Group 1

Assessment of Doctoral Reforms Since 2005 – Systemic Meta-Level

Aleksandra Kanjuo Mrčela, Andrés Bernasconi, Barbara Grant, Chaya Herman, Corina Balaban, Dick Strugnell, Hongjie Chen, Janet Rutledge, Maresi Nerad, Marketa Lopatkova, Martin Grund & Rosemary Deem

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Overview of Sections:

Preamble

Since the advent of the 21st century, in light of globalization and of governments wishing for their countries to become knowledge societies, the Center of Innovation and Research in Doctoral Education (CIRGE) at the University of Washington, Seattle, in the US from 2005 began a series of international workshops starting to explore the forces that were driving reforms and changes in doctoral education around the globe and the forms these changes were taking. These workshops, which included experts from all six continents, including graduate deans, funders of doctoral education, top administrators, and, of course, doctoral students, were vehicles for stimulating cross-national research and for establishing international networks for information exchange and collaboration. The goals were to stimulate action to promote the education of innovative and socially responsible doctoral recipients worldwide; equal distribution of high-quality doctoral education around the world; and greater inclusion of diverse societal groups in doctoral education.

The first workshop, in 2005, held in Seattle, focused on understanding the issues of that particular time. It resulted in a book publication of 14 country profiles titled *Towards a Global PhD? Forces and Forms in Doctoral Education Worldwide* (2008). The second workshop, in 2007, held in Melbourne, Australia, investigated the effects of globalization and new quality assurance practices on doctoral education, as well as doctoral education's potential for nation building. It also asked what is a PhD in terms of competencies acquired. The findings were published in a book titled *Globalization and Its Impacts on the Quality of PhD Education Worldwide: Forces and Forms of Doctoral Education Worldwide* (2014). The third workshop in 2009 took place in Kassel, Germany. The heart of this workshop was to develop and agree upon practical recommendations for graduate deans, funders of doctoral education, and professorial advisors to doctoral candidates. The resulting policy recommendations, *The Policy Potential of Innovation and Internationalization in Doctoral Education: Recommendations for Equity, Diversity and Innovation* are published in an article, "Global Perspectives on Advocating for Change in Doctoral Education," in *Learning and Teaching: The International Journal of Higher Education in the Social Science* (3:1, 2010). The last of the workshops zeroed in on a particular region, Southeast Asia, and took place in Penang, Malaysia, in 2010. Its goal was to form a regional, collaborative network that would become a "knowledge hub" for doctoral education in the region. The result of this workshop was that graduate deans from Thailand and Malaysia who were present passed a declaration that acknowledged that doctoral education should be a source for social cooperation and the sustainability of natural, human, and institutional resources.

Seven years later, CIRGE and its network saw a need to review the development of the forces and forms in doctoral education worldwide again. There have been significant changes in doctoral education worldwide in the last decade: in many countries, the numbers of doctoral candidates and doctoral-granting institutions have increased, with the intention to help drive both national innovation and research performance of individual institutions, especially in Asia. Worldwide, there is a greater focus on diverse employment prospects and transferable skills of doctorate holders and postdocs. At the same time, the world is changing faster than ever. Seemingly adverse developments with yet unknown effects, namely digitization as a potential driver of progress as well as a simultaneous deterioration of democracies, which have aligned with the rise of populist or fundamentalist movements, characterize the second decade of the 21st century. Training doctoral candidates to become the next generation of

creative, critical, autonomous, and responsible intellectual risk-takers is more essential than ever in these times of epochal challenges and unsettling changes.

We approached the Volkswagen Foundation, a private German foundation which has allocated substantial resources to doctoral education, for grant funding to review the successes and failures of reforms since 2005 and to explore ways of training and preparing new generations of doctoral holders.

Now, during the first week of September 2019, we are coming together in Hannover, Germany, the site of the Volkswagen Foundation, to undertake this review while considering the newly configured and constrained global context and to discuss the findings against the general background of common values, namely academic and research freedom as part of universal human rights and ethics, research integrity, and societally relevant and responsible research.

Five groups, with participants from all parts of the world, completed this review by each focusing on a specific topic related to doctoral education. The following two papers were prepared by 12 people from Australia, Chile, China, Czech Republic, New Zealand, Slovenia, South Africa, Great Britain, and the United States: the first paper focusing on forms and structures; the second on quality assurance.

Section I:

Forms and Structures

1. Changes to Forms

In most national reports, there is a distinction between the traditional form of the PhD (a substantial and original contribution to knowledge through research, scholarship and investigation, usually written as a monograph) and other, newer forms of the doctorate (for example, professional, creative practice, or industrial doctorates). The reform of the *form* of the doctorate itself has taken place unevenly – much earlier in some countries, which have offered, for example, professional doctorates for several decades now, but only quite recently in others, and not yet at all in some countries (although some of these latter countries anticipate it).

