (partners and research lines, summarised in [Appendix C](#)). It was almost impossible to access the original proposals for the CoEs, monitoring reports and evaluation studies. Missing this kind of information may therefore have restricted the possibilities for triangulation of information, but this effect has not been too serious because I could overcome it to a considerable extent by integrating the perceptions of several types of actors involved in the set-up and operation of these initiatives.

Second, I could not conduct interviews with business actors in Chile. This drawback may have given rise to some bias in my understanding of how firms conceive UILs and their interaction in the context of CoEs. However, I was able to interview centre staff working directly with firms, which helped me to understand firms' perspective, although not to eliminate the absence of information. In order to deal with that potential bias, I also explicitly raised this concern whenever this risk appeared – for example, in Sections 6.3.2 and 7.2.1.

Regarding new avenues of research, this study has suggested some possibilities. The first area to explore is the organisation of boundary-spanning structures like CoEs in other developing countries. As most experiences and studies refer to developed countries, further research in developing countries is needed to know if the patterns found in the Chilean and Peruvian cases are also found elsewhere. Moreover, using a similar methodological approach would be important to see whether the conceptual distinctions formulated in [Chapter 6](#) (between *context* and *channels* of UILs as well as between *CRCs* and *RTOs*) can be confirmed in both developing and developed countries.

The second area requiring further research is the barriers to UILs considering the conceptual framework this study has proposed, with three different types of barriers along with their specific configurations and relationships. A framework with a broader configuration of *orientation-related* barriers – not only those that relate to R&D activities – and a category of *capacity-related* barriers would be suitable to study these phenomena in countries and sectors with relatively low R&D activities. Extensive research in Latin American countries and low-tech sectors is therefore needed.

A third line of research relates to the role of international partners, mainly RTOs and universities, in local UILs. Most studies have focused on the internationalisation process of those organisations from the perspective of their *home* country and have shown that international activities are mainly guided by academic and economic interests and concentrated in the developed world. Further research on the internationalisation process from the point of view of *host* developing countries is required, particularly with regard to technology transfer and innovation aspects.

On a different matter, my findings indicate some form of co-evolution between the capabilities, interests and needs of universities, firms and intermediaries. There are studies suggesting the co-evolution of technologies, markets and institutions (Nelson 1995), and the evolution of UILs advancing through three stages of technological development – namely the early, medium and mature stages – each requiring different channels of interaction (Schiller and Lee 2015). Moreover, the evolution of intermediary roles according

to the changing needs in the market has also been highlighted (Intarakumnerd and Goto 2018; Klerkx and Leeuwis 2008; Shiu et al. 2014). This means that UILs as well as CoEs may be seen as dynamic and co-evolving phenomena. It would be interesting to carry out research on this aspect to understand how the organisation of CoEs and their activities evolve over time and co-evolve with the capabilities and needs of their stakeholders.

Finally, the dynamic and evolving nature of UILs also suggest potential complementarities and conflicts between different intermediaries. In this study, I have attempted to provide some insights about the competition-cooperation relationship between universities and centres (Section 9.1.1), but more research is needed to understand such relationships, not only between them but also with other actors in the innovation system.

## 9.6. Final remarks

Overall, this thesis contributes to the literature on UILs in three respects: CoEs as boundary-spanning structures between universities and business actors, UILs and their barriers, and the internationalisation of RTOs and universities. In the domain of CoEs, this work has characterised them as specific *contexts* of UILs within which several channels are used. This study also sets out a conceptual distinction between *CoEs* and *RTOs* as intermediaries, based on the different configurations of their interactions with firms and universities. Moreover, I found that the configuration of CoEs in Chile and Peru differs substantially from initiatives in developed countries.

In terms of barriers to UILs, this work advances the understanding of their theoretical foundation, helping to explain *orientation-related* and *transaction-related* barriers based on differences between the university subsystem (which goes beyond the science system) and the business subsystem. It has also developed a conceptual framework in which a third category of barriers, labelled as *capacity-related* barriers, plays a relevant role because it can help explain, at least partially, the configuration of the other two types. Moreover, capacity drawbacks, which comprise weaknesses in actors and conditions in the collaborative infrastructure, may limit international interactions and provide insights to



explain why international partners of CoEs have been fulfilling a very limited role in building local capabilities and supporting local UILs.

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## Appendices

### Appendix A. Related approaches to NSI – Triple Helix and Open Innovation

There are certain research areas and academic communities focusing on the analysis of UILs, which can relate to or even compete with the NSI literature. Among these we can mention, for instance, the Triple Helix approach and the Open Innovation ‘paradigm’, on which some insights will be given in this appendix. One common feature of these bodies of literature is that they propose explanations for interactions between different actors in the process of innovation, particularly between firms and universities.

#### **The Triple Helix approach**

According to Etzkowitz (2003: p. 295), the “Triple Helix thesis postulates that the interaction in university-industry-government is the key to improving the conditions for innovation in a knowledge-based society. Industry operates in the Triple Helix as the locus of production; government as the source of contractual relations that guarantee stable interaction and exchange; the university as a source of new knowledge and technology, the generative principle of knowledge-based economies.” This author has also stated that the three helices (university, industry and government) are evolving internally and so are their interactions: universities become entrepreneurs alongside their traditional academic roles of teaching and research; industry is moving from large firms towards start-ups; and government is shifting towards a common role of encouraging interactions among the helices.

