Internationale Graduiertenkollegs

Studie im Auftrag der
Deutschen Forschungsgemeinschaft (DFG)

Anhang 3:
Materialienband „Literature Review and Analytical Framework for the Study of Internationalisation of Graduate Education and Research Training“

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Februar 2014

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Letzte Änderung: 03.07.2014

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1 Introduction

Can high-level research and research collaboration be stimulated, supported and improved through international collaboration? In particular, which role can support for the internationalisation of doctoral and first-stage researchers play in this context? Is there a productive role for funding programmes such as the DFG's International Research Training Group (IRTG) programme? This paper is written in support to the study led by Technopolis and the University of Twente studying the rationale and role of such programmes, in particular of the IRTG scheme.

A key starting point for the present paper is the observation that high-level research, in a growing number of scientific disciplines and thematic fields, is inspired by or occurs through inter-institutional collaboration of researchers (e.g. Katz & Martin 1997; Shrum et al. 2007), increasingly as international collaboration, taking various forms (mobility and exchange of researchers; joint projects; joint publications etc.; for a recent overview see Ulnicane-Ozolina 2013). Since several decades, together with an increasing international mobility of scientific researchers, international research collaboration "has grown significantly in academic research. This is reflected in the growth of internationally co-authored (or collaborative) scientific articles, that is articles with at least one international co-author (in terms of institutional affiliation). Between 1988 and 2001, the total number of international articles more than doubled, increasing from 8 to 18% of all scientific articles" (Vincent-Lancrin 2006, 14, see also Figure 1; see also van Rijnsoever & Hessels 2011)

Moreover, taking co-authorship as proxy of research collaboration, the US National Science Foundation (NSF) recently reported that the number of international articles (with authors from at least two countries) grew even faster in the last decade, therefore tripling in share between 1988 and 2010, from 8% (NSF-NSB 2008) to 24%(NSF-NSB 2012). According to NSF, "32% of U.S. articles in 2010 were internationally coauthored, up from 23% in 2000. Even higher rates of international coauthorship are evident among the countries of the European Union, where large Framework Research Programs have strongly encouraged it, and in Switzerland. Both Japan's and Asia-8's international coauthorship rates have increased over the past 10 years, and more countries passed the 50% mark over the decade (...) China's S&E article output grew sufficiently over the decade to place it as the world's second largest S&E article-producing nation (and its) internationally coauthored articles as a share of its total article output remained (…) at 27%." (NSF-NSB 2012)

As the NSF reports, the number of countries collaborating on an article also expanded. In 2003, more than 60 countries had co-authored with other countries, compared with 32 in 1996 (NSF-NSB 2006). Over the period 1995-2005, intercontinental co-authorship increased as a percentage of total article output for the US (from 17% to 27%), for the EU (from 18% to 26%), and for Asia (from 16% to 19%) (NSF-NSB 2008), revealing an increased international interdependence of the research enterprise (Narin, Stevens et al. 1991; Glänzel and Schubert 2004; Glänzel and Schubert 2005; NSF-NSB 2008). However, as Leydesdorff & Wagner (2008, 317) put it, "during

the period 2000-2005, the network of global collaborations appears to have reinforced the formation of a core group of fourteen most cooperative countries. This core group can be expected to use knowledge from the global network with great efficiency."

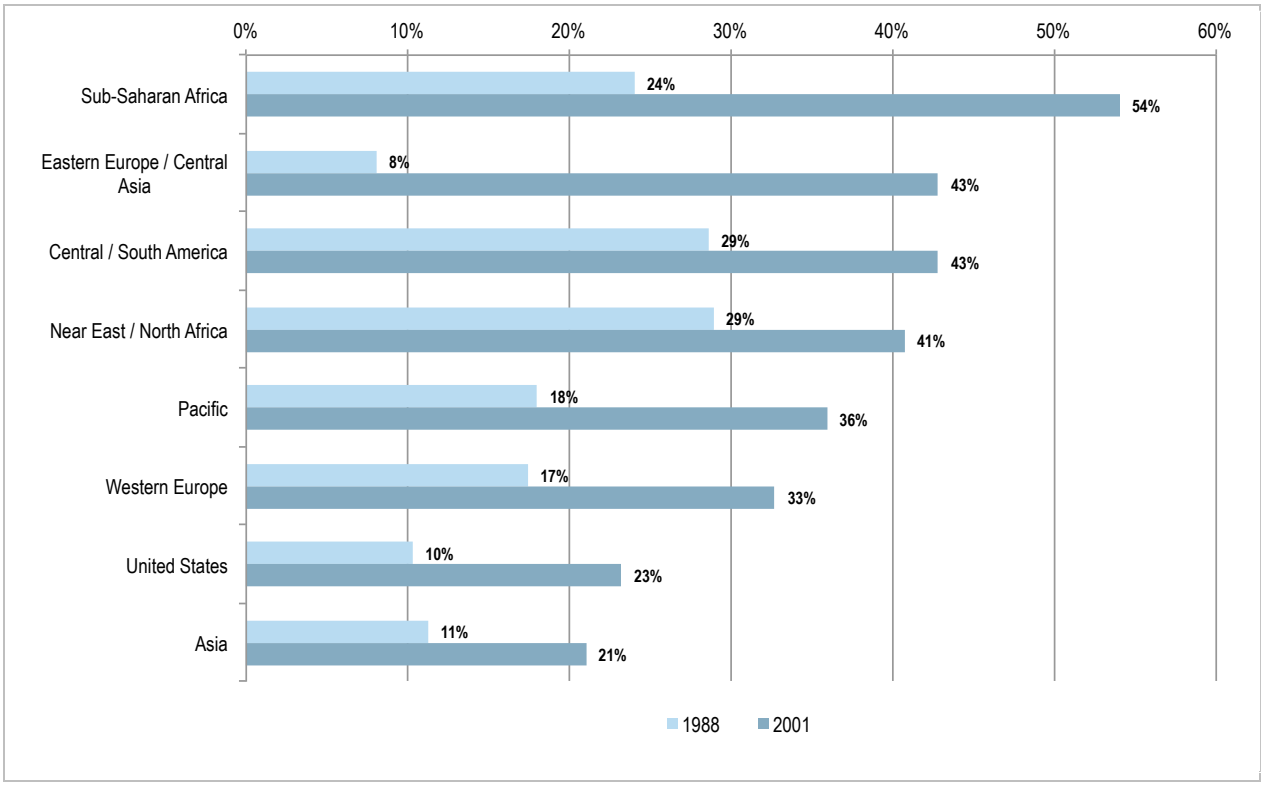

Figure 1: Percentage of international collaborative scientific articles, by region (1988, 2001)
Source: Vincent-Lancrin 2006, 16 citing NSB, 2004. Note: The data correspond tot he number of articles with at least one foreign coauthro as a share of the total number of articles from the region or country. Articlevolume is in whole counts, where each institutional coauthor is credited with the whole count. Data come from the Institute for Scientific Information, Science Citation Index and Social Science Citation Index; CHI Research Inc.; and National Science Foundation, Division of Science Resources Statistics, special tabulations.

Against these findings, for the remainder of the document we will take this strong trend towards internationally highly inter-woven research collaboration as a fact. In this context, which role can support for the internationalisation of doctoral and first-stage researchers play? What is known about the role of related graduate education and research training conditions? To explore these questions we will take a number of steps:

First, we discuss the literature regarding the rationales explaining the internationalisation of higher education in general and of graduate education and research training in particular. We analyse why it is important, and what can be expected from it. In so doing, we discuss how relevant institutional actors diverge in their perspectives. In that chapter we analyse a) the perspective from the policy/political agenda which emphasises on societal goals such as the intention to increase competitiveness, multiculturalism, and integration / globalisation; b) the institutional / instrumental perspective, which emphasises on means to increase (research) resources and opportunities and reduce costs; and c) the pedagogical / cognitive / professional / human perspective, which emphasises on effects on the individuals' skills and personal conditions.

Second, we discuss the literature regarding the various forms of internationalisation of graduate education and research training. These forms include a) student and first-stage researcher's mobility, b) senior researcher and teaching/staff's mobility, c) international curricula/joint programmes/joint supervision, d) international research collaboration, and e) other forms (branch campuses, mutual programme recognition, transnational higher education institutions, and distance education programmes). We note that although most of the literature found on the topic refers either to higher education or research activities, it can be considered for fruitful debates with respect to research training groups of the types supported by DFG as well.

Third, we discuss the approaches found in the literature for assessing the effects of programmes supporting the internationalisation of graduate education and research training. In so doing, we refer to grey literature and identify the criteria used in empirical assessments of activities performed by a) the U.S. Fulbright Scholar Program, b) the Visiting Fulbright Student Program, c) the Erasmus Mundus Programme, and d) the National Science Foundation's (NSF) Integrative Graduate Education and Research Traineeship Program (IGERT), among other.

Fourth, on the basis of the literature reviewed, we claim that a fruitful way to study the rationale and role of DFG's IRTG Programme is by relying on a resource-oriented approach. In so doing, we discuss what can be expected (or not) from internationalisation of research training programmes to a) offer first-stage researchers improved research conditions and (scientific) development perspectives; b) extend the international research and cooperation opportunities for the participating senior researchers and teaching staff; c) expand and strengthen the international cooperation network in the research fields of the participating scientists; and d) achieve formalised strategic alliances of international visibility for their universities. To support this claim, we refer to the literature where such outcomes have been found or could be inferred logically as an extension of beneficiaries of the internationalisation of higher education. In particular, we survey the literature on the effects regarding the internationalisation of graduate programmes on the three main actors: the students, the teaching staff, and the host institution. With respect to the effects on students and first-stage researchers, two main effects are discussed: skills and career prospects. Regarding the effects on senior researchers/teaching staff, the literature discussed relates mostly to their research productivity, networking and funding opportunities. Finally, the effects on host institutions involve increased funding, reduced cost and attractiveness / visibility.

In the last chapter we summarise the main findings of this exercise, suggest a heuristic helping to understand the conditions of emergence and stabilisation of international research collaboration, with a particular focus on the role of doctoral and early stage researchers and the mobilisation of related resources, and identify key factors and framework conditions to account for the resource-based approach to internationalisation as proposed to better understand DFG´s IRTG Programme rationales and role.

During the collection of related literature, the choice was made to focus the search to include both scientific and grey literature about the drivers, forms and effects of internationalisation of

doctoral education programmes, as a way to provide a scientific and a contextualised view of the topic considering different approaches. In this process, a diverse spectrum of scientific disciplines was included in the analysis ranging from internationalisation of PhD training programmes in the areas such as nursing, library and information studies, the humanities, business schools, life sciences, natural sciences, engineering and science and technology studies. The collected literature covers internationalisation efforts in various countries and areas such as the US, the UK, the Nordic countries, Africa, Asia, Latin America and Europe.

The procedure took place in two phases: in a first phase literature was collected using the databases of ISI- Web of Knowledge, Scopus and Google Scholar. In addition to this, literature was sought in specific journal databases including the journals Research Policy, Higher Education, and the Journal of Studies in International Education. The keywords that were used to collect the literature in this phase were: “international higher education”, “internationalisation graduate school”, “internationalisation graduate education”, “impact internationalisation graduate education”, “cross-border collaboration higher education”, “indicators internationalisation graduate education”, “cross-border supervision PhD” and “cross-border education PhD”.

In a second phase, we a) broadened the scope of the search strategy to include more generic terms such as “higher education”, “graduate education”, “graduate training”, “research training”, “doctoral training”, “PhD training”, “graduate school”, “joint PhD program*”, and “international research collaboration”; and, b) performed searches of grey literature and key websites to identify key materials found in the references emerged from phase one, as well as on the basis of the recommendations given by DFG staff, Technopolis and UT colleagues as a result of their comments and feedback. In this phase, the search strategy was then narrowed to focus on graduate programmes and research training groups similar to the ones supported by DFG. The purpose was to better complement the literature found on the internationalisation of higher education while pointing to its relevance for the study intended.

After collecting a total of 257 documents (scientific and grey literature combined), the documents were analysed focusing on the main purpose of the research to support the study of DFG’s IRTG programme rationale and role. The analysis led to the identification and selection of 90 documents that were used in this review.

A note for greater conceptual clarification is important to be made at this point. Although the focus of this research is on the rationales and role of the internationalisation of research training programmes, the reader will notice that sometimes we assume that “higher education,” “graduate education” “doctoral education” and “research training” are the same type of activities, involve the same actors and respond to the same drivers and logic. This is of course not always the case as sometimes a clearer distinction between these concepts is important to be made as they are in fact three different aspects. However, the literature and current understanding of the rationales and role of the internationalisation of the latter (i.e. research training) is much less developed than that on the former two. We draw and “extrapolate” on these activities to exemplify and guide the discussion related with the rationale and roles of internationalisation of

research training programmes. We do this whenever we judge it's relevant and useful. In fact, we claim that many of the issues related with the internationalisation of higher education and of graduate education are similar enough to those related with the internationalisation of research training. When this is clearly not the case, we make the necessary differentiation, and point to the inaccuracy of generalising assumptions and conclusions.