Professional Doctorates and Professional Practice Doctorates

The most common of the 'newer' forms of the doctorate is the professional doctorate (such as the Doctor of Education, of Engineering, of Audiology, of Physiotherapy, of Clinical Psychology), which provides an opportunity for experienced professionals to develop an inquiry-focused and research-informed approach to learning at work. Differences between the traditional, research-based PhD and the professional doctorate lie in the length of the written work (thesis) and the scope of the structured work (courses) versus the unstructured (individual) research. Sometimes the assessment criteria (e.g. professional doctorate theses may require explicit reference to professional practice) may differ as well. In some countries, such as Australia and New Zealand, where the dominant model of the doctorate is a 100% independent research-based programme of study, in the professional doctorate model the first full-time equivalent year of the student's programme comprises coursework and the development of the proposal.

In the US, there are three types of professional doctorates. The first type is the "traditional" professional doctoral degree, such as the doctor of education, of engineering, or the doctor of social work. The difference between the research doctorate (PhD) and the professional doctorate is not between more or less structure: both are structured. Rather, the traditional professional doctorate requires fewer research methods courses, and does not require a large-scale *original* research project based on a theoretical conceptual framework. The thesis of a professional doctorate is a piece of practical work such as the development of a curriculum innovation based on an extensive literature review, followed by the implementation and evaluation of the innovation; or a procedure tested in practice and systematically analyzed for its effects. ii) The second professional type of doctoral degree is the doctor of medicine (MD), law (JD), or dentistry (DD). These have existed since the late 19th to early 20th centuries and are not considered research doctorates, i.e. PhDs. These types of doctorates require coursework and practical

experiences.[1] iii) The third and newest type of professional doctorate degree is the professional practice doctorates, for example, the doctor in audiology, acupuncture, art therapy, nursing, physical or occupational therapy. The majority of these degrees have emerged between 2000 and 2015 and are appear mainly in health-related fields, where once aspiring professionals completed master's degrees. Now, driven by their professional associations' requirements, these professionals either must or are expected to complete doctorates to enter practice. The new professional practice doctorate mostly requires some kind of written thesis, but not a research-based one. In short, It is an extension of the master's degree course-work by a year or two (Zusman, 2017).

Some reports describe a blurring of differences between the professional doctorate and the PhD e.g. in Australia (and New Zealand), **"**more applied, practice-based and professional research is increasingly conducted in PhD programs and more theoretical research is undertaken in professional doctorate programs" (Australia country report). In NZ, the expectations of the length and qualities of the final thesis are commonly the same for both the PhD and the professional doctorate and conform to national standards. In the UK, however, expectations vary by institution.

Joint and Dual Doctorates

A more recent development is that of joint and dual doctoral degrees. Joint doctoral degrees are awarded by universities, that is by faculties and departments, which cooperate in transnational networks. Double degrees, also called co-tutelle arrangements, require joint supervision and the fulfillment of the requirements of both universities i.e. programs. These new forms of doctoral degrees most often have physical mobility built into their programs.

New Forms of Research Theses

Associated with the rise of new forms of the doctorate are new forms of the thesis. Increasingly, the monograph is being joined by theses-by-prior-publication (mostly done by those with a research record but no doctorate) or by concurrent publication, as well as theses that include artefacts, performances and so on. For example, in Germany and the UK, a form of doctorate exists that is in fact an external doctorate with a number of already published articles or books combined into one piece of research work, without any stay at a university, but a final public defence of their submitted research (rigorosum). Many, but not all universities in Germany, as well as in the UK offer such a format. In the US, some PhD programs allow publications that result from the research done as part of the degree to form the major part of the thesis, often three published or publishable journal articles.

[1] The US/NSF data do *not* report the MD, JD, DD within the annual doctorates awarded, except the NSF Science & Engineering Indicators, include these degrees to be comparable with the reporting of doctoral degrees in other countries.

A related reform is the trend towards more English-language doctorates being produced in non-English-language institutions/nations.

2. Changes in Participation

In the past two decades (2005-2015), we have seen a trend toward growing levels of participation in doctoral education in a number of countries, particularly in China, but also in South Africa, Malaysia, Mexico, Brazil and Chile. In most emerging economies, this growth was from a low base. Increased participation in doctoral education has occurred mainly due to the growth in universal access to education that, as a pipeline effect, has increased enrolments in tertiary education. However, such growth is also likely to be a result of governments' awareness of the role of doctoral education in the knowledge economy (an awareness prompted by policies from international agencies such as the OECD and the World Bank). Many governments now link doctoral education to innovation, economic growth and global competitiveness, despite an absence of clear evidence for such an immediate link.