Etzkowitz (2003) has criticised, without much evidence, the NSI approach for regarding industry as the main institutional sphere (helix), while government and university play only supporting roles. According to him, in the Triple Helix each sphere performs multiple and interchangeable roles and they do so without affecting their original roles, while the interactions between helices are understood as reciprocal relationships between equal partners.

Regarding this thesis, we can argue that, despite Etzkowitz’s claim, firms have been and will continue to be the main locus of innovation, but the trigger factor could be within the other ‘helices’ and in the interactions between different actors. Under the NSI approach, firms



play a fundamental role, but it does not mean that other actors cannot also play major roles. For instance, the catch-up experiences of South Korea and Taiwan have shown that public research organisations and explicit public policies both played essential roles in building technological capabilities, supporting innovation and fostering economic growth (Mazzoleni and Nelson 2007), while universities and government played essential roles in the earlier forging ahead experiences of Germany and the USA (Mazzoleni 2008).

Second, the notion of the ‘entrepreneurial university’ seems to provide a partial understanding of the scope of universities’ activities and their contributions to innovation, the economy and society. Higher education systems are complex and incorporate a variety of university ‘species’, some of which are not committed to entrepreneurship (Martin 2003; Martin and Etzkowitz 2000). Moreover, the mechanisms through which universities impact on the innovation systems are much more diverse than just commercialisation of research results (Hughes and Kitson 2012; Hughes and Martin 2012; Martin and Tang 2006). Additionally, there is no clear evidence on whether the new ‘entrepreneurial mission’ of universities can be performed without harming research and teaching (Martin 2003; Martin and Etzkowitz 2000).

Regarding the trend of industry towards start-ups and spinoffs from universities in the Triple Helix, we can argue that an industrial structure is diverse and depends on several factors. One of them relates to the sources of technological accumulation, which determine whether an industry is governed by large firms or small specialised start-ups or adopts some other structure (Pavitt 1984).

In addition, the Triple Helix thesis seems to lack the flexibility needed to incorporate certain actors and interactions that do not fit properly into the dynamics of the helices, such as intermediaries, international partners (multi-national enterprises – MNEs, international research and technology institutions – RTOs, and foreign universities) and global networks. Those aspects are encompassed in the broad and flexible concept of NSI and the complementary approaches described in Section 2.2.

Finally, it is worth noting that in Latin America a similar approach was earlier proposed by Sábato and Botana (1968), who stated that in order to promote innovation there must exist a well-shaped 'scientific-technological triangle' with three vertices: the scientific-technological infrastructure, government, and the productive sector. They stated that there are intra-relations within each vertex of the triangle and also inter-relations between vertices; the latter can take two forms: i) vertical inter-relations between government and the other two vertices, because they depend on explicit government actions, and ii) horizontal inter-relations between the productive sector and the scientific-technological infrastructure.

It seems that Sábato and Botana privileged the role of the state through its vertical relations with the other vertices of the triangle. This is probably one of the most important differences compared with the Triple Helix approach, a difference that has been also noted by Etzkowitz and Leydesdorff (2000), who have criticised the Sábato Triangle based on the argument that interactions in the triple helix take place between equal partners.

In conclusion, given that the aim of this study is to understand the process of building university-industry linkages and the roles of international partners in CoEs, the NSI approach seems more appropriate than the Triple Helix thesis. The NSI concept provides a more flexible framework, particularly for analysing the participation of international partners and the multiple channels through which universities and firms interact with one another.

### **Open innovation**

A second related concept is that of Open Innovation, understood as the strategy implemented by firms to manage internal sources of knowledge (from their R&D units or activities) in combination with external ones (from other firms, laboratories, universities, and so forth) as well as internal and external channels to market (Chesbrough 2003, 2006). According to Chesbrough (2006), the driving factors of this paradigm are: the mobility of skilled highly educated workers, private venture capital that facilitates the creation of start-ups, external options for ideas 'sitting on the shelf' to get the marketplace, and the

increasing capability of external suppliers of knowledge, which comes from the expansion of universities as well as from the increased presence of venture capital.

The first observation on this approach is that the term ‘open innovation’ has been used with different meanings, which makes the concept somewhat ambiguous and hinders its theoretical development (Dahlander and Gann 2010; Huizingh 2011). However, that seems to be one of the virtues of the concept because, according to Huizingh (2011), it encompasses, connects and integrates a variety of existing ideas.

Second, the phenomenon depicted by the ‘open innovation’ paradigm is not new, in that firms have been conducting open innovation activities for decades before Chesbrough coined the term (Huizingh 2011). Dahlander and Gann (2010) have identified examples that can be traced back to the late 19th century, while Pavitt (1984) found that more than 40% of the 2,000 most significant innovations in Britain from 1945 to 1979 were carried out using external sources of knowledge. Moreover, Mansfield (1998) found that academic research has had an increasing importance for innovation, in terms of its contribution to new products and processes in several sectors.