Therefore, for the purpose of this research, and to put it simply, when a clear distinction needs to be made we understand "higher education" as the formal training of individuals that comes after high school and that typically takes place at universities and involves educational programmes such as bachelors', masters' and doctoral or so-called graduate education. We therefore understand "doctoral education" as part of higher education, that most of the time takes place within university boundaries and is perceived as a third phase of study. Most of the time it is structured in the framework of an educational programme of a disciplinary faculty, and involves obligatory class attendance with lectures, tutorials, projects, etc., like any other 'regular' scholarly programme within universities. It may involve teaching and research duties, and is judged completed after a dissertation is successfully defended. This "format" is the common denominator in the U.S., and increasingly in Europe. In this framework, graduate education also involves masters' programmes, some of which are research-based or professional-based. Finally, we understand "doctoral/research training" as the first stage of independent scientific work. In this framework, such training is perceived as aiming to provide the individual the necessary "tailored-made" conditions and tools for her to exploit her research interests and potential, and to start building her future career in academia or in laboratories or consultancy firms. In this framework, PhD researchers may be affiliated to single-discipline academic units or to a combination of different academic units and therefore perform research with a strong multidisciplinary focus. It most of the time involves teaching and research duties, and ends with a successfully defended dissertation. This is the most common way to understand "doctoral education" in Europe, and is also one of the targets of the DFG's IRTG Programme. Regarding this last type, Reichert discusses how the recent reform on graduate research training across Europe has led to the introduction of new organisational forms such as transversal courses to develop generic skills training or "overarching support structures such as graduate schools that incorporate interdisciplinary exchange forums, transferable skills training and support services" (Reichert, 2009: 18). This description corresponds to research training groups of the types this project focuses on, and for which internationalisation can be a special feature with merits (and costs).

In addition, it is also worth noting that there are similar issues between the internationalisation of research training and the internationalisation of research performance. For this reason, we also draw on the literature on this topic to better understand the drivers and role of the internationalisation of research training programmes. We will also point to these aspects when judged relevant/necessary. The following is a discussion of the findings from the search and analyses described.

2 Internationalisation of Graduate Education and Research Training: Rationales and Drivers

One of the main findings of the review done in the framework of this study is that, when it comes to analysing the goals, forms, drivers and effects of the internationalisation of doctoral education and research training, many different perspectives emerge. Regarding higher education, Knight identifies different rationales in relation to why institutions would seek to internationalise their programmes. These include the political (often driven by national governments), economic (primarily the desire to use higher education to help a nation or region compete in the global market), academic (enhancing quality in teaching, research and service), cultural and social rationales (primarily the focus on the development of individual learners to improve the quality of their lives) (Knight & De Wit, 1995; Knight 2004 in Deardorff, 2004). According to van Damme (2001) internationalisation of higher education focuses on an enhanced experience for students, the establishment of networks to increase efficiency, and financial growth (van Damme, 2001).

Therefore, three relevant institutional actors appear to have diverging perspectives on the internationalisation of higher education, including graduate education. As Abdullahi et al. state, “policy-makers tend to focus on ideological goals and university administrators on formalities and practicalities of international cooperation whereas teachers emphasise pedagogical issues” (Abdullahi et al., 2007: 9). We notice that these same actors may have similar perspectives regarding research training. In this chapter, a review of the literature considering these three perspectives is presented.

2.1 The Policy/Political Perspective

Internationalisation of higher education and of research is commonly referred both in scholarly work and political discourse as the strategy of governments and institutions to take advantage of (and cope with) globalisation to enhance excellence in research and innovation by connecting top talent from within and abroad with the intentions to improve competitiveness, integration, and multiculturalism (Stromquist, 2007).

For example, following this perspective, and based on these promises, international educational collaboration is flagged as one of the priorities of the European Innovation Union as specified by the European Commission, for whom “[o]ur education systems at all levels need to be modernised. Excellence must even more become the guiding principle. We need more world-class universities, raise skill levels and attract top talent from abroad.” (European Commission, 2010: 2-3).

From this perspective, geopolitical considerations have always been influential in the thinking and policies regarding internationalisation of higher education, including graduate education programmes and perhaps also research training; more in terms of researchers’ mobility than in

terms of other forms of internationalisation, however. As Van Damme (2001) posits regarding higher education, former colonies and (post) colonial relations continue to characterise current flows of students from the Global South to the Global North. According to the author, during the cold war countries strived for the attraction of students and teaching staff from ideologically associated nations. Indeed, after World War II, international training was seen as a strategy to foster development and democracy, first in the Atlantic community, then in the Global South.

More recently, internationalisation of higher education, and increasingly of graduate education, has been seen as a strategy for advancing economic integration and expansion of the internal market, where public policies have the ambition, among other goals, of increasing the cooperation of researchers in order to develop the international dimension of higher education (Stromquist, 2007). Based on this policy/political rationale, in Europe for example large portions of funding is allocated by governments to support student and researcher mobility and intra-European research collaboration. The design of the EU Framework Programmes clearly has this rationale in mind. Similar trends exist regarding support to NAFTA and MERCOSUR research collaboration.

Hence, based on this approach, internationalisation of higher education, graduate education and research training is also thought of as a tool to enhance competitiveness, effectiveness and economic growth. As Huang (2003) argues, in the case of China internationalisation of higher education was while first more oriented to modernise industry, agriculture, defence and science and technology fields through international cooperation (between 1978 and 1992), later it became more focused on taking up the challenges of globalisation to participate in (market oriented) competition in the academic field (Huang, 2003).

Teichler (2004) stresses how internationalisation of higher education is used to expect qualitative leaps instead of gradual change; whereby to be “international” is becoming the norm, as “all higher education institutions have to be international, national and possibly local (glocal); these efforts are systematised and embedded; international affairs no longer marginal and no longer “confined to internationalisation specialists” (Teichler, 2004: 9).

Furthermore, under this rationale internationalisation is referred to as “a need” or “a must” in today’s political perception of the role of higher education (European University Association, 2005) and research (Georghiou, 1998). As Qiang (2003) claims, education has become part of the globalisation process and therefore it can no longer be regarded in a purely national context. As the author posits, “this calls for a broader definition of internationalisation, which embraces the entire functioning of higher education and not merely a dimension or aspect of it, or the actions of some individuals who are part of it” (Qiang, 2003: 248). We claim that the same rationale applies regarding research and research training as well.

International research funding programmes addressing the so-called Grand Challenges increasingly tend to offer support for doctoral and early stage researchers (in parallel with training programmes; see e.g., the UCL’s ‘Grand Challenge 100’ PhD training programme). The Dutch NWO states in its website “healthcare, energy, urbanisation and scarcity of raw materials are

issues faced by countries throughout the world. With its own themes, NWO connects with European and global research themes: the Grand Challenges. The successful international embedding of Dutch research will increase the chance of breakthroughs and innovation."

Finally, from the political/policy perspective, internationalisation is also seen important to bring peace, mutual understanding, tolerance, and multiculturalism. As van Damme puts it, "broad cultural values such as internationalism, and cross-cultural educational and scientific exchange are positive goods in themselves, or the conviction that it also promotes the international understanding and cross-cultural sensitivity among home students and the wider community" (van Damme, 2001). This rationale does not seem immediately relevant regarding research training, rather it applies indirectly.

2.2 The Institutional / Organisational / Instrumental Perspective

Another way internationalisation of higher education (including graduate education and research training) is portrayed in scholarly work comes from the institutional/organisational/instrumental perspective. From this perspective, internationalisation is a means to increase resources, opportunities, and to reduce costs. As Van Damme sees it regarding higher education, internationalisation is "the most important societal challenge universities all over the world had to face in the last decades." (Van Damme, 2001: 416). Furthermore, the author defines internationalisation as "the activities of higher education institutions, often supported or framed by multilateral agreements or programs, to expand their reach over national borders" (van Damme, 2001: 417). From the author's view, internationalisation of higher education primarily takes place "within a national environment" while it has international objectives such as the diversification and growth of financial input by recruitment of fee-paying foreign students, broadening of curricula and educational experiences for domestic students in foreign partner institutions, and regional networking in order to allow a more cost-effective use of resources (Van Damme, 2001).

Following this rationale, Eckel et al. (2004) claim that the objectives of internationalisation of higher education are to "position institutions in new markets and create the potential to generate new tuition dollars" (Eckel, Green, & Affolter-Caine, 2004), where shortage of institutional funding of home institution is seen as leading to attract international students as source of income.

For Stromquist, internationalisation is predominantly a search for student markets (Stromquist, 2007). This view is consistent with that of Bennett and Kane, who discuss the internationalisation of higher business education and put forward five possible indicators that affect the speed of internationalisation for institutions: a) the age/size of the school (larger business schools may have more in-house skills and backgrounds to internationalise, while smaller schools may be more flexible and can so move to internationalise faster); b) managerial inclination (more internationally experienced senior managers, who make resource-related decisions can influence the process of internationalisation); c) resource availability and financial situation, d) the employability issue (internationalisation may give graduating students more possibilities) and e) the

reliance on foreign students (institutions that depend for funds on international students may be expected to be driven to enhance internationalisation efforts) (Bennett & Kane, 2011: 357-8).

Although this utilitarian view of internationalisation is perhaps less accurate regarding research training, as the target population is not usually charged fees, but the opposite as they are sometimes employed by the university or research institution, it may in fact apply in other ways worth exploring. We will refer to them while discussing the analytical framework proposed in section 5.

2.3 The Pedagogical / Cognitive / Professional / Human Perspective

Finally, the study of internationalisation of higher education, including graduate education, has also been found to respond to the pedagogical/cognitive/professional/human perspective. From this point of view, Deardorff summarises the purposes of internationalisation of higher education in terms of the impact on students. According to the author, it would make students more internationally knowledgeable and inter-culturally competent (Deardorff, 2004: 8). For this reason, the author focuses on the effects of internationalisation efforts on students by viewing intercultural competence, learning goals, course content, pedagogy campus life, enrolment patterns, and institutional policies and practices (Engberg, Green, 2002: 16 in Deardorff, 2004: 13). According to van Damme international programmes respond to the conviction that “it is the most effective means (for) preparing future graduates for the needs of an increasingly international professional life in a global economy” (van Damme, 2001). Volet notes how one of the challenges of internationalisation is the enhancement of intercultural competence and skills for the critical reflection on the situated and non-neutral nature of knowledge (Volet, 2003: 8) to develop qualitatively sound programmes. Nerad (2010) discusses the importance of “translational” soft skills (Nerad, 2010: 6). Other “soft skills” studied as resulting from internationalised programmes include self-confidence (U.S. Department of State, 2005), language proficiency (Altbach & Knight, 2007), and entrepreneurship (Deardorff, 2004; Carney et al, 2011). We claim that these issues are also relevant regarding research training.

3 Forms of Internationalisation of Graduate Education and Research Training

In this chapter we discuss the literature found to support a characterisation of the ways the internationalisation of higher education, including graduate education and research training, take place. Since some forms of internationalisation fit best (or have been proven/reported for) one type of education/training than others, we make this distinction explicit when relevant. Another important distinction to make is when some forms respond best to one of the approaches to internationalisation discussed in chapter 2 than to another.

The review of the literature unveils the different forms internationalisation of graduate education and research training takes or can take. Dolby & Rahman (2008) provide a historical overview of the internationalisation process of higher education in general in Europe and in the USA, showing how it was first conceived as a natural extension of regional, then colonial boundaries, which then moved to support communities emigrated mostly to the Americas, then became used strategically/politically to promote peace and mutual understanding during post-World War II, then was conceived instrumental for expanding markets and ideological/political influence during the Cold War period. Currently, it is seen as a way to improve quality and impact of education and research. According to van Damme (2001), internationalisation of higher education may involve one or a combination of eight forms: a) student mobility, b) teaching staff mobility, c) internationalisation of curricula (including joint programmes), d) branch campuses, e) institutional cooperation agreements and networks, f) mutual recognition agreements, g) transnational university networks (including mergers of institutions), and h) transnational virtual delivery of higher education. Clearly, the first three forms of internationalisation listed are more relevant for analysing the rationales and roles of research training than the remaining five. A more relevant form of internationalisation from the perspective of the intended study is international research collaboration. Focusing on higher education, Teichler (2004) highlights four topics that are of importance to assess internationalisation. According to the author “[it] is often discussed in relation to physical mobility, academic cooperation, academic knowledge transfer, and international education” (Teichler, 2004: 7). Discussing all these forms in detail is out of the scope of this research. A selection of key features is discussed, when judged relevant for the study intended. For this reason, we focus on physical mobility, research collaboration, and internationalisation of curricula, and will briefly touch upon the others.