We need to differentiate between an increase in enrolled doctoral students and an increase in doctoral degrees awarded. Not all who enrol in doctoral studies complete with a doctorate. The paper on quality assurance will discuss attrition rates during doctoral education.

In countries with a longer tradition of broad participation in higher education, growth in the number of doctorates is often associated with the increased number of international students, as in the case of UK, Australia and New Zealand where active recruitment of international students has occurred. The US has also benefited from an increase in international doctoral students, especially from Asian countries. In South Africa, likewise, much growth is associated with the increased number of international students from other African countries. In these countries, some growth in numbers is also a result of paying more attention to inclusion. This is particularly evident with respect to the rise in the representation of women (for example, in Germany and in the Czech Republic, but also in the US, where women now constitute more than half of all US doctorate recipients), albeit in an uneven pattern across disciplines/fields of study. In some jurisdictions, other under-represented and/or non-traditional or marginalized groups are also targeted for increased inclusion at doctoral level. For example, in New Zealand, a larger amount of government funding flows from the enrolment and successful completion by doctoral students from two target groups (Maori/indigenous and Pacific Islands peoples); and in the US, national governmental funding agencies also encourage increases in historically underrepresented race and ethnic groups.

At the same time, in some countries we are witnessing a decrease in the number of local doctoral graduates, which parallels a decrease in the overall population or in the 18-year age cohort (Japan).

Table 1

Increase in PhD Production 1991-2014

Country	1991	2004	2008	2012	2014
Australia	N/A	5,000	6,500	6,547	8,400
Brazil	N/A	N/A	10,700	13,912	16,745
China	2,000	23,400	43,800	51,713	53,653
Germany	22,000	23,100	25,600	26,807	28,147
India *(2011)	N/A	17,850	18,700	21,544*	21,830
Japan *(2011)	10,000	16,900	17,300	15,911*	15,045
Russia***	N/A	29,850	27,700	34,403	36,533
South Korea	1,000	7,950	9,400	12,243	12,931
United Kingdom	8,000	15,300	16,600	20,438	25,020
United States**	37,000	48,500	61,730	62,071	67,591

Source: Nerad (2020), Governmental innovation policies and change doctoral education worldwide: Are doctoral programs converging? Trends and tensions In *Structural and Institutional Transformations in Doctoral Education: (Mis)alignment with Doctoral Candidates' Career Expectations* (Proposed Title), edited by S. Cardoso, O. Tavares, Ch. Sin, and T. Carvalho. London: Palgrave McMillian (forthcoming).
Data sources: NSF Science Indicators 2016 and 2018, chapter 2, Appendix Table 2–37.
**The US data include professional doctorates, MD and JD in order to be comparable.
*** the Russia data are studies completed , but not dissertation, and degree awarded.

Comparing Data Across Countries

Comparing data across countries, even in 2019, needs to be done with caution. For this workshop we had asked the workshop participants to provide us the number of doctorates awarded in recent years. However, we are not certain whether the figures provided are indeed comparable. Not only were not all the same years available, but we also do not know which doctorate degrees are included or not. The two current sources of available comparative doctorate degree data are from OECD and those from the US National Science Foundation, *NSF Science and Engineering Indicators*, a biannual publication that has detailed footnotes of what is included or not. We know, for example, that Germany does include the law doctorates and the medical doctorate in their official statistics. As described earlier, the US does not include those in their regular statistics but, for purposes of comparison, does so in the *NSF Science and Engineering Indicator* country comparative data. We know that Chile also does not include the law and medical doctorate in their official statistics. In the process we also learned that Russia officially reports 2 sets of data on doctorates: one that reports those who completed their PhD studies (similar to what is called in the US ABDs =all-but-the dissertation) in three years. This is a normative term. One cannot be a student in the PhD program for more than three years. The second number reflects the PhD degrees that were awarded in a given year. Thus, in this paper we have used only the numbers provided by NSF and added to the appendix the table with figures we have collected from the workshop participants.

3. Reforms to Institutional Structures

Since the turn of the century, several structural changes in doctoral education can be witnessed worldwide. Over the years, progress has been made by universities establishing broader support structures for students engaged in doctoral education. These structured offerings have been called 'professionalisation', competencies development or 'structuration'. This refers to universities taking further their institutional responsibilities as part of a virtuous cycle of good practice, despite reservations about possible increased bureaucracy, increase in time-to-degree, and over-structuration (and thus a loss of opportunities to develop autonomy). A good description of the newer *structured doctoral education* as introduced to continental Europe is given by Kehm (2006), who describes it as "the integration of this qualification phase into programmes, centres, schools or colleges, etc. and the addition of systematic curricular provisions to offer theoretical, methodological and labour market related competences to the research work on the dissertation" (p.73). In what follows, we sketch these structural changes, some of which overlap with each other.