Third, the open innovation approach is used to analyse how firms manage internal and external sources of knowledge and technology, focusing mainly on aspects of R&D (Henkel et al. 2014; Howells et al. 2012; Laursen and Salter 2014), but neglects the way other actors of the system behave and the variety of channels they use when interacting with firms. Therefore, the NSI approach provides a more comprehensive framework for analysing UILs because it goes beyond R&D activities and incorporates the perspective of multiple actors (universities, research organisations and intermediaries, for instance).

However, the Open Innovation approach provides interesting insights regarding UILs. First, universities and their interactions with firms play a fundamental role in the context of open innovation (Perkmann and Walsh 2007). Second, the abundant sources of knowledge outside firms may lead to the development of intermediaries (Chesbrough 2003, 2006). Finally, the open innovation strategy in firms can be analysed in a broader framework, namely the NSI (Perkmann and Walsh 2007).

## Appendix B. The standard initial interview protocol

The interview protocol is the standard set of questions, which have been adapted according to each interviewee's background: university actors (academics, authorities and technology transfer officials), business actors, international partners, intermediaries or civil servants.

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Interviewee Code: _____
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### Interview Protocol

Barriers and the roles of international partners in university-industry relations: The case of Centres of Excellence in Latin America

The aim of this study is to understand the dynamics of university-industry linkages (UILs) in Latin American countries, in two interconnected aspects. The first issue is concerned with what kind of barriers universities and firms face when interacting with each other in the context of Centres of Excellence. The second aspect is how these actors overcome those barriers and how international research and technology institutions contribute to that process.

For that reason, this interview is divided in three parts. One of them is dedicated to questions aimed to contextualise the role of the interviewee in the scheme of CoE. The second one, related to **barriers to interactions** between local universities, local firms, and foreign research and technology institutions. The third part contains questions relating to the **roles played by foreign institutions**.

### **PART I**

Questions related to the context of Centres of Excellence:

1. How many years have you been working in the creation and operation of centres of excellence?
2. What is your role in these activities? Provide details.
3. Before becoming involved in centres of excellence in Peru, had you had previous experience in building interactions with firms/foreign universities?
  - a. If yes, please explain briefly that (those) interaction(s).

- b. Is that previous experience similar to what is happening within this the centre of excellence? If not, what do you think the most important differences are?
4. I understand that Centres of Excellence (CoE) require the participation of local partners and international institutions. In this specific context, what kind of **activities** are (were) negotiated and carried out with Peruvian firms/universities?

Description of Collaborative Activities	x/v
a. Setting a common research agenda	
b. Collaborative research projects with Peruvian universities/firm	
c. Consultancies to firms	
d. Contract research	
e. Technology licensing (technology transfer)	
f. Setting of firms (start-ups/spin-offs)	
g. Training to firms' employees	
h. Co-supervision of Master and Doctoral students	
i. Personnel exchange with Peruvian universities/firms	
j. Diffusion activities (publication, conferences, workshops)	
k. Other scientific or technological services:	

## **PART II**

Questions related to **barriers to university-industry linkages** in the context of Centres of Excellence:

5. In the context of this Centre of Excellence, I would like to know what **barriers and challenges** you found when interacting with Peruvian firms/universities.
- a. Let's start with barriers that have to do with different perspectives between you (your institution) and your partners (university/firms). What of the following problems have you found?

Description of Barriers	x/v
i. Differences in research orientation (basic vs. applied)	
ii. Differences in time scale (long-term vs. short-term)	
iii. Lack of interest in interacting with universities/firms/international partners	

iv. Lack of incentives to interact with universities/firms/international partners	
v. Mutual lack of understanding (in terms of objectives, priorities, and practices)	
vi. Other cultural differences	

How did you (your organisation) and your partners deal with these barriers?  
What kind of activities did you undertake?

- b. In terms of reaching agreements for collaborative activities with Peruvian firms/universities, what factors are (were) the most difficult to deal with?

Description of Barriers	x/v
i. Disagreements concerning interaction costs	
ii. Conflicts on Intellectual Property (distribution of proprietary rights/benefits)	
iii. Disagreements on confidentiality and disclosure of results	
iv. Difficulties in identifying/finding partners	
v. Other difficulties in reaching agreements (transaction-related barriers):	

How do you (your organisation) and your partners dealt with these barriers?  
What kind of activities did you undertake?

- c. Regarding capabilities in your institution and your counterparts (firms/ university/ international partner), which of the following problems did you face when you negotiated or undertook collaborative activities?

Description of Barriers	x/v
i. Lack of technical capabilities in local universities (low quality research and low capabilities of professors)	
ii. Lack of managerial, negotiation and marketing skills in local university personnel	
iii. Lack of technical capabilities in local firms (low absorptive capacity)	
iv. Lack of managerial, commercialisation and marketing skills in local firms' employees	

v. Lack of internal resources for interacting with firms/universities (of Penn State University)	
vi. Lack of experience in working with firms/universities/international partners)	
vii. Other difficulties or limitations you have found:	

How do you (your organisation) and your partners dealt with these barriers?  
What kind of activities did you undertake?

- d. Regarding the funding scheme of Centres of Excellence promoted by CONCYTEC/CORFO, do you think its design (could) hinders, in some extent, interactions with other partners (firms/university/foreign institutions)?  
If yes, explain which parts/requirements/rules of the funding scheme (could) hinder the building of interactions with other partners.
- e. Turning to the environment surrounding the building of universities-industry linkages in your region or country, which of the following problems have you found? Based on your perception and experience.