Physical mobility can be divided between student and first-stage researcher mobility and senior researcher and teaching staff mobility.

Student mobility is one of the most studied forms of internationalisation. The reason is that it is both a policy target, and a two-way factor determining- and resulting from- research collaboration and joint programmes. There are two types, horizontal or vertical mobility. According to Kehm (2006), horizontal mobility involves a limited period of study and research abroad, as well as the exchange of doctoral students between countries. This is the type of mobility foreseen in

the IRTG programme. Vertical mobility involves doctoral students leaving their home country to get a doctoral degree in another country. According to the author, the former form of internationalisation is in practice less frequent than expected. The author points to three issues preventing horizontal mobility and exchange: in countries with tuition fees, doctoral students constitute an income for the institution; therefore the institution will try to keep the doctoral student there. In many countries, the author adds, it is feared that brain drain will set in, that is, once doctoral students have gone abroad, possibly to an institution with better infrastructure, or to a country with higher income and better living conditions, they will not return. Furthermore, the author thinks that in some subjects there is fear that an exchange of doctoral students will involve an exchange of innovation, research results and knowledge that might be turned into a profit through patents and licenses by the host institution, thus creating a competitive disadvantage (Kehm, 2006: 67-78).

Kehm (2006) finds an increasing degree of competition for best talent among European countries; preferably for the whole duration of their training or their specific programme and less so for temporary periods abroad. However, according to the author, in Europe a stronger emphasis is still placed on temporary mobility and exchange within the framework of institutional collaboration and networks, joint doctoral degrees and inter-sectorial mobility (Kehm, 2006: 67-78). This is indeed part of the debate around the conceptualisation of a European doctorate which, contrary to the case in many other places, including the U.S., doctoral programmes are less structured and conceived as tailor-made “training programmes,” where international training and experience is a key component of the “training package.” The trend in North America, Kehm (2006) adds, differs from Europe, as North American institutions try to attract doctoral students for the whole duration of their qualification period, and even provide attractive conditions to keep international doctoral degree holders in the country (Kehm, 2006).

Senior researcher and teaching staff mobility is another form in which internationalisation of higher education takes place. It is important to note that the distinction line with student mobility programmes is not always clear, especially because in many countries postgraduate and Ph.D. students are considered university employees, more than students in stricto sensu. Traditionally, international mobility among the professoriate is focused on research and scholarship, and education and teaching have become reasons for international mobility only recently. In Europe, programmes such as ERASMUS / SOCRATES and UMAP also promote regional teaching staff mobility projects alongside student mobility, and some multilateral and bilateral programmes, such as Fulbright, specifically focuses on staff mobility. For the European Commission, teaching staff mobility does not seem to be an end in itself, but by developing inter-institutional networks with the aim to de-nationalise curricula and to develop European programmes. Senior research mobility in the framework of research training programmes is less frequent or at least less evident. In practice, most of the mobility of academic staff within projects is for relatively short periods.

According to an interim evaluation of Erasmus Mundus II, contrary to institutional programmes designed to support the internationalisation of students, those related with the mobility of senior

researchers and teaching/staff are less frequent rather of the type bottom-up, as mobility is typically conceived as a 'natural' phenomenon in the academic profession, due to the traditionally international character of scientific research in the global and increasingly competitive research enterprise with its many conferences, meetings and joint research projects (Commission, 2012). As said before, teaching/staff mobility is both a determinant of- and a result from- research collaboration and joint programmes; that is, a two-way phenomenon in the internationalisation process of graduate education and research training.

Internationalisation of curricula is another common way higher education in general and graduate education and research training in particular acquire a global perspective. Regarding internationalisation of higher education, Van der Wende (1997) has researched several developments in this respect. She thereby used the rather broad OECD-typology of international curricula ranging from curricula with some international content, over curricula that address cross-cultural skills, to curricula leading to internationally recognised professions and special curricula designed for foreign students. Most of these international curricula are found first in higher education programmes, and in the areas of economics and business studies, the humanities and social sciences.

Today, more disciplines and educational levels have expanded their scope via the internationalisation of their curricula. DFG-supported International Research Training Groups involve some of these types of curricula internationalisation.

In this framework, student and staff mobility is sometimes encouraged and supported by governments and research councils because they are expected to bring curricula improvements in the collaborating institutions and departments. Eckel and colleagues (2004) describe the development of Curricular Joint Ventures (CJVs) as "strategic alliances between higher education institutions or between higher education institutions and other partners such as corporations, or non-profit or non-governmental organisations that result in new academic programs each partner alone does not offer" (Eckel et al (2004). This rationale of course applies to international partners as well.

In practice, the internationalisation of curricula is a hard goal to achieve, as institutions tend to defend their autonomy or simply do not give it the support needed. The European experience in this form of internationalisation probably coincides with other attempts at curricular reform initiated 'from above,' that is, top-down, inspired by the political/policy perspective discussed earlier. Indeed, according to van Damme, the 'Europeanisation' of curricula for example, was not one of the clearly observable outcomes of the ERASMUS programme, as institutions adapted their curricula for a number of reasons, more because of 'entrepreneurialism' than of European ideals. Similarly, according to the evaluation of the initial impacts of the National Science Foundation's (NSF) Integrative Graduate Education and Research Traineeship (IGERT) Program, the internationalisation of such groups was not the priority of the PIs at the moment (Carney et al. 2006: 29-30).

Van Damme (2001) claims that one of the most powerful and successful inducements to internationalising curricula has come from the growing impact of internationally organised professional associations . As the author posits, some of these international professional associations started to deal with issues of education and training, such as quality assurance, international minimum standards, criteria of professionalism, accreditation, etc. The European Union, the author adds as an example, increasingly deals with minimum standards of education and training in view of the mobility of labour and the recognition of entry into specific professions in the common market. Free trade agreements such as NAFTA or ASEAN often contain clauses on mutual recognition of licensing or certification procedures in view of the international mobility of professional services.

According to van Damme, institutional cooperation agreements and networks that involve collaboration projects, joint programmes and student and/or teaching staff exchange turn into large interuniversity networks, such as the SANTANDER or COIMBRA groups. However, as the author adds, at the moment many of these networks are to be seen as rather loose and voluntaristic meeting-points (van Damme, 2001).

International Research Collaboration is another way graduate education but particularly more so research training is internationalised. The literature on the characteristics and on the determinants of research collaboration is rather abundant. Katz and Martin define research collaboration as the working together of researchers to achieve the common goal of producing new scientific knowledge (Katz and Martin 1997). A variety of ‘collaborative activities’ has been identified as falling under this broad concept. As Bordons and Gomez (2000) claim, these include the expression of opinions, the exchange of ideas and data, working together during the course of a project, working separately on different parts of a project with the purpose of integrating the results at the end, sharing equipment, and exchanging personnel (Bordons and Gomez 2000).

As Katz and Martin (1997) acknowledge, both the concept of ‘working together’ and the assumption of a ‘common goal’ as a distinctive characteristic of a collaborative activity are rather conceptually and empirically problematic since, a) it is not clear how closely researchers have to work together in order to constitute a collaboration, and b) either no two researchers ever have precisely the same goals, or, conversely, every single researcher in the world is in fact a member of a big collaboration called ‘scientific community’ for they all work to advance scientific knowledge and are all somewhat interrelated: they all exchange ideas on what experiments to do next, what hypothesis to test, what new instrumentation to build, how to relate their latest experimental results to theoretical models, and so on” (Katz and Martin 1997).

As Bordons and Gomez acknowledge, if we take a narrow definition and agree that collaboration is defined as two or more scientists working together on a joint research project, sharing intellectual, economic and/or physical resources, a wide range of situations still can be included, and a wider array of contributions will in fact be excluded under such definition.

Several types of collaboration are identified in the literature. As Bordons and Gomez (2000) point out, they can be theoretical or technical, the former being based on the exchange of ideas,

the provision of advice, or criticism, and the latter being based the share of resources, methods, etc. (Bordons and Gomez 2000). Another typology of collaboration is offered by Hagedoorn, Link et al (2000), who claim that research partnerships can be either formal or informal and can involve any type of partners (i.e. scientists, technicians, students, employees, etc.), belonging to universities, enterprises or government agencies committed to research projects. While formal research partnerships include research corporations (equity joint ventures focusing on research, and research joint ventures) and contractual arrangements such as strategic technical alliances, etc., informal agreements include short-term research project- specific endeavours (Hagedoorn, Link et al. 2000), and less visible but not less important social contacts.

Why do researchers collaborate? According to Beaver (2001) researchers collaborate to gain access to equipment or other types of resources; to access to new funds; to obtain prestige or visibility; for professional advancement; to make progress more rapidly; to tackle “bigger” problems (more important, more comprehensive, more difficult, global); to enhance research productivity; to claim primacy, ownership and rewards; to get to know more people and to create a network; to learn new skills or techniques; to share the excitement of an area with other people; to find flaws more efficiently, reduce errors and mistakes; to keep one more focused on research and avoid doing other activities; to reduce isolation, and to recharge one’s energy and excitement; to educate (a student, graduate student, or oneself); to advance knowledge and learning; and for fun, amusement, and pleasure (Beaver 2001).

Deciding to collaborate also depends on the characteristics of the discipline one works in. In fact, some R&D projects belonging to disciplines such as physics are more likely to be collaborative than projects belonging to, for example, the social sciences and the humanities such as sociology or philosophy. Indeed, As Frame and Carpenter claim, the fact that most disciplines differ in their epistemological and methodological characteristics makes research collaboration a complex enterprise (Frame and Carpenter 1979). Whereas such differences can translate into practices or ethos that negatively affect the progress of inter-disciplinary collaboration, in some cases they can affect it positively.

What is International Research Collaboration? Arguably, the similarities between research collaboration and international research collaboration are greater than the differences between the two. However, distinctive aspects of international research collaboration, besides the ‘obvious’ condition that partners belong to different nations, include a different set of drivers, enablers, modalities, and consequences.

As for the drivers of International Research Collaboration, and according to Wagner and Leydesdorf (2005), these include: a) location of specific resources. Marine research for example would probably require accessing different ocean resources from different countries; b) unique expertise. The treatment of some disease may well require local expertise in those areas where it has developed and being investigated from the past; c) location of large-scale equipment. A space research initiated in Russia would probably need to work at NASA to do some of their experiments; d) global problems requiring global solutions. Global warming would probably re-

quire research performed in different places of the planet to monitor and understand the causes (Wagner and Leydesdorff 2005).

As for the enablers of international research collaboration is concerned, the literature identifies the following: a) the return to home country of former 'brain drained'. Melin (2004) claims that one of the factors driving international research collaboration are the social networks created by foreign students and professors who return to their home countries and maintain their contacts with their mentors, colleagues or students in the countries where they spend part of their academic lives (Melin 2004); b) the Diaspora. Many of those who do not return to their countries of origin keep the contacts made in the past or develop new ones with their co-nationals they meet in international workshops or other academic and social events (Basu and Kumar 2000; Chaparro, Jaramillo et al. 2004); and c) the Cultural-, geographic-, historical-, linguistic-, proximity. One is more likely to collaborate with whom one shares more basic characteristics than with those one shares less common characteristics (Frame and Carpenter 1979; Narin, Stevens et al. 1991; Katz 1994; Farrell 2001; Lee 2004; Levine and Moreland 2004; Wagner 2005); In addition, relatively low costs of transportation and communication have contributed importantly to the collaborative enterprise across borders. Arguably, the internationalisation of research training follow these logics, both either because the first-career researchers collaborate as part of her research project, or because their trainers and supervisors involve them in their own research projects with foreign partners.

Other forms of internationalisation of higher and graduate education (and perhaps research training) involve the establishment of branch campuses, mutual programme recognition, transnational higher education institutions, and distance education programmes. We will briefly describe those forms.

The establishment of branch campuses abroad is another form of expression of the internationalisation of graduate education. This form is more frequently found regarding higher education, including graduate programmes, than, to our knowledge, research training programmes as such. In fact, this type reflects a market-oriented, entrepreneurial approach to the recruitment of students. It combines enrolment of foreign students with extending their educational supply in other countries by setting up local campuses under the full authority of the mother institution, and provided the local state legally permits the granting of foreign diplomas and degrees on its territory. In this tendency, the process of internationalisation shifts from the demand to the supply side, where, according to van Damme (2001), the branch campuses offer programmes tailored to foreign conditions and needs, mostly in another language and targeted at the more affluent students (Van Damme, 2001: 424-5). An example of this type of strategies is the one followed by The Georgia Institute of Technology, which has a Campus in France and several joint ventures in Costa Rica, China and Singapore. In principle, there is no reason to think that this form of internationalisation would not work regarding research training, as reputation and quality of the "mother institution" is one of the driving forces for students, researchers and teachers around the world when making decisions about their localisation.

Sometimes inter-institutional agreements involve mutual recognition of programmes and credits, which are often inspired by the need to increase quality and market size of education services, international mobility of researchers, and expansion of academic networks. McBurnie and Pollock (1998) distinguish the following forms these agreements can lead to: a) Franchises: under franchising agreements an institution grants a host institution in another country the permission to provide some of the programmes and degrees of the first under mutually agreed conditions; b) Twinning: twinning agreements between higher education institutions in different countries are set up to offer joint programmes; and c) Articulation: students are enrolled in programmes or part of programmes in the host institution, leading to credits recognised by the other institution. No evidence of such forms has been found regarding research training programmes, however.

According to van Damme (2001), sometimes transnational inter-university recognition agreements of the types described above can become so important in the higher education market that the cooperating partners transform themselves in real transnational networks of institutions, clustering around the names of the most prestigious institutions in the core of the academic market. According to the author, these networks trade in the global educational marketplace while the partners keep their respective national identities and award degrees and diplomas within the legal framework of foreign higher education systems (van Damme, 2001). Again, although these forms of internationalisation are mainly designed for undergraduate and graduate programmes, and hardly found involving research training programmes of the types supported by the DFG, in principle there is no reason why they cannot be instrumental for these type of programmes.

Finally, technologically supported distance education and ‘Open Universities’ is another trend growing rapidly in the internationalisation of higher education, including graduate education (although not found involving research training programmes as such). The clearest example of this virtual internationalisation is the establishment of cyber-universities: The International University, ‘The University of the Web’ (Pease 1998). A more recent development is the Massive Open Online Course -MOOC. According to MOOC List´s website , a MOOC is “an online course aimed at large-scale participation and open (free) access via the internet. They are similar to university courses, but do not tend to offer academic credit. A number of web-based platforms (initiatives) supported by top universities and colleges offer MOOCs in a wide range of subjects.”

According to Van Damme, the eleven most important open universities in the world together enrol about 3 million students (van Damme, 2001). Although the view of the future of global higher education as one “dominated” by a limited number of global virtual universities supported by powerful corporations falls more in the realm of science fiction than reality, the truth is that the number of higher education institutions combining traditional delivery modes with virtual modes is growing rapidly.

Although this form of internationalisation is more frequently found among undergraduate and graduate programmes than among research training programmes (we did not find evidence of

such form of internationalisation concerning the latter type of programmes), there does not seem to be a good reason to think that it would not work well concerning research training.

In sum, there are many forms of internationalisation of higher education, which sometimes involve (or could involve) graduate education and research training groups of the types supported by DFG. Each responds to a different rationale and involves different levels of administrative complexity. In the following chapter we present approaches described in the literature to study and account for the effects of internationalisation of graduate and research training programmes specifically. In so doing, an emphasis is made on a resource-based rationale to account for internationalisation's potential and impact involving those types of programmes.

4 Approaches to Assessing the Effects of Internationalisation of Higher Education and What We Can Learn from Them

Studies of the internationalisation of graduate education focus on specific subjects, take different forms (methods) to assess its effects and use various indicators. Knight and De Wit (1995) developed different models for the evaluation of internationalisation efforts involving higher education programmes. Although there are no equivalent frameworks to assess the internationalisation of research training programmes, we believe that the existing frameworks can help in better understand the main purpose of the study intended. Hence, according to Knight and De Wit, these approaches involve a) the activity approach, where the focus lies on activities such as developing curricula, international exchange of students and staff, or joining research projects; b) the competency approach, which focuses on new knowledge and skills; c) the ethos or cultural approach, focusing on the valuing and support of intercultural perspectives; and d) the process approach, which focuses on the integration of internationalisation at all levels (from the human to the policy level) to assess how these incorporate an international dimension into the institution. These include programme and institutional policies (Knight & De Wit, 1995: 16-17). To illustrate, the programme (both research and educational programme) activities that Knight and De Wit analysed are listed (Ibid, p. 18-19) in Table 1:

Strategic models to achieve internationalisation are discussed by the same authors. These include a) Neave's model, which is described as leadership driven and base unit driven (centralised and decentralised models); b) Davies' organisation model, which is a prescriptive model comprising of a matrix (central systemic strategy, ad-hoc central, system-marginal, ad hoc marginal) to structure the organisational aspects of internationalisation strategies; c) Van Dijk and Meijer's model, which adds three dimensions to Davies' approach: policy (the importance attached to the aims of internationalisation), and type of support and implementation (method); and d) Rudzki's model, which takes four dimensions of internationalisation: student mobility, staff development, current innovation and organisational change (Knight & De Wit, 1995).

Other authors refer to Knight and De Wit's process approach when reviewing internationalisation of higher education (Deardorff, 2004; Leask, 2001; Qiang, 2003). In this sense, Deardorff – referencing De Wit (2002) – posits that "most assessment processes focus on activities, projects, and programs of internationalisation" (Deardorff, 2004: 78) while instead, De Wit proposes that such processes should focus on the key perspectives of "inclusion of the international dimension as a key component in the general academic (…) review system," the quality of "specific internationalisation policies, procedures, and programs (i.e., international students, work or study abroad, student and faculty exchanges, research, language instruction, technical assistance, etc.)" and the "internationalisation of quality assurance procedures themselves" (De Wit, 2002, p. 156 in Deardorff, 2004: 78). In line with this, Deardorff suggests to focus more on the effects of internationalisation efforts on students by viewing intercultural competence (through e.g. surveys) instead of a "supply-side focus" (Engberg, Green, 2002: 16 in Deardorff, 2004: 13).

Education related activities	Research related activities
• Foreign language studies • Recruitment of foreign students for full degree programmes and/or special programmes • Study abroad opportunities for students for full degree programmes or special programmes • International cooperation agreements • International exchange of students • International exchange of faculty for teaching • International guest lectures • Joint and/or double degree programmes • Systems for study and degree equivalence • Systems of credit transfer • International internships for students and faculty • International fieldwork training for students • International summer courses and programmes • International study visits by students and faculty • Community partnerships • Intercultural training	• The establishment of centres of excellence or research with an international mandate or focus • Incorporation of an international perspective and international issues into existing research centres and programmes • Increasing collaboration with international partners • A comparative approach, especially given the increasing emphasis on the application of research • Dissemination of research results and sharing of knowledge through international networks and communications systems, such as international reviews and publications, databases, conferences, seminars, workshops and colloquia on discipline- and specialisation-related research • The establishment of networks of research institutes by discipline and/or specialisation; • The establishment of networks and associations of researchers by discipline and/or specialisation • Participation in international R&D programmes and funds • Individual international mobility of researchers • International sabbatical leave opportunities for faculty • Research-related training of postgraduates and PhD students • International quality control and review of research • Research directed to topics that are intrinsically international, such as regional and global environmental issues, international relations, international business and international lay • Cooperation between researchers and research institutes and international business

Table 1: Education and research activities observed to assess the effects of internationalisation of higher education
Source: Knight & De Wit, 1995: 18-19

In order to assess the effectiveness of internationalisation of higher education at the institutional level, different models and indicators are put forward in the literature. Childress (2009) – with a focus on the USA – regards Knight's internationalisation cycle, consisting of different phases (awareness, commitment, planning, operationalisation, review and reinforcement (Knight, 1994) and concludes that some institutions may not follow this path and that further research is necessary to review how these phases unfold in practice. According to the author, this research should focus on "how faculty involvement in internationalisation plans is developed and sustained to achieve institutions' internationalisation goals" (Childress, 2009: 306).

Alternatively, Beerkens and Derwende use a resource based view to analyse how alliances and cooperation between institutions are based on compatibility and complementarity (Beerkens & Derwende, 2007: 63). By viewing institutes as bundles of resources they conclude that centra-

lised institutional forms (national laws, organisational rules) negatively impact cooperation, while decentralised norms (culture, norms and beliefs) had less negative impact. Furthermore, academic and cultural diversity can be a source of complementarity while there is not a strong relation between performance success and compatibility (Ibid, p. 74) . According to the author, the more successful forms of cooperation are based on “loose structures that do not significantly impact the organisations of member universities” (Ibid, p. 77).

Ramachandran (2011: 217) defines a number of drivers and indicators to track internationalisation efforts of institutions. According to the author, “these drivers may include academic departments and units such as the registry, student affairs and international offices (...) Indicators must be tied up to each driver and evaluated at periodic intervals to measure the progress of internationalisation efforts (which can in turn) be modified based on the university’s needs.” This illustrates that on an institutional level various perspectives are at work and need to be taken into account when assessing the effects of internationalisation.

Other analytical frameworks designed to assess the role of internationalisation of graduate education are those applied in empirical programme evaluations. These include the evaluation of programmes aiming at increasing scientific excellence by facilitating (mostly) international mobility, such as a) the U.S. Fulbright Scholar Program (U.S. Department of State, 2002), b) the Visiting Fulbright Student Program (U.S. Department of State, 2005), and c) the Erasmus Mundus Programme (Commission 2012); as well as programmes aiming at increasing scientific excellence at research training groups by facilitating (mostly) international collaboration, such as the National Science Foundation’s (NSF) Integrative Graduate Education and Research Traineeship (IGERT) Program, which has gone through two evaluations so far: a) the initial impacts of the IGERT Program (Carney et al, 2006), and b) the short-term professional outcomes of IGERT graduates (Carney et al, 2011). The following is a brief description of such frameworks:

An evaluation of the U.S. Fulbright Scholar Program was made publicly available by the U.S. Department of State in 2002. Most of the direct beneficiaries of this programme are American college and university faculty, as well as professionals and independent scholars, to lecture and conduct research in many countries (140 in 2002) throughout the world. The evaluators looked at the broader impacts of the programme on individuals and institutions both in the US and in the Fulbright scholar’s host countries, as well as the contribution of the programme to the professional and personal lives, activities, and achievements of programme alumni. The overall objective of the evaluation was to assess whether the programme was achieving its legislative goals, namely those related with:

a) Serving the national interests and promoting mutual understanding,

b) Building knowledge and long-term relationships with host countries and foreign colleagues, and

c) Making U.S. campuses and communities more international.

In 2005, the U.S. Department of State released the results of an evaluation of the Visiting Fulbright Student Program (U.S. Department of State, 2005). This programme provides awards to

non-U.S. citizens to study at the graduate level in the United States, and supports pre-academic and enrichment activities as well. The criteria used for the evaluation referred to:

a) Satisfaction, including overall satisfaction with grant conditions, and with opportunities to study, conduct research, and develop interactions with a diverse set of American colleagues and friends;

b) Educational/professional and cultural learning, including personal and professional interactions and activities at the host institutions; participation in social, community, and enrichment activities; and learning about the U.S. culture and society;

c) Effects on behaviour, including personal and professional enhancement/attainment; professional contributions (products, resources, knowledge) to home or host institutions; and using and sharing new knowledge/skills; and

d) Linkages, ties, and institutional change, including, development and maintenance of personal, professional, and institutional linkages and ties; and participatory activities designed to foster international cooperation and/or educational exchange.

In 2012 the European Commission revealed the results of the evaluation of the Erasmus Mundus (EM) Programme (Commission 2012). This programme provides grants to a) Action 1: joint programmes at masters and doctoral levels including scholarships and fellowships to participate in these programmes, b) Action 2: partnerships between European and third-country higher education institutions including scholarships and fellowships for mobility at all academic levels, and c) Action 3: projects to enhance the attractiveness of Europe as an educational destination and a centre of excellence at world level. The evaluation emphasised the novelties introduced in phase II of the EM Programme (the extension of the joint programmes to the doctoral level, the offering of scholarships for European students, the widening of the scope of the Action 2, the possibility for third-country higher education institutions to participate in the EM joint programmes). In particular, the evaluators looked at the results of the programmes at the individual, institutional (or inter-institutional), and system levels. The evaluation criteria focused on:

a) Relevance of the programme, in terms of promoting excellence, building capacity and developing international cooperation; complementarity with other EU programmes; synergies between measures/actions; and European added value;

b) Effectiveness of the programme, including contribution to the EU strategies/policy goals, the achievement of objectives, geographical coverage, impact on academic excellence, accessibility, contribution to the visibility of EU higher education, gender participation, awareness of the programme, impact on mobility, employability of the beneficiaries, and the risk of “brain drain”;

c) Sustainability of the programme, including administrative burden/costs, leverage power of the programme’s brand, likely continuity of the programme, cooperation models and mechanisms, relations with non-educational organisations, and dissemination and exploitation of the project results; and

d) Efficiency of the programme, including the cost-effectiveness of the programme, the sufficiency of the size of the budget, the attractiveness and competitiveness of the programme for high quality candidates, the public perception of the programme among the stakeholders, the adequacy of monitoring and implementation arrangements, and the success of the programme novelties.