Description of Barriers	x/v
i. University networks include few firms	
ii. Lack of funding for further developments	
iii. Missing support for identifying/finding partners	
iv. Absence or low profile of liaison offices in universities	
v. Other problems:	

6. Now I would like to ask questions about certain aspects that could have had an influence (positive or negative) on building interactions with Peruvian universities/firms:
- a. Before being involved in activities within this Centre of Excellence, had you worked with your counterpart (firm/university) in previous projects or initiatives?  
How did that previous experience help with building interactions in the context of centres of excellence?
- b. In the context of this Centre of Excellence, your institution has to perform several collaborative activities with other actors (firms/universities). How do

you think performing several activities could hinder or help to overcome the barriers about which we talked earlier?

- i. Has this situation helped to build trust and mutual understanding between partners? If yes, explain how it helped.
  - ii. Has it hindered or facilitated the negotiation process with universities/firms/international institutions? Explain how.
- c. When building interactions with your counterparts (firms/universities), did you or your organisation turn to external individuals/organisations who have facilitated dialogue, communication or negotiation between partners?
- i. If yes, how do you think the external actor helped in the process of building interactions?
  - ii. If no, why did not you turn to an external actor?
- d. Did any internal specialised unit of your organisation facilitate dialogue, communication and negotiation with other partners? For instance, Technology Transfer Office, Intellectual Property unit, legal advice unit, etc.
- i. If yes, how do you think these units helped in the process of building interactions?
  - ii. If no, why did not you turn to these internal units?
7. Regarding the operation of Centres of Excellence, did this Centre experience high turnover of industrial partners? If yes, what do you think the main reasons for this are?
- a. Did industrial partners participate in the stage of definition of the research agenda and governance of this Centre of Excellence?  
If yes, was the industrial partners' roles central or peripheral?  
Are all those industrial partners currently involved in the operation of and activities within this Centre of Excellence?
  - b. Regarding people who negotiated the creation of this Centre of Excellence on behalf of your organisation, were they involved in the first 3-5 years of operation of the centre?

8. In the case of turnover of industrial partners. What measures did you or your organisation take to prevent industrial members from leaving the project?

What strategies were implemented to attract new industrial members?

9. Is anything else that you would like to add regarding barriers to interactions and mechanisms to overcome them? Any specific barrier that you would like to talk about any measure or activity implemented that you consider important.



**PART III**

Questions related to the ***roles played by foreign research and technology institutions***, in the context of Centres of Excellence:

10. What roles did your organisation fulfil in the process of creating this centre of excellence? In other words, what was its contribution in that process?

a. What roles does it fulfil in the operation of this centre of excellence?

11. What roles have your organisation fulfilled in the process of building interactions between universities and firms?

a. Have you facilitated the process of dialogue and mutual understanding between partners? How was this role fulfilled? What activities were implemented?

b. Have you facilitated the process of negotiation? How was this role fulfilled?

c. Have you contributed to build capabilities in both universities and firms? How was this done?

Description of intermediary roles	x/v
Providing advisors for assisting firms/universities in several decisions.	
Supporting R&D activities in several aspects.	
Supporting new business creation, linking with investors, incubators, etc.	
Supporting member firms to recruit human resources and collaborate with universities.	
Operating a virtual laboratory system with international partners.	
Sales promotion of product of industrial members in global value chains.	
Other roles:	

d. Have you promoted knowledge flows between local firms and universities with international actors and their access to global networks?

i. How have these activities been working in the last three years?

12. What difficulties do you think your organisation has when interacting with local partners (firms and universities)?

13. Have you perceived any kind of conflicts between local universities and your organisation?

14. Is anything else that you would like to add regarding the roles played by foreign research and technology institutions? Any specific activity/role that you would like to describe or you consider important.

### Appendix C. List of Centres of excellence in Peru and Chile

The following table shows the list of seven centres of excellence awarded in Chile in two calls. The first call led to four initiatives being funded, but we include only three because one of them, the Wageningen Centre, closed after a few years of operation. In Peru, there were two calls with one CoE being funded in each, while a third call was suspended. Moreover, there is a Peruvian initiative that was not supported with core funding but started operations on a smaller scale, based on other sources of funding (the Water Competences Centre).

We can observe that CoEs in both countries differ from each other in terms of the type of international partners. In Chile they are mainly research and technology organisations (RTOs), while in Peru they are foreign universities. Moreover, the only Chilean centre with firms as *co-executing partners* is the UC Davis LINC.