In 2006, an evaluation of the initial impacts of the National Science Foundation's Integrative Graduate Education and Research Traineeship (IGERT) Program was made public. Through support of interdisciplinary graduate education programmes in Science, Technology, Engineering, and Mathematics (STEM), the IGERT program aims to educate U.S. Ph.D. scientists and engineers with the interdisciplinary backgrounds, deep knowledge in chosen disciplines, and technical, professional, and personal skills to become, in their own careers, leaders and creative agents for change (Carney et al, 2006). The purpose of the evaluation was to assess the programme goals of:

a) Educating students in an interdisciplinary environment while being well grounded with depth of knowledge in a major field (looking at its contribution to their professional and personal development),

b) Catalysing cultural change in graduate education (looking at the extent to which faculty engage in interdisciplinary teaching and research), and

c) Promoting and facilitating diversity (looking at recruitment characteristics and demographic and disciplinary outcome indicators).

Since one of the objectives of the programme is to provide students with an international perspective, the study focused in this respect on international experiences, which involves:

a) Working with international scientists in the U.S.,

b) Working with international scientists abroad (often through internships), and

c) International travel or conference attendance.

The study also compares IGERT students and non-IGERT students with respect to

a) The extent to which they are familiar with current research being conducted in their field in foreign countries,

b) Their international experiences as listed above, and

c) The extent to which they feel prepared to collaborate with international researchers in the future.

A more recent evaluation of the NSF's IGERT program was conducted to study the short-term professional outcomes of IGERT graduates and to assess whether IGERT-funded graduate students are prepared for successful STEM-related careers and have developed the requisite research, teaching and leadership capacities. It also explored how IGERT graduates have fared in their early careers, one to eight years post-graduation, relative to their counterparts trained through more traditional single-discipline programmes (Carney et al, 2011).

In particular, it performed two sub-studies: one descriptive study investigated about IGERT graduates: a) Career interests, motivations, and demographic characteristics, b) extent to which and time to degree, c) early career outcomes and job responsibilities, and d) perceived effects of training on enrolment, dissertation research, degree completion, ability to obtain jobs, and career preparedness.

The second sub-study was done to compare the short-term career trajectories and outcomes of IGERT PhD graduates and comparable non-IGERT PhD graduates (Carney et al, 2011). Particularly interesting for this review, it is worth mentioning that although the focus of the study was not to assess the role of international education, it did inquire about graduates global awareness and engagement, that is, the extent to which IGERT graduates were aware about the global dimensions of their STEM fields and related research. In this sense, the study investigated:

a) Whether the graduates knew if scientists in other countries were engaged in work relevant to their current research, and

b) Whether they have engaged in global interactions as part of their current responsibilities: been informed of research in other countries, used international databases or citations, worked on a team with colleagues who are located abroad, attended professional conferences outside the US, travelled to other countries for work-related purposes, discussed the international nature of their scientific enterprise in a regular undergraduate or graduate course, had applied or been recruited for a position outside the US, worked abroad, or had learned a foreign language on behalf of their career. They compared such indicators between IGERT and non-IGERT graduates. The study did not investigate whether IGERT projects that received an international supplement have more broad global perspectives than graduates from other projects, however.

We will refer to some of the findings of these works while fleshing out - and in support to- our proposed analytical framework for studying DFG's IRTG Programme's rationales and role. That is the purpose of the next chapter.

5 A Resource-Oriented Approach to Study Internationalisation of Research Training Programmes

Taking into account current understanding of what internationalisation of higher education and graduate programmes entails and/or could achieve (see discussion in chapter 2), as well as the forms in which it can be found (see discussion in chapter 3) and assessed in practice (see chapter 4), this chapter discusses the applicability of an analytical framework to study internationalisation taking into account the specificities of graduate and research training programmes of the type supported by DFG.

We understand internationalisation of research training programmes from an instrumental perspective: primarily, as a strategy of researchers and universities to increase their pool of resources available for the scientific and structural developments. We call this the resource-oriented approach to internationalisation. In this sense, internationalisation is seen as a strategic tool or instrument for securing resources for universities and their members, so that they can a) offer the first-stage researchers improved research conditions and (scientific) development perspectives; b) extend the international research and cooperation opportunities for the participating senior researchers and teaching staff; c) expand and strengthen the international cooperation network in the research fields of the participating scientists; and d) achieve formalised strategic alliances of international visibility for their universities.

As discussed earlier, there are several approaches to study the role of internationalisation of graduate education. We chose the resource-oriented approach to better account for the characteristics of programmes such as the DFG's IRTG Programme, as it emphasises on the ways programmes/institutions, and particularly their administrators, tend to perceive internationalisation. Indeed, the proposed approach can be effectively used to account for the drivers and effects of the internationalisation of research training programmes considering the three main actors involved: a) the participant PhD student, b) the involved senior researchers, and c) the host institutions. In the following sections these categories are related with:

a) The level of first-stage researchers' research conditions and scientific development perspectives,

b) The level of involved senior researchers (and teaching staff) cooperation and networking, and

c) The level of the performance and visibility of participating host institutions.

The following sections discuss the literature found in support of these categories.

5.1 First-stage Researchers' Conditions and Scientific Development Perspectives

As seen before, the importance of evaluating internationalisation of graduate education is analysed in the literature by focusing on the effects on students, in particular with respect to the conditions they face to perform their research, obtain the appropriate orientation, access to key resources, and exploit their potential. As discussed earlier, this view is consistent with the pedagogical/cognitive/professional/human perspective of internationalisation discussed in section 2.3. In this sense, personal and professional effects sought involve skills development as well as career opportunities in a highly competitive world market.

Outcomes referred to the development of skills and knowledge include improved research qualifications and personal development (Kyvik, Karseth, Remme, & Blume, 1999). In this sense, as Thorstensson (2001) claims, international education should offer students opportunities for professional and academic growth and availability of advances, educational resources and instructional technical equipment they would not have otherwise (Bornsztein in Thorstensson, 2001: 321). Indeed, according to a recent evaluation of the joint doctoral programme supported by the Erasmus Mundus (EM) programme, 58% of the respondents valued skills development as their main motivation for participating in an international joint programme. And according to the Graduate Impact Survey, two thirds of the respondents indicated that Erasmus Mundus skills were relevant in their jobs. As the report shows, the ex-post evaluation of the first phase found that 75% of graduates believed they would not have gained the same skills and experience through more conventional courses, since EM offered them experience with multiple universities and intercultural interaction (Commission, 2012).

One way of acquiring such research skills and of expanding career opportunities in the framework of a graduate programme is through work experience. According to Carney et al (2006), who conducted the evaluation of the IGERT program, supplemental international funding appears to play an important role in fostering opportunities to work abroad for IGERT graduates (Carney et al (2006: 30). Moreover, according to the authors, IGERT students at projects where PIs indicated they have begun addressing the need to develop an international perspective are more likely than comparable students at projects with no internationalisation strategy to report that they are familiar with current research being conducted in their field in foreign countries, and that they believe they are "very well prepared" to collaborate with international scientists in the future (Ibid: 30).

"Soft skills" are also seen as important outcomes of internationalised programmes. According to one of the survey respondents in the framework of the assessment of the Visiting Fulbright Student Program, "[due to the program] I reached a level of confidence in my abilities and in myself which I could never have imagined possible" (U.S. Department of State, 2005).

Language proficiency has also been found to be an important outcome of these programmes (Altbach & Knight, 2007). Killick in turn argues that all students benefit from an internationalised

curriculum because “globalisation has changed the world of work at home, as well as abroad” (Killick, 2008: 2, in Bennett & Kane, 2011: 355), whereby international graduate education offers students the opportunity to become more inter-culturally competent (Deardorff, 2004). As one IGERT graduate who participated in the evaluation of the corresponding NSF programme put it “[t]he single greatest contribution to my graduate education was the International IGERT supplement that provided the opportunity for me to work in a lab in [another country] and experience a different culture.” (Carney et al., 2011: 64). In fact, this inter-cultural competence enables to exchange ideas, and as Deardorff (2004) puts it, develops skills to “lead and serve effectively in a multinational and multicultural world” (Deardorff, 2004: 12) .

According to Forray and Goodnight (2010), who focus on the effects of internationalising higher business education, there is also an effect on career opportunities. According to the authors, while students report a low level of experience with international corporate business concerning their career, recruiters find a “global perspective” very important in their candidates. Students note the importance of international work experience and the fluency in a second language as important for their development. In fact, according to the assessment of the Visiting Fulbright Student Program, “almost 95% [of the respondents] said it [their international experience] gave them greater insight into their professional fields and contributed to their subsequent educational or career choices and decisions (...). 83% have incorporated knowledge gained during their Fulbright experience into their subsequent professional activities (U.S. Department of State, 2005). According to an evaluation of the Erasmus Mundus programme, nearly half of the respondents indicated a substantial impact of their experience on future career prospects (Commission, 2012).

Apart from the development of skills, cultural competencies and career opportunities, effects in the professional networks of students are also found. According to the assessment of the Visiting Fulbright Student Program, “81% or more have maintained active, on-going friendships and professional relationships that they established during their grants (U.S. Department of State, 2005).

Despite these positive effects, internationalisation of graduate education is also reported to have some challenging effects for students. One of them includes a delay in the completion of the thesis (Kyvik et al., 1999). More importantly, a recent evaluation of the Erasmus Mundus Programme found that joint doctoral programme beneficiaries “did not necessarily have the opportunities to apply their skills in their home countries.” According to the evaluation, “one risk [of the joint doctoral students] results from their inclination towards academic jobs, which have become vulnerable in the context of the economic downturn” (Commission, 2012).

In sum, research skills acquisition and career perspectives development depend mostly on a) the quality of the training and education programmes, b) the quality of the research conditions as expressed, among other aspects, in terms of orientation, working conditions, access to key facilities and equipment for research, and the level of autonomy the candidate is given, and c) the opportunities the students have to expand their cultural and language skills and network size.

5.2 Involved Senior Researchers and Teaching Staff's Cooperation and Networking

Ideally, students and staff are equally encouraged through internationalisation to a) enhance their professional and academic profile, b) increase their capacity to interact with other cultures, c) improve knowledge and understanding of epistemological differences, d) develop global perspectives, and d) become "world scientists." Stone explains further some of these aspirations (Stone, 2006: 140). Some of the expected or unexpected effects of participating in international research training include a) staff's mobility, b) expansion of self's scientific network (as expressed by participation in joint projects and co-authorships), c) increased professional autonomy, d) recognition by the international community (as expressed by citations, prizes, and memberships), e) international awareness, f) research funding, and g) language improvement.

In fact, as discussed above, one of the main drivers for the internationalisation of graduate programmes is to increase the mobility of the involved researchers and teachers. For example, in the framework of the Erasmus Mundus Programme 3,000 academics taught or conducted research activities in the joint courses or partnerships funded between 2007 and 2011 (Commission, 2011). According to the Fulbright Scholar Program's website, since its inception in 1946, it has provided almost 310,000 participants with the opportunity to "study, teach and conduct research, exchange ideas and contribute to finding solutions to shared international concerns." Little is known about the effects of such support on the number of people deciding to spend longer periods beyond, say twelve months abroad, however.

What is indeed very well known is that mobility is perceived as having a positive impact on scientific productivity. The relationship between international mobility of staff and publications is made by- for example- Kyvik, who finds that in the Nordic countries faculty who stayed abroad had an average of 15% more publications than colleagues who had not. This level increased to more than 60% when publications in non-Scandinavian publications were viewed. The effect of research stays abroad was somewhat stronger in the humanities and social sciences than in the natural and medical sciences and technology (Kyvik et al., 1999). Furthermore, the impact of higher education internationalisation programmes on the performance of researchers and teaching staff when they are the target beneficiaries is also well known. According to the outcome assessment of the U.S. Fulbright Scholar Program, "[s]ome 45 per cent or more reported that they wrote or edited articles or books, advised students, provided technical advice to colleagues and host institutions, participated in professional conferences, reviewed and developed curricula, translated materials, wrote grant proposals or helped others write them, served on faculty committees, organised professional events, did paid or unpaid consulting, participated in creative or performing arts, and served on faculty committees." Moreover, according to the programme assessment report, "almost all of the scholars have produced professional works that incorporated knowledge, information, materials, or data obtained during their grants: 76 per cent gave papers or presentations at scholarly or professional meetings. 71 per cent published papers in refereed journals." (U.S. Department of State, 2002).