#### *List of Centres of excellence in Peru and Chile*

CHILE	
First call winners (2009)	FRAUNHOFER CHILE RESEARCH – CENTRE FOR SYSTEMS BIOTECHNOLOGY FCR – CSB Fraunhofer Chile Research Foundation - Germany  <u>Co-executing partners:</u> Fundación Chile Universidad de Talca Universidad Católica de Valparaíso Universidad Andrés Bello
	CSIRO-CHILE INTERNATIONAL CENTRE OF EXCELLENCE IN MINING AND MINERAL PROCESSING Commonwealth Scientific and Industrial Research Organisation (CSIRO) - Australia  <u>Co-executing partners:</u> Universidad de Chile
	CIRIC: COMMUNICATION AND INFORMATION RESEARCH AND INNOVATION CENTRE Institut National de Recherche en Informatique et en Automatique (INRIA) - France  <u>Co-executing partners:</u> Universidad Católica de Chile Universidad Católica de Valparaíso
Second Call winners (2012)	INTERNATIONAL CENTRE OF EXCELLENCE FOR SOLAR ENERGY – ICESE Fraunhofer Chile Research Foundation - Germany  <u>Co-executing partners:</u> Universidad Católica de Chile

	<p>CENTRE OF EXCELLENCE IN NANOFIBERS LEITAT CHILE Foundation LEITAT Chile - Spain</p> <p><u>Co-executing partners:</u> Universidad de Santiago Universidad Politécnica de Valencia Universidad Autónoma de Barcelona</p>
	<p>SMI-ICE-CHILE, SUSTAINABLE MINERALS INSTITUTE INTERNATIONAL CENTRE OF EXCELLENCE CHILE Sustainable Minerals Institute of Queensland University (SMI) - Australia</p> <p><u>Co-executing partners:</u> Universidad de Concepción</p>
	<p>UNIVERSITY OF CALIFORNIA DAVIS LIFE SCIENCES INNOVATION CENTRE - UC DAVIS LINC University of California Davis - US</p> <p><u>Co-executing partners:</u> Universidad de Talca Universidad Andrés Bello Universidad de Tarapacá Firms: wineries San Pedro, Concha &amp; Toro.</p>
PERU	
First call winner (2014)	<p>CENTRE FOR TECHNOLOGICAL, BIOMEDICAL AND ENVIRONMENTAL RESEARCH</p> <p><u>Partners:</u> Universidad Nacional Mayor de San Marcos Universidad Federal de Minas Gerais (UFMG), Brazil Washington University, US Centro de Investigación de Enfermedades Tropicales de la Marina de los EEUU, Perú (NAMRU-6) BTS Consultores. Solución e Innovación Biotecnológica. Corporación Educativa CETEMIN Global Yaku Consultores</p>
Second Call winner (2015)	<p>INNOVATION COCOA CENTRE</p> <p><u>Partners:</u> Universidad Peruana Cayetano Heredia Universidad Nacional Agraria La Molina Pennsylvania State University, US Cafetalera Amazónica - Grupo ECOM Central Café y Cacao - Central de cooperativas de productores La Ibérica S.A.</p>

Source: Administrative records and public information

Author's own elaboration

## Appendix D. Characterising the activities of the Centre for Systems Biotechnology

Element/Activity	Description
<b>Common agenda<sup>57</sup></b>	<p>Regarding this aspect, we find different perspectives. Some interviewees mentioned that there exists a common agenda among the CoE partners (five interviewees), while others stated the opposite (eight interviewees). It is worth remembering that firms are not part of this CoE; rather they are clients and did not participate in the creation of the CoE nor in the definition of its agenda.</p> <p>Those who mentioned that there is a common agenda stated that they participated designing research lines and projects with other partners.</p> <p>In case of a negative answer, there are two distinct approaches. One comes from academics, who mentioned that the agenda was set up by the international partner (leading organisation). Universities have not participated in defining research lines.</p> <p>The second approach comes from people working for the new structure created by the international partner for this CoE. They stated that there is not a common agenda because universities decided what to do with the resources instead of deciding jointly a common strategy. They pursue their own agenda, and this was not even the agenda of the university, but that of a particular professor.</p> <p>However, it was recognised that building a common agenda would be easier with academics than with firms because academics have vision, while the firms are just looking for R&amp;D and knowledge applied to them.</p> <p>For other CoEs, interviewees used a simile with a Christmas tree with a decoration put by each person that arrives without following a pattern. This is a situation in which 'each one was developing its own projects, with little interaction'.</p>
<b>Collaborative projects</b>	<p>The first aspect to highlight is that collaboration is not limited to co-leadership of projects between a researcher in one organisation and another in another one. Collaboration can involve different levels depending on which actors are engaged.</p> <p>The leading organisation (international partner) built an internal structure of the CoE and it has collaboration with both universities and firms, but separately.</p> <p>In case of collaboration between the internal team of the CoE and <i>universities</i>, some activities are developed in the university and others in the CoE, depending on their capabilities. In general, collaboration starts in the design phase of a project and its application for funding. In some cases, 'there was a sort of co-leadership' of the project. However, interactions with the CoE do not include</p>

<sup>57</sup> A list of aims or possible future achievements (Cambridge Dictionary) pursued jointly by partners, which has been agreed upon by them. In this case, for example, the definition of research and business lines of the CoE.

Element/Activity	Description
	<p>researchers from the parent organisation, but the local team. One explanation for this is the costs of international collaboration.</p> <p>With <i>firms</i>, it is hard to say that they collaborate through their scientists, but they do it with their engineers, executives and facilities. Their main contribution to projects is through logistic aspects such as samples, people to do fieldwork, or giving researchers access to their facilities to carry out some tests.</p> <p>Therefore, with firms there is a broad range of collaboration, ranging from no involvement in the case of consultancies, for example, to joint development. However, the most successful cases happen 'when there is actual joint work'.</p> <p>What is difficult when working with firms is to have more than two firms involved in a project (two principals). In general, there is one firm for each project (this also happened to another CoE). What sometimes occur is that the CoE has to turn to a consulting firm to complement its capabilities and provide a full solution to the client (a firm).</p> <p>An interesting approach was given by a senior member of the management team, who stated that collaboration was limited and done mainly to fulfil the funding requirements. According to this person, it was hard to do and is even considered a burden rather than something mutually beneficial.</p>
Contract research	<p>With an exception, all interviewees who answered this question (10 out of 18) stated that the CoE does perform research contracts for firms, which are funded by both public and private resources.</p> <p>Contract research is considered the first channel of interactions with firms. This can be explained by the organisation model of the centre, based on which it does not offer a pre-existing solution. Staff members of the CoE see firms' problems, think of how they can be solved and design and generate a solution, mostly departing from R&amp;D. In this regard, the CoE is different from a consulting firm.</p> <p>The majority of contracts come with public funding (mainly from CORFO) and that is the reason why people speak of the 'corforisation' of innovation in Chile. In these cases, the CoE and firms apply jointly for funding. Chilean governmental support is regarded as being stronger than that in any other Latin American country.</p> <p>However, in terms of amount of money, the CoE has two big projects funded directly by firms. One of them is from Germany.</p>
Consultancies and services	<p>Most interviewees that answered this question (9 out of 10) stated that the CoE is providing <b>consultancy</b>, but it is not its main business line. The CoE had some interesting consultancies such as road mapping of technology upgrading for a region.</p> <p>However, providing consultancies can be risky because it can divert attention and resources from long-term objectives. The CoE should</p>

Element/Activity	Description
	<p>be focused on producing innovation projects rather than becoming a consulting firm.</p> <p>A potential explanation for the reduced importance of consultancies is that the funding agency and other government actors do not want CoEs to compete with consulting firms, making it difficult for centres to provide consultancies and services.</p> <p>In general, CoEs have different business models, but they can provide consultancies, and that is a source of income in the short run. Commercialisation of products based on R&amp;D will not yield income neither in the short nor the mid-term.</p> <p>In the case of <b>services</b>, the CoE does not have a consolidated and standardised portfolio of them, but it has provided sporadic services such as tests and analyses (requested mainly by academics) or certification courses.</p> <p>According to one interviewee, whether to provide consultancy and services is not a resolved issue. It is something that should be discussed internally, because the CoE is currently configured as a centre based on R&amp;D activities and delivers services related to it. Delivering services would mean a change in the form of operation.</p>
<b>Commercialisation of results:</b> <b>Licencing and spinoffs</b>	<p>The CoE has generated some patents and is negotiating the first license, eight years after it started operations.</p> <p>This situation can be explained by several aspects: there are few patents and fewer opportunities to licence them; patents have been developed from a bottom-up approach, because of researchers' interests, but there was no interest in the marketplace, with various cases in which the CoE 'put a ribbon on and left' them in the shelf.</p> <p>Other CoEs chose different models. For one of them, an interviewee stated that the centre was intended to develop new technologies in collaboration with local partners instead of being a technology transfer centre that brings foreign technologies and sells them in Chile. Meanwhile another CoE does not work on transferring foreign technologies because the agro food industry and environment are led by best practices and public good rather than by imported technologies; this centre is considering activities beyond R&amp;D such as technology adaptation and even extension.</p> <p>In the case of <b>spinoffs</b>, the situation is similar. The CoE is in the process of developing a spinoff but it is complex, and it is not being given enough time to achieve this result. Under the Chilean conditions, it is almost unrealistic, but the CoE is making efforts to comply with the funding requirement, as it is in the case of technology licencing.</p> <p>Like in the case of patents, there is also criticism about spinoffs, which are considered to be overrated and respond to a new fashion in the field.</p>

Element/Activity	Description
<p><b>Training of people and building capabilities:</b></p> <ul style="list-style-type: none"> <li>- Training to firms</li> <li>- Training of students</li> <li>- Mobility</li> <li>- Diffusion events</li> </ul>	<p>Activities for building capabilities in the context of the CoE are diverse. In this regard, the centre was expected to train both local firms and academics in new technologies.</p> <p>However, proper training activities were not undertaken. Training activities are sometimes included as part of some research projects. This situation can be explained by: i) firms do not invest in training of their own staff; ii) it is not the role of CoEs, even though they have the capabilities to do it; and iii) universities are fulfilling that function successfully.</p> <p>So, building capabilities happens in the following ways: internal training activities, supervision of students, mobility of people, and diffusion events.</p> <p>The structure created by the international partner (internal team) has an <b>internal policy</b> to train its staff in different topics, in Chile and abroad. The CoE sends its staff abroad or it brings people from abroad. These activities include neither university's nor firms' staff.</p> <p>In terms of <b>supervision of students</b>, some projects include doctoral students who are trained in aspects related to knowledge application to meet firms' needs. However, the number of these students is small, which can be explained by three factors: i) academia is still conservative in the sense that the only ethical option for a PhD is to be involved in academia; ii) the CoE works with people already trained at the PhD level, not with students, with some exceptions; and iii) the risk of including students in projects with universities is that researchers leave them in charge of the interactions. A critical view of this situation is that CoE's contribution to the training of PhDs is the same as in any other project.</p> <p>A senior interviewee stated that there is not a programme such as the British Case Studentships<sup>58</sup>, and that may be the reason why not too many firms have research departments. However, the CoE has delivered some PhDs to society, who are candidates to be hired by firms or who will be able to produce technologies and knowledge applied to them.<sup>59</sup></p> <p>There are different types of <b>mobility</b>. For example, internships for students of local universities in the CoE or abroad and international students visiting the CoE. Foreign researchers or professors can also visit the CoE and local universities.</p> <p>However, there is not very much personal mobility nor academic mobility. Even though the latter is common in Germany, in Chile it is</p>