An evaluation of the Erasmus Mundus Programme concludes that from the case study evidence, the job-related gains to staff were very significant because research is increasingly globalised (results include joint publications, new courses, more international visibility, such as citations and references). Scholars appreciated new teaching experiences, opportunities for carrying out joint research projects, opportunities to make use of high quality equipment and laboratory facilities, links made with enterprises in a research context and familiarisation with employment opportunities (Commission, 2012).

There is little evidence to what extent international doctoral training programmes, with or without involving mobility, affect international research collaboration. Jonkers and Tijssen observe a positive correlation between the opportunity to spend time abroad and the number of international co-publications (Jonkers & Tijssen, 2008: 311). Relating to the effects of internationalisation programmes, the assessment of the U.S. Fulbright Scholar Program reports that “75 per cent of Scholars have continued to collaborate with colleagues from their host countries or institutions since completing their grants.” (U.S. Department of State, 2002). Relating publications to location (host and home institutions), Jonkers and Cruz-Castro conclude that having foreign experience helps explain “the propensity to co-publish internationally” (Jonkers & Cruz-Castro, 2013) and researchers collaborate to a higher degree with their former host system.

Recently, Ulnicane-Ozolina (2013) found that research institutes influence international research organisation depending on its governance structure (thematic, organisational and resource-based features). She studied seven longitudinal case studies of international research collaboration by German non-university institutes working on the field of nano-science and technologies, and found that institutes with a explorative type of governance are more likely to engage in a long-term formal and informal international collaboration; institutes with an industrially relevant type of governance tend to limit their collaboration to large, externally funded projects, which are designed according to the needs of companies; and institutes with a “catch-all” type of governance increasingly collaborate within formal projects with opportunities for creative informal decreasing . She finally concludes that “Each type of the institute governance facilitates the choice of a certain type of formal projects: small scale thematically open, large scale industrially relevant or applied and thematically pre-defined projects. While collaboration among institutes with diverse types of governance can be beneficial due to complementarities, it can also increase costs of collaboration as their institutional differences have to be reconciled” (Ibid. P.6).

In particular, the author found that, in many cases, a) specialised expertise attracts collaborations, b) decentralised organisational hierarchies empowers young researchers to launch new collaborations, c) active and diverse communication channels increase opportunity structures for collaborations, d) recruitment of internationally mobile staff with publication record enables new collaborations, and e) staff mobility fosters collaborations.

The effects of international research collaboration on productivity and on research quality are well known. Abramo et al. claim that in the case of Italy, international collaboration produces real and remarkable results in the scientific performance of research groups (Abramo, D’Angelo,

& Di Costa, 2009: 167). Ordonez (2008) also found positive effects of international cooperation on research teams in Colombia, not only in terms of the number of bibliographic products but also in terms of research orientation and visibility (Ordonez, G., 2008, Ordonez et al., 2010). This leads to the insight that the internationalisation of scientific production is associated with a higher quality of publications. However, Jonkers & Tijssen (2008) find that although foreign experience is positively correlated with the number of publications indexed by ISI Thompson, there is no positive correlation between the years spent abroad and the publication output (Ibid, p. 327). Moreover, as Kyvik et al put it, this international networking is important to productivity in international publishing for "if such stays are not followed up by keeping in touch with foreign colleagues, there are virtually no differences in productivity between those with stays abroad and those without" (Kyvik et al., 1999, p. 387). The latter was also confirmed by an evaluation of the Humboldt Research Fellowship programme (Warta & Geyer 2011).

It is also well known that networking influences access to international funding sources (Cañibano et al., 2011; Ivancheva & Gourova, 2011; Van Bouwel et al., 2011). The reason is that it increases visibility and interaction with key partners and "clients". However, we did not find studies providing evidence that such effects are direct results attributable to the internationalisation of graduate programmes specifically.

Finally, in a similar vein, we also found that international mobility and career prospects are not always positively related as in some national contexts the reverse effect has been reported. For example, Cruz-Castro & Sanz-Menendez (2009) question the assumption that mobility enhances one's academic career. In the Spanish context, they found that non-mobile careers are a strong predictor of the timing of rewards in terms of obtaining early permanent positions. These findings must be interpreted in the context of organisational and institutional features of the Spanish academic system which promotes the development of internal academic research job markets. Again, we did not find evidence linking such effects to staff participating (or having participated) in international research training programmes. However, we consider that having those effects in mind is important to better understand the role and rationale of the internationalisation of doctoral training.

The internationalisation of the academic curriculum, one of the forms discussed in chapter 3, also affects teachers' performance. Abdullahi et al (2007) note how this form does not simply lead to an adjustment of the curriculum, but rather to a transformation of it. According to the author, it requires a long preparation of staff, as these expect international students to be "too teacher dependent, lacking in independent study skills, and tending to adopt rote learning strategies" (Abdullahi et al., 2007: 21). At the same time, Ramachandran argues that in the UK the inclusion of international students enriches discussions in the classroom (Pandit, 2007 in Ramachandran, 2011: 202). This enrichment is reciprocal for the students (Ibid). Finally, an internationalised curriculum (and the attendance of international students) may put an extra pressure on teachers and administrations which need institutional support (teaching assistants, student individual/personal support, etc.), due to high transaction costs.

In sum, extant literature shows the potential/inferred (positive and challenging) effects of internationalisation on teaching and research staff's performance in general, and their productivity and networking activities in particular. Positive effects on these factors are arguably the result of their assumed relatively higher visibility compared with those affiliated with "local" research training groups, allowing them to develop partnerships with colleagues and students from different backgrounds and origins, thereby extending and maintaining their network and broadening their opportunities.

5.3 Performance and Visibility of Participating Host Institutions

The drivers and effects of the internationalisation of graduate education programmes on the host institutions that were discerned in the literature can be grouped into four categories: a) financial aspects, b) visibility (reputation), c) performance (research productivity, outreach, networking) and d) institutional learning (procedures, goals, strategies, vision).

As to the financial aspects, Bennet & Kane (2011) underline that internationalisation is often a result of the need for higher education institutions to become more market driven due to a decrease in public funding. In fact, for some it is seen as a way to gain additional income through tuition-paying foreign students. As Kritz poses "universities also see foreign students as a source of foreign exchange and university revenue" (Kritz, 2006: 26).

Furthermore, in some cases internationalisation is seen as a means to reduce costs (Reichert, 2009: 117 on discussing the example of Switzerland). Eckel and colleagues – who discuss curricular joint ventures in the USA - argue that "inter-institutional collaboration [could] be an important strategy to maximise resources and to gain access to the global marketplace" (Eckel et al., 2004: 299).

However, the fact that internationalised higher education leads to an increase in costs is also underlined. According to Throsby, costs involve the development of infrastructure to "deliver foreign student services and programs, the on-going costs of program delivery, and the time-stream of benefits that may accrue to the institution as a result of its internationalisation activities" (Throsby, 1998: 6). This is also why authors stress the importance of national funding support for internationalisation. Horta, for instance states that "public funding and support is critical if countries want to have national prominent universities competing at [the] global level" (Horta, 2009: 387). Jorgensen also identifies governmental support as crucial for collaboration. Cross-border funding – via for example the Erasmus Mundus Joint Doctorate – also allows the development of know-how for European universities about collaboration, which would give Europe a competitive edge as a region (Jorgensen, 2012: 23). In fact, a recent evaluation of the Erasmus Mundus Programme concludes that many of the 24 joint doctorates programmes supported between 2007 and 2011 would not have been created without the EU programme (Commission, 2011). Moreover, according to the evaluation, "the Erasmus Mundus label allowed institutions, which are outstanding in their field but not internationally prestigious, to access external funding

and gain easier recognition of their courses. Allowing previous beneficiaries to retain the label would increase the sustainability of their courses." (Commission, 2012).

According to Ulnicane-Ozolina (2013), depending on the research institute's governance properties, international research collaboration can be an output leading to its visibility and impact on its main research field. As she posits, "multiple in-house, local, national and international links facilitates international collaboration by 1) allowing institutes to link up with complementary expertise, 2) in-house & local links provide new international contacts & support international collaboration and 3) involvement in multiple networks provides flexibility in shaping international collaboration, choosing topics & acquiring external funds" (Ibid., p. 205).

The author also found that "increasingly international recruitment of qualified senior researchers facilitates international collaborations by enhancing organisational communicative and collaborative links and providing new opportunity structures for international collaboration" (Ibid.p, 208). Furthermore, she finds that a) "support for incoming & outgoing temporary and permanent international mobility facilitates emergence of new collaborations by providing information on research competences & interests & enabling informal contacts", b) "hosting visiting scholars valued for enhancing & developing research profile facilitates exchange of ideas between visiting scholars and host institutions that can facilitate emergence of new collaborations", c) temporary mobility within established collaboration can intensify and deepen collaboration", and d) "permanent international move of core collaborator can lead to redesign of collaboration" (Ibid., p. 208-209).

Regarding graduate research training, the author found in her case studies that support and supervision of PhD students and Post Docs doing laboratory work is a key driver for international research collaboration. As she puts it "good laboratory work done by PhD students and Post Docs facilitates efficient collaboration (...) thesis on time facilitates better planned, but more predictable & less risky collaborative research" (Ibid., p.202), and "encouragement of PhD initiatives for interaction facilitates joint research activities when laboratory work done by PhD students" (p. 211).

However, according to the author, "formal & informal organisational and national differences in PhD students 'status, length of study, requirements & support available can affect joint research activities" (p. 208). Furthermore, as the author posits, "the in-depth case studies indicate that, particularly in the case of long-term collaboration, there is also a reverse influence of international research collaboration on the governance of an institute. International collaboration can influence a number of institute governance properties such as research profile, modes of recruitment and funding sources" (p. 228).

According to Reichert (2009), internationalisation has influenced national higher education structures and policies in Europe, which has led to convergence but also to diversification (the Bologna process is used as an example of both processes) . In fact, one of the promises of internationalisation on the level of institutions is that it will lead to better functioning in a global society by, according to Deardorff, "achieving international standards and competing success-

fully with institutions around the world," as well as by realising a higher (inter)national profile, which results in attracting staff and students (Deardorff, 2004: 12).

Kyvik & Tvede (1998) warns about the tension that may arise between national and international orientations as a result of such standardisation, however (Kyvik & Tvede, 1998: 11). Nerad refers to this as "converging practices" of graduate education that have different effects on regions. According to the author, due to the globalisation of graduate education, institutions are faced with a double function: "to build a nation's infrastructure by preparing the next generation of professionals and scholars for the local and national economy, both inside and outside academia, and educating their domestic and international graduate students to participate in a global economy and an international scholarly community". This, the author claims, leads to tensions, as universities often function under a national lens (Nerad, 2010: 2) .

In sum, the internationalisation may explain/lead to a higher visibility of the host department/institution, which may attract more and better students and researchers, therefore improving its financial stability and influence within the host university and in the field it specialises. Additional gains of internationalisation relate to their management capabilities and efficiency resulting from the learning process related with it.

6 Discussion and Conclusion

This paper started out with the question: which role can support for the internationalisation of doctoral and first-stage researchers by means of structured international collaborations between research groups play in the context of the general trend towards internationally highly interwoven research collaboration? As stated already in the introduction, we had to accept that the literature and current understanding of the rationales and role of the internationalisation of the research, and here in particular of doctoral and first-stage research, is much less developed than that on the graduate and doctoral education.

Table 2 shows main elements for the understanding of the role of internationalisation of doctoral research training. It outlines the key factors and framework conditions identified as a result of the literature reviewed, plus informed inferences.

First-Stage Researchers' Research Conditions and Scientific Development Perspectives	Senior Researcher and Teaching Staff s' Cooperation and Networking Perspective	Participating Host Institutions Perspective
1. Perceived quality of training and education 2. Access to facilities and equipment for research 3. Improved research skills 4. Research autonomy 5. Working conditions 6. Culture and/ or language improvement 7. Career progression, job options inside and outside academia, nationally and internationally	8. International research collaboration (joint projects, co-authorships) 9. Research funding (sources and instances) 10. Research autonomy 11. Productivity: publications, patents) 12. International recognition in the research community (citations, prizes, memberships) 13. Language improvement	14. Improve financial stability 15. International visibility, reputation, attractiveness (joint programmes, strategic alliances, students and professors) 16. Institutional learning (procedures, strategic management practices) 17. "Political" stance within the University (negotiating power, participation in boards)
Framework Conditions a) Characteristics of the host institutions b) Characteristics of the researchers involved c) Characteristics of the research activities envisages d) Characteristics of the (joint) qualification activities for doctoral students e) Characteristics of the students f) Role of other programme(s) and incentives for internationalisation		

Table 2: Factors and conditions contributing to an effective role of international doctoral research training in research collaboration

Against this background, in the previous chapters, we analysed the literature found on the rationales explaining the importance, characteristics and role of internationalisation of higher education in general and of graduate research training in particular. In this framework, we identified three different perspectives: the a) policy/political perspective, b) the institutional/instrumental perspective,

and c) the pedagogical/cognitive/professional/human perspective. We found that although these approaches are not mutually excludable, they tend to guide the analysis of the phenomenon studied by focusing on some aspects while overlooking others. For the purpose of studying the DFG IRTG Programme´s rationales and role, we claim that several aspects of each framework are worth considering but a clearer emphasis should be put on the aspects highlighted in the framework of the institutional/instrumental perspective. Based on this perspective, we propose the "resource- oriented approach," which we claim responds better for focusing on the drivers and effects around the three main policy targets of the programme: the PhD students, the participating senior researchers, and the participating host institutions; for which internationalisation is an important means to achieve their goals in today's challenging research environment.

Based on the review of the literature, and as detailed in chapter 5, a model that understands internationalisation of doctoral training programmes in terms of increasing resources makes sense because research collaboration, which is increasingly considered the "norm" in the production of new knowledge in most scientific fields, is perceived to have greater epistemic authority than individualistic research (Wray 2002; Beaver 2004), as it facilitates the diffusion of information and ideas, increases access to new knowledge and research tools, offers visibility, and encourages feedback (Crane 1972; Beaver and Rosen 1979; Rigby and Edler 2005). As a result, it is commonly associated with creativity (Burt 2004; Levine and Moreland 2004), scientific productivity (Landry, Traore et al. 1996; Beaver 2001; Lee and Bozeman 2005), research quality (Katz and Hicks 1997; Rigby and Edler 2005), innovative capacity (Georghiou 1998; Tsai and Ghoshal 1998; Belderbos, Carree et al. 2004), the creation of science and technology human capital (Rogers 2001; Bozeman and Corley 2004), the consolidation of research agendas (Ordonez 2008), and the expansion of research areas and disciplines. Furthermore, research collaboration is claimed to be the result of increased complexity of problems and raising costs of research, which makes knowledge- and instrument-sharing necessary (Gibbons, Limoges et al. 1994; Adams, Black et al. 2005), whereby the sheer boost of international research collaboration is explained by the implementation of government policies (Georghiou 1998; Wagner, Brahmakulam et al. 2001), the increased mobility of scientists across borders, and the advancement of the communication technologies and networking capabilities and tools.

As Shrum et al. (2007) stated, so far there is no comprehensive theory of scientific collaboration, certainly not concerning the role of doctoral and first-stage researchers in international collaboration. Ulnicane-Ozolina (2013) provides as a research heuristic a process model that allows for a long-term analysis of actors, processes, resources and the governance of international research collaboration. Figure 3 below depicts this model in a self-explanatory way, where the key components related with the

- emergence of collaboration,
- informal and formal processes of research-related interaction,
- various collaboration results and outcomes, and
- the potential renewal of collaboration

are identified as inter-related, not necessarily causal elements with features that characterise its structure and dynamism. At all stages of this evolutionary process, activities of and resources and support for doctoral and first-stage researchers can play an important role. Ulnicane-Ozolina (2013) provides in her case-studies relevant evidence of this role, yet the role of doctoral research was not the main focus of her research.

Drawing on a framework like this, international research training can be seen as both resulting from and facilitating international research collaboration in a systemic and dynamic way, where PhD education and research is embedded in bi- or multi-lateral inter-institutional international research projects/programmes; where exchange of senior researchers and PhD students is facilitated; and where joint awarding of PhD degree may materialise through the collaboration.

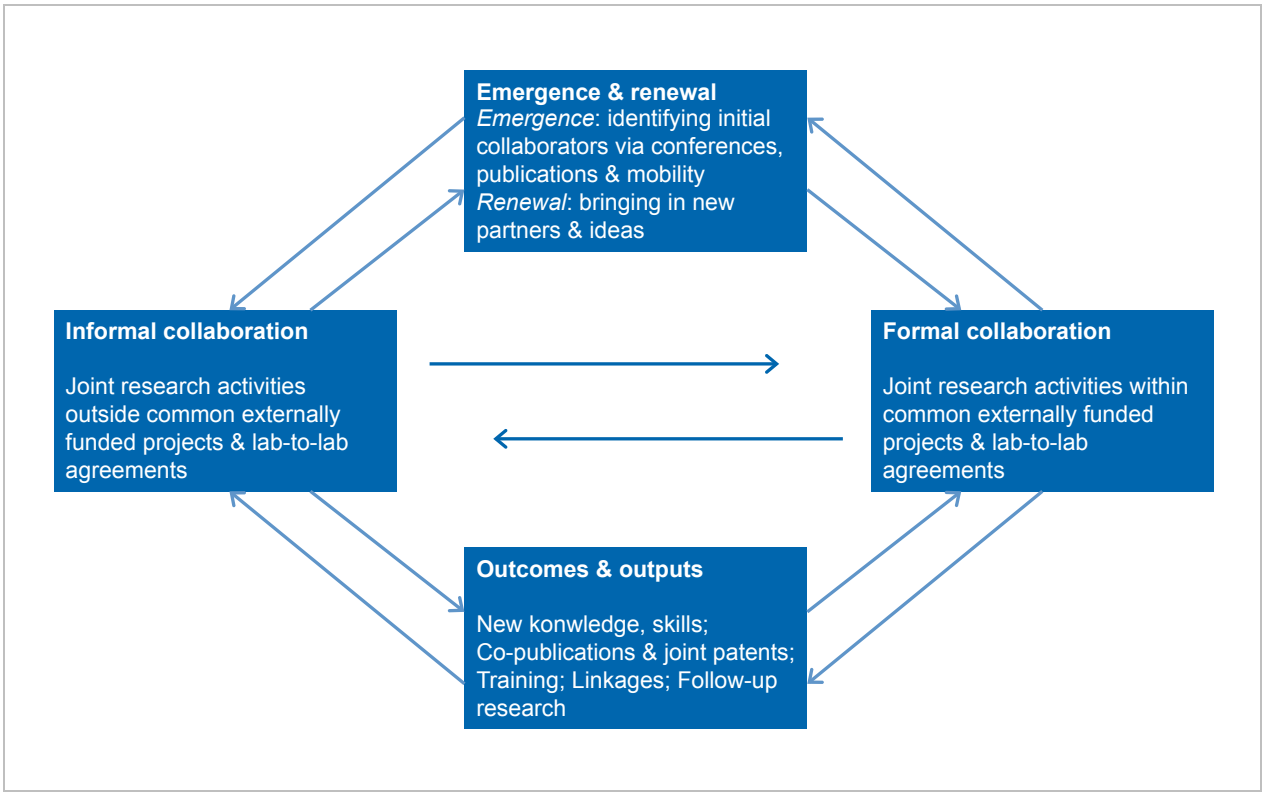

Figure 2: Process model of international research collaboration
Source: Ulnicane-Ozolina, 2013: 31.

Against this background we assume that the internationalisation of doctoral research training and related support programmes a) can offer the doctoral candidates improved research conditions and (scientific) development perspectives, because it can increase their exposure to new knowledge, (research) cultures and resources their home universities/research institutes may not have or be able to provide otherwise; b) can extend the international research and cooperation opportunities for the participating senior and junior researchers, which is key for the performance of any research aiming to innovate and be highly valued both within the research community and in society; c) can expand and strengthen the international cooperation network in the research fields of the participating researchers, as it will provide the dynamism necessary for maintaining and developing “invisible colleges” (e.g. Wagner 2008), necessary for the ad-

vancement of the sciences and the technologies in a constantly changing global system of innovation and needs; and d) can – where appropriate – result in formalised strategic alliances of international visibility for their universities, which largely depend on the attractiveness of talented students, researchers and teachers in an increasingly competitive market.

Nevertheless, further empirical research, both in-depth and representative, is necessary to understand options and limitations of related funding schemes (such as the DFG-IRTG) or other policy measures. On the basis of the literature found, we propose to combine the above sketched process model of international research collaboration with a resource-based approach to analyse the ways internationalisation can be instrumental for universities and researchers to a) offer the doctoral candidates improved research conditions and (scientific) development perspectives; b) extend the international research and cooperation opportunities for the participating researchers; c) expand and strengthen the international cooperation network in the research fields of the participating researchers; and d) achieve formalised strategic alliances of international visibility for their universities. We claim that this approach can be effectively used to account for the drivers and effects of the internationalisation of graduate education and research training considering the three main actors involved: a) the participant PhD student, b) the involved senior researchers, and c) the host institutions. We notice, however, that for this approach to satisfactorily and comprehensively account for the rationales and role of internationalisation, various framework conditions have to be taken into account.

7 References

Abdullahi, I., Kajberg, L., & Virkus, S. (2007). Internationalization of LIS education in Europe and North America. New Library World, 108(1/2), 7–24. doi:10.1108/03074800710722144

Abramo, G., D'Angelo, C. A., & Di Costa, F. (2009). Research collaboration and productivity: is there correlation? Higher Education, 57, 155–171. doi:10.1007/s10734-008-9139-z

Adams, J. D., G. C. Black, et al. (2005). Scientific teams and institutional collaborations: Evidence from US universities, 1981-1999. Research Policy 34(3): 259-285.

Altbach, P. G., & Knight, J. (2007). The Internationalization of Higher Education: Motivations and Realities. Journal of Studies in International Education, 11, 290–305. doi:10.1177/1028315307303542

Basu, A. and B. S. V. Kumar (2000). International collaboration in Indian scientific papers. Scientometrics 48(3): 381-402.

Beaver, D. D. (2001). Reflections on scientific collaboration, (and its study): past, present, and future. Scientometrics 52(3): 365-377.

Beaver, D. D. (2004). Does collaborative research have greater epistemic authority? Scientometrics 60(3): 399-408.

Beaver, D. D. and R. Rosen (1979). Studies in Scientific Collaboration .2. Scientific Co-Authorship, Research Productivity and Visibility in the French Scientific Elite, 1799-1830. Scientometrics 1(2): 133-149.

Beerkens, E., & Derwende, M. (2007). The paradox in international cooperation: Institutionally embedded universities in a global environment. Higher Education, 53, 61–79. doi:10.1007/s10734-005-7695-z

Belderbos, R., M. Carree, et al. (2004). "Cooperative R&D and firm performance." Research Policy 33(10): 1477-1492.

Bennett, R., & Kane, S. (2011). Internationalization of U.K. University Business Schools: A Survey of Current Practice. Journal of Studies in International Education, 15(4), 351–373. doi:10.1177/1028315309348736

Bordons, M. and I. Gomez (2000). Collaboration networks in science. Web of Knowledge - a Festschrift in Honor of Eugene Garfield. B. Cronin and H. B. Atkins. Medford, NJ., Information Today Inc: 197-213.

Bozeman, B. and E. Corley (2004). Scientists' collaboration strategies: implications for scientific and technical human capital. Research Policy 33(4): 599-616.

Burt, R. S. (2004). Structural holes and good ideas. American Journal of Sociology. 110(2): 349-399.

Cañibano, C., Otamendi, J., & Solís, F. (2011). International temporary mobility of researchers: corss-discipline study. Scientometrics, 89, 653–675.

Carney, J., Chawla, D., Wiley, A. & Young, D. (2006). “Evaluation of the Initial Impacts of the National Science Foundation’s Integrative Graduate Education and Research Traineeship Program.” Final Report. Contract # REC9912174, B15285X. Abt Associates, Inc. NSF, Arlington, VA. USA.

Carney, J., Martinez, A., Dreier, J., Neishi, K., & Parsa, A. (2011). “Evaluation of the National Science Foundation’s Integrative Graduate Education and Research Traineeship Program (IGERT): Follow-Up Study of IGERT Graduates.” Final Report. Contract # GS-10F-0086K. NSF, Arlington, VA. USA.

Chaparro, F., H. Jaramillo, et al. (2004). The role of diaspora in facilitating participation in global knowledge networks: lessons of the Red Caldas in Colombia. Washington, D.C., Report prepared for the Knowledge for Development Program. The World Bank: 25.