<sup>58</sup> The Co-operative Awards in Science and Engineering (CASE) studentship programme in the UK allows university-industry collaborative teams to apply jointly for research studentship awards. This scheme promotes joint supervision of students between academics in universities and scientists from industry (Demeritt and Lees 2005)

<sup>59</sup> This is an important contribution of CRCs to the Australian NSI (Harman 2002, 2005).



Element/Activity	Description
	<p>not. If it happened, it would create a gap in the CoE's capabilities, because it was hard and costly for the centre to have trained people and would be difficult to replace them.</p> <p>The CoE organise and participate in different kinds of <b>events</b>, both academic and non-academic. Organisation and participation in events are important activities to disseminate the CoE's capabilities, letting people know that the centre exists.</p> <p>Moreover, for some CoE projects, a particular publishing and communication platform is developed, supported by journalists who disseminate information of the projects.</p> <p>Diffusion activities include newsletters, building stands in fairs, workshops, brochures, presence in social networks and so on.</p>

## Appendix E. Characterising the activities of the Cocoa Innovation Centre

Element/Activity	Description
<b>Common agenda</b>	<p>Even though there is not an explicit (formal) requirement to have a 'common agenda', the CoE has a strategic plan which has been discussed by its board and approved by all partners. This common agenda has strategic lines within which partners can present projects to be funded.</p> <p>Despite most interviewees claiming that there is a common agenda, one person from the business sector stated that there is no such tool between researchers and businesspeople; in other words, there is not a 'fusion of scientific agenda with the commercial agenda'.</p>
<b>Collaborative projects</b>	<p>There are different levels of collaboration. Collaboration starts in the process of approval of projects presented by partners of the CoE. This process includes participation of academics and businesspeople in the scientific and business committees as well as on the board. Collaborative projects were expected to reflect scientific and commercial aspects but, according to one interviewee, the CoE does not have any scientific-commercial project yet.</p> <p>The second level of collaboration occurs in the design and execution of projects, where academics are the leading actors. In general, projects are led and performed by university researchers. Collaboration in projects can happen between researchers of different universities, according to their capabilities (complementary competences).</p> <p>Firms participate in some projects, but they do not co-lead them. Their participation consists of actions relating to logistics such as providing samples, access to equipment to do tests, vehicles for mobilising people, participation of their staff, and people in the field.</p> <p>The CoE does not allow nor promote joint design of projects between partners. In terms of projects, the international actor collaborates with universities but not with firms. This collaboration is through tests in their laboratories.</p>
<b>Contract research</b>	<p>The CoE does not develop contract research because it is not its main objective. According to its model, it was created to generate technologies to support the country's competitiveness. According to one interviewee, this aim would not be achieved if intellectual property went to third parties or even to an international actor.</p>
<b>Consultancies and services</b>	<p>Some interviewees stated that providing consultancy is planned and necessary, as part of the CoE's objectives. It is expected because the centre has the capabilities to do it, but it is important for it not to be 'diverted from its main objective of developing technologies'. It is expected to be a technology centre rather than a consulting firm.</p>

Element/Activity	Description
	<p>Most interviewees (8 out of 10) recognised that the CoE is not currently providing consultancy. However, most interviewees stated that it is necessary and expected.<sup>60</sup></p> <p>Even though it was suggested because the CoE has experts and it is an easy and fast way to generate income, it is not doing it.</p> <p>In terms of services, the CoE provides some services through a laboratory of one university. These services are analyses of samples, tests and support to students and researchers in aspects related to their research projects (technological services).</p>
Commercialisation of results Licencing and spinoffs	<p>Even though it is too early to assess the centre's performance in terms of technology licenses, the CoE has been conceived as a technology centre aiming to generate technologies to be transferred. Technology commercialisation is supposed to give the CoE sustainability. For that reason, the centre is working on projects which should lead to the creation of patents and then their licencing.<sup>61</sup> These activities are therefore expected because they are the main objective of the CoE.</p> <p>Besides patents, the CoE has created certain products derived from cocoa, such as a drink, which could be commercialised.</p> <p>Moreover, spinoffs are expected but have not yet happened. It is more complex and the CoE has no clear idea about it. For example, there is a commercial project, which has the potential to generate a spin-off company, but it depends on future decisions.</p>
Training of people and building capabilities: - Training to firms - Training of students - Mobility - Diffusion events	<p>The CoE performs different activities intended to build capabilities. It has, for instance, open courses and workshops addressed to general audiences including firms' staff, academics, and students.</p> <p>The CoE does not provide proper <b>training activities to firms</b> as part of its business. Even though these activities were designed and the CoE has the capabilities to deliver them, they have not been prioritised.</p> <p>Some research projects include training to firms, particularly to small producers, but it is very limited.</p> <p>Students are included in some research projects, the <b>supervision</b> of whom can be analysed from two perspectives. From a narrow notion of supervision, they are supervised by professors in one university and have visits to or internships in other academic organisations, in Peru or abroad. To have co-supervision, there must be a joint programme because each university has its own regulations for this purpose.</p> <p>However, considering a broad definition of supervision, there is some indication that students participating in CoE projects are co-supervised</p>

<sup>60</sup> In another centre, according to its model, a consulting firm was created to provide services, separating the research part, which is in charge of the CoE, from the business part, developed by the consulting firm.