Childress, L. K. (2009). Internationalization Plans for Higher Education Institutions. Journal of Studies in International Education, 13, 289–309. doi:10.1177/1028315308329804

Commission (2012). “Interim Evaluation of Erasmus Mundus II (2009-2013)”. Specific contract EAC - 2011 – 0255. Final Report.

Crane, D. (1972). Invisible Colleges: diffusion of knowledge in scientific communities. Chicago, IL, The University of Chicago Press.

Cruz-Castro, L. and L. Sanz-Menendez (2009). Mobility versus job stability: Assessing tenure and productivity outcomes. Research Policy 39(1): 27-38.

Deardorff, D. K. (2004). The Identification and Assessment of Intercultural Competence as a student outcome of internationalization at institutions of higher education in the United States. North Carolina State University.

DFG. (2012). Guidelines. Form 50.07 – 10/12. www.dfg.de

Dolby, N., & Rahman, A. (2008). Research in International Education. Review of Educational Research, 78, 676–726. doi:10.3102/0034654308320291

Eckel, P. D., Green, M. F., & Affolter-Caine, B. (2004). Curricular Joint Ventures: a new chapter in US cross-border education? Policy Futures in Education, 2(2), 299–315. doi:10.2304/pfie.2004.2.2.6

European University Association. (2005). Doctoral Programmes for the European Knowledge Society - Report on the EUA Doctoral Programmes Project (pp. 1–44).

Forray, J. M., & Goodnight, J. E. (2010). Think global, act local: a methodology for investigating international business curriculum priorities using stakeholder feedback. Organization Management Journal, 7(1), 56–64. doi:10.1057/omj.2010.3

Farrell, M. P. (2001). Collaborative circles: friendship dynamics and creative work. Chicago, University of Chicago Press.

Frame, J. D. and M. P. Carpenter (1979). International Research Collaboration. Social Studies of Science 9(4): 481-497.

Glanzel, W. and A. Schubert (2005). Domesticity and internationality in co-authorship, references and citations. Scientometrics 65(3): 323-342.

Glänzel, W. and A. Schubert (2004). Analyzing scientific networks through co-authorship. Handbook of Quantitative Science and Technology Research: The Use of Publication and Patent Statistics in studies on S&T Systems. H. Moed, W. Glänzel and U. Schmoch. Dordrecht, The Netherlands, Kluwer Academic Publishers.: 257–276.

Georghiou, L. (1998). Global cooperation in research. Research Policy, 27(6), 611-626.

Gibbons, M., C. Limoges, et al. (1994). The New Production of Knowledge: The dynamics of science and research in contemporary societies., Chapters 1-2. Sage Publications.

Hagedoorn, J., A. N. Link, et al. (2000). Research partnerships. Research Policy 29(4-5): 567-586.

Horta, H. (2009). Global and national prominent universities: internationalization, competitiveness and the role of the State. Higher Education, 58, 387–405. doi:10.1007/s10734-009-9201-5

Huang, F. (2003). Policy and Practice of the Internationalization of Higher Education in China. Journal of Studies in International Education, 7, 225–240. doi:10.1177/1028315303254430

Ivancheva, L., & Gourova, E. (2011). Challenges for career and mobility of researchers in Europe. Science and Public Policy, 38(3), 185–198.

Jonkers, K., & Cruz-Castro, L. (2013). Research upon return: The effect of international mobility on scientific ties, production and impact. Research Policy, 1–12. doi:10.1016/j.respol.2013.05.005

Jonkers, K., & Tijssen, R. (2008). Chinese researchers returning home: Impacts of international mobility on research collaboration and scientific productivity. Scientometrics, 77(2), 309–333. doi:10.1007/s11192-007-1971-x

Jorgensen, T. E. (2012). CODOC – Cooperation On Doctoral Education between africa , Asia , Latin America and Europe (pp. 1–54).

Katz, J. S. (1994). Geographical Proximity and Scientific Collaboration. Scientometrics 31(1): 31-43.

Katz, J. S. and D. Hicks (1997). How much is a collaboration worth? A calibrated bibliometric model. Scientometrics 40(3): 541-554.

Katz, J. S. and B. R. Martin (1997). "What is research collaboration?" Research Policy, 26(1): 1-18.

Kehm, B.M. (2006). Doctoral education in Europe and North America: a comparative analysis. In Teichler, Ulrich (ed.): The Formative Years of Scholars. Wenner-Gren International Series Vol. 83. London: Portland Press, S. 67-78.

Knight, J. (1994). Internationalization: Elements and checkpoints. Canadian Bureau for International Education Research, 7, 1–15.

Knight, J., & De Wit, H. (1995). Strategies for internationalisation of higher education: historical and conceptual perspectives. In H. De Wit (Ed.), Strategies for the Internationalisation of Higher Education. A Comparative Study of Australia, Canada, Europe and the United States of America. (pp. 5–32). EAIE Secretariat, Van Diemenstraat 344, 1013 CR Amsterdam, The Netherlands.

Kritz, M. M. (2006). Globalisation and internationalisation of tertiary education (pp. 1–50).

Kyvik, S., Karseth, B., Remme, J. A., & Blume, S. (1999). International mobility among Nordic doctoral students. Higher Education, 38, 379–400.

Kyvik, S., & Tvede, O. (1998). The Doctorate in the Nordic Countries. Comparative Education, 34(1), 9–25.

Landry, R., N. Traore, et al. (1996). An econometric analysis of the effect of collaboration on academic research productivity. Higher Education 32(3): 283-301.Lee, S. (2004). Foreign-born scientists in the United States -Do they performe differently than native-born scientists? School of Public Policy. Atlanta, GA, Georgia Institute of Technology. PhD Dissertation: 228.

Lee, S. and B. Bozeman (2005). The impact of research collaboration on scientific productivity. Social Studies of Science 35(5): 673-702.

Levine, J. M. and R. L. Moreland (2004). Collaboration: The social context of theory development. Personality and Social Psychology Review 8(2): 164-172.

Leydesdorff L. and C. Wagner (2008). International collaboration in science and the formation of a core group, Journal of Informetrics 2(4), 317-325; http://dx.doi.org/10.1016/j.joi.2008.07.003

McAllister, P., & Redd, K. (2007). International Graduate Applications and Admissions in Science and Technology: The Role of Graduate Education in Supporting Innovation.

Melin, G. (2004). "Postdoc abroad: inherited scientific contacts or establishment of new networks?" Research Evaluation 13(2): 95-102.Narin, F., K. Stevens, et al. (1991). "Scientific Cooperation in Europe and the Citation of Multinationally Authored Papers." Scientometrics 21(3): 313-323.

Narin, F., K. Stevens, et al. (1991). Scientific Cooperation in Europe and the Citation of Multinationally Authored Papers. Scientometrics 21(3): 313-323.

NSF-NSB (2006). Science and Engineering Indicators 2006. National Science Board. Arlington, VA, National Science Foundation, Division of Science Resources Statistics.

NSF-NSB (2008). Science and Engineering Indicators 2008. National Science Board. Arlington, VA, National Science Foundation, Division of Science Resources Statistics.

NSF-NSB (2012). Science and Engineering Indicators 2012. National Science Board. Arlington, VA, National Science Foundation, National Center for Science and Engineering Statistics.

Nerad, M. (2010). Globalization and the Internationalization of Graduate Education: A Macro and Micro View. Canadian Journal of Higher Education, 40(1), 1–12.

Ordonez, G. (2008). International Research Collaboration, Research Team Performance, and Scientific and Technological Capabilities in Colombia -A Bottom-Up Perspective. PhD Dissertation. in Public Policy. Georgia Institute of Technology - Georgia State University. Atlanta, GA.

Ordonez-Matamoros, H. G., S. E. Cozzens, et al. (2010). International Co-Authorship and Research Team Performance in Colombia. Review of Policy Research 27(4), 415-431.

Qiang, Z. H. A. (2003). Internationalization of Higher Education: Policy Futures in Education, 1(2), 248–270.

Ramachandran, N. T. (2011). Enhancing international students' experiences: An imperative agenda for universities in the UK. Journal of Research in International Education, 10, 201–220. doi:10.1177/1475240911413204

Reichert, S. (2009). Institutional Diversity in European Higher Education - Tensions and challenges for policy makers and institutional leaders (pp. 1–162).

Rigby, J. and J. Edler (2005). Peering inside research networks: Some observations on the effect of the intensity of collaboration on the variability of research quality. Research Policy 34 (6): 784-794.

Rogers, J. (2001). Theoretical Considerations of Collaboration in Scientific Research, AAA.

Shrum, W., J. Genuth, and I. Chompalov (2007). Structures of Scientific Collaboration. MIT Press.

Stone, N. (2006). Internationalising the Student Learning Experience: Possible Indicators. Journal of Studies in International Education, 10, 409–413. doi:10.1177/1028315306287633

Stromquist, N. P. (2007). Internationalization as a response to globalization: Radical shifts in university environments. Higher Education, 53, 81–105. doi:10.1007/s10734-005-1975-5

Teichler, U. (2003). Mutual Recognition and Credit Transfer in Europe: Experiences and Problems. Journal of Studies in International Education, 7, 312–341. doi:10.1177/1028315303257118

Teichler, U. (2004). The Changing Debate on Internationalisation of Higher Education. Higher Education, 48, 5–26. doi:10.1023/B:HIGH.0000033771.69078.41

Thorstensson, L. (2001). This Business of Internationalization: The Academic Experiences of 6 Asian MBA International Students at the University of Minnesota's Carlson School of Management. Journal of Studies in International Education, 5, 317–340. doi:10.1177/102831530154004

Throsby, D. (1998). Financing and Effects of Internationalisation in Higher Education - The Economic Costs and Benefits of International Student Flows (pp. 1–57). Paris.

Tsai, W. P. and S. Ghoshal (1998). Social capital and value creation: The role of intrafirm networks. Academy of Management Journal 41(4): 464-476.

Ulnicane-Ozolina, I. (2013). Influence of institute governance on international research collaboration: Towards a typological theory. Dissertation. University of Twente, The Netherlands [This PhD research project was sponsored by Deutsche Forschungsgemeinschaft, DFG, in the context of the Research Group 'Governance of Research' (FOR 517)].

U.S. Department of State (2005). Outcome Assessment of the Visiting Fulbright Student Program. Office of Policy and Evaluation. Bureau of Educational and Cultural Affairs. U.S. Department of State.

U.S. Department of State (2002). Outcomes Assessment of the U.S. Fulbright Scholar Program. Office of Policy and Evaluation. Bureau of Educational and Cultural Affairs. U.S. Department of State.

Van Bouwel, L., Lykogianni, E., & Veugelers, R. (2011). Mobility of European researchers to the US : student mobility vs . researcher mobility. Science and Technology Indicators Conference (pp. 7–9).

Van Damme, D. (2001). Quality issues in the internationalisation of higher education. Higher Education, 41, 415–441.

Van der Wade, M. (1997). Internationalising the Curriculum in Dutch Higher Education: An International Comparative Perspective. Journal of Studies in International Education, 1, 53-72. Doi: 10.1177/102831539700100204

van Rijnsoever, F. J. ; Hessels, L. K. (2011). Factors associated with disciplinary and interdisciplinary research collaboration. Research Policy, 2011, Vol.40(3), pp.463-472

Vincent-Lancrin, S. (2006). What is Changing in Academic Research? Trends and Futures Scenarios. OECD-CERI Report. Published also in European Journal of Education. Volume 41, Issue 2, 169–202.

Volet, S. (2003). Challenges of internationalisation: Enhancing intercultural competence and skills for critical reflection on the situated and non-neutral nature of knowledge. Biennial Language and Academic Skills in Higher Education Conference (pp. 1–11). Student learning Centre, Flinders University, Adelaide. Retrieved from http://researchrepository.murdoch.edu.au/id/eprint/8134

Wagner, C. S. (2005). Six case studies of international collaboration in science. Scientometrics 62(1): 3-26.

Wagner, C. S. (2008). 'The New Invisible College: Science for Development.' Brooking Press: Washington DC.

Wagner, C.S. and Leydesdorff, L. (2005). Network structure, self-organization, and the growth of international collaboration in science. Research Policy, 34(10), 1608-1618.

Warta, K. and A. Geyer (2011): Evaluation des Humboldt-Forschungsstipendien-Programms der Alexander von Humboldt-Stiftung. Technopolis Austria GmbH, Wien. (http://www.humboldt-foundation.de/pls/web/wt_show.text_page?p_text_id=1409433)

Wray, K. B. (2002). The epistemic significance of collaborative research. Philosophy of Science 69(1): 150-168.

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