<sup>61</sup> The other CoE has been built upon similar grounds. It is intended to produce patents, but licencing and applications have not been evaluated yet.

Element/Activity	Description
	<p>by researchers in more than one organisation. This is still limited to the academic world because co-supervision with firms does not happen yet. <b>Mobility</b> of people involved in the CoE happens in different ways. For instance, students can have internships in or visits to foreign organisations and they can also visit some firms. Researchers and CoE staff travel to different organisations to attend events and have internships, while foreign researchers visit the CoE.</p> <p>There is not academic mobility in the sense that researchers from a university move to the CoE or to firms.<sup>62</sup></p> <p>In terms of <b>diffusion activities</b>, the CoE organises some of them and participates in others. The CoE organises events periodically, where researchers, students and experts from other organisations can participate. Some activities of diffusion are internal to the CoE and its partners.</p> <p>Events organised by the CoE are not co-organised with firms, but they can participate.</p> <p>The purpose of participating in events is to make the CoE visible to a larger community. However, a critical view is that nobody speaks about the centre; neither actors from the academic sector nor from the business sector know the CoE.</p>
Other relevant activities	<ul style="list-style-type: none"> <li>- Participation in policy-making spaces such as technical working groups related to the CoE's expertise.</li> <li>- Standard-setting activities within the scope of the CoE.</li> <li>- Formation of a panel of tasting of cocoa and chocolate.</li> </ul>

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<sup>62</sup> In the case of another CoE, the model of which is based on training human resources, some of its clients have asked the CoE's manager to recommend people to be hired. In this case, for example, a post doctorate who was working for the CoE was hired by a public organisation and now performs activities in both places.

#### Appendix F. Short note about the need for CoEs

The conclusions and recommendations of this thesis seems to be based on an implicit assumption about the need for CoEs in the Chilean and Peruvian innovation systems. Questioning their necessity in these countries and for the agriculture sector is valid, so some critical reflections are needed here. The analysis is developed as an appendix because this study did not aim to assess the impact and effectiveness of CoE programmes as a policy instrument<sup>63</sup> but has nevertheless provided some potentially valuable insights with regard to the need for CoEs.

One aspect refers to the necessity of doing research in the agriculture sector. In this regard, some studies have highlighted that indigenous research and adaptive research is always needed in this sector because of its country-specific characteristics (Mazzoleni and Nelson 2007; Wright and Shih 2010). Finding the appropriate technology may vary depending on a number of factors such as climate, soil types and distance from the market (Pardey et al. 2010). Moreover, patterns of innovation and the roles of intermediaries in the agriculture sector also differ significantly across countries, as showed by Dutrénit, Rocha-Lackiz, and Vera-Cruz (2012).

The second aspect is whether CoEs should exist at all, given that universities are already doing research in these areas. There are some reasons in favour of the coexistence of these two actors. As stated in Chapter 9, having a certain institutional diversity is generally advantageous for technological development. In the same vein, some authors (e.g. Nelson 2006) have argued in favour of having universities do research under certain criteria: in particular, open disclosure, exceptional patenting and non-exclusive licensing. Moreover, other authors (Dasgupta and David 1994; Rosenberg and Nelson 1994) have argued in favour of having a division of labour between universities and firms with regard to

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<sup>63</sup> As mentioned in several parts of the thesis, studying the impact and effectiveness of CoEs in Chile and Peru needs to be done at some stage in the future, when those aspects can then be properly assessed.

conducting R&D. This institutional diversity could include CRCs as boundary-spanning structures between these two worlds.

CoEs could create a different environment not only for carrying out research (pre-competitive research) but also for building capabilities in firms through various activities such as training, consultancies and services. These activities in CoEs can be performed by some university researchers in close relationship with industrial partners. Moreover, we have found in Chapter 7 that there are two groups of university researchers – those who are interested in linking with firms and those who are not. CoEs would allow interested researchers to collaborate more closely with business actors, while uninterested ones would continue doing research under the criteria mentioned earlier. The beneficial co-existence of these two groups of researchers has been highlighted by Lundvall and Borrás (2011).

Third, the internationalisation of both universities and RTOs is mainly driven by economic and academic or scientific interests, sometimes with the expectation of contributing to the development of capabilities in the host country (Fraunhofer 2017; Frølich 2006; Youtie et al. 2017). In this context, the coexistence of universities and CoEs opens up opportunities to benefit from different flows of knowledge and technology. Universities can continue to collaborate with international partners in research, while CoEs can promote other types of international cooperation, in terms of technology and innovation. The boundary-spanning nature of centres positions them in a ‘vantage point’ not only to connect universities and business actors but also to promote international collaborations with a different perspective compared to universities.