Centralized Graduate Schools, Structured Programs and Targeted Leadership

We have seen internationally widespread reforms in institutional structures for doctoral education with the emergence of graduate schools as well as key senior academic and administrative leadership positions associated with these schools. A centralized structure allows for great institutional oversight, greater centralized innovation, and facilitates the emergence of enhanced quality assurance (for more on quality assurance, see paper B on Quality Assurance).

For example, the EUA-CDE Report 2019 (based on a survey of 250 European universities from 36 countries) shows that the organisation of doctoral education in Europe has undergone a rapid transformation in the past decade. As universities have increasingly assumed a more comprehensive approach towards early-stage researchers, a wide diversity of practices, policies and structures has been implemented to deliver more robust training and support for various aspects related to doctoral research. The survey shows that doctoral programmes and schools are now by far the dominant form of organisation in Europe. Doctoral programmes with specific elements such as taught courses, milestones, mobility options, etc. (i.e. structured programs) are present in 73% of responding universities, either "to a great extent" (24%) or "always" (49%). These units oversee the development of their programmes, ensure quality, develop regulations and guidelines, and so on. According to the EUA-CDE report they exist in 62% of responding universities, either "to a great extent" (17%) or "always" (45%). The emergence of doctoral programmes and schools as the predominant organisational form of doctoral education does not take away from the central role of doctoral supervisors, but the survey results indicate that, nowadays, the latter only rarely work without institutional oversight. These European doctoral schools are also mostly field or theme specific, i.e. a doctoral school in material sciences, in social sciences.

In contrast, in the US a central, campus-wide Graduate School (sometimes called Graduate Division or Graduate College) has existed since the early 1900s. Such a graduate school is an educational catalyst, not an "administrative octopus." This campus-wide division has five basic functions, and several specific roles: 1) It is the executive policy body of an academic senate committee that assures the quality of master's and doctoral education across the entire university. 2) It is an administrative unit for all matters of post-graduate and post-doc affairs and, as such, oversees basic requirements of admissions and degrees for all doctoral and master's programs at a university. 3) It ensures that basic requirements are the same across all programs and colleges. 4) It is a service unit for post-graduate programs and post-graduate students. In this function, in connection with the campus career center, it provides professional skills training to help doctoral students succeed in a variety of employment settings. 5) It is an institutional research unit for graduate matters, collecting and analyzing data on various aspects of graduate education at its university, such as time-to degree, attrition, career path information, and exit surveys that inquire about satisfaction with advising services provided at the departmental and campus level. This research provides a basis for establishing policy for the Graduate Council and the Graduate Dean. What is new is that these graduate schools offer professional development workshops, including workshops towards non-academic careers.

In yet another example, New Zealand universities have had Graduate Schools (as well as a Dean of Graduate Studies and a senior administrator) for the past two decades or so. Gradually, over time, they are moving from being concerned mostly with functions 1, 2, 3 and 5 outlined in the US example above to encompass the more developmental activities characteristic of the fourth function. This is also the case for the UK, where graduate schools for taught master's degrees, as well as doctorates, first emerged in the early 1990s as a failure of universities to really support postgraduate education. In more recent times, doctoral schools have focused only on research degrees.

Supervision/advising

The structure of doctoral supervision/advising is also under reform. Most notable in some countries is the shift away from reliance on the single-supervisor model towards diverse *multiple-supervisor models*. Another notable reform in some countries is the emergence of mandatory *supervisor training* and development, although this seems more widespread in Commonwealth countries than others – perhaps because they, too, are more likely to have the 100% independent research model. Where it does take place, this training is most commonly for new supervisors and/or newly appointed academics/faculty, and often with considerable emphasis on training them into awareness of their institution's bureaucratic and regulatory framework. However, refresher provision for experienced supervisors is common in the UK and NZ, for example. Overall, supervision has become more regulated, sometimes being subject to codes or guidelines for practice, and commonly enmeshed in institutional reporting requirements and quality assurance.

In this vein, the EUA-CDE Report 2019 found that doctoral supervision has become a collective effort shared by the academic supervisor, other qualified members of the supervisory team and various structures put in place by the university. While the supervisor continues to play a central role in doctoral education (now often described as "support and guidance for early-stage researchers") and is even seeing her or his responsibilities expand dramatically, it is becoming increasingly rare for them to work without any form of institutional oversight. The survey asked about institutional rules and guidelines that are in place to organise various aspects of supervision, ranging from the appointment procedure for supervisors to their training. It also asked to what extent early-stage researchers find themselves supervised by a single supervisor or a supervisory team, either with members internal to the institution or from other universities. The outcomes show that rules and guidelines are in place for most aspects of doctoral supervision. For example, the appointment of supervisors is addressed in 89% of responding universities; formal reporting by doctoral candidates on their activities in 86%, and formal feedback by supervisor(s) in 73%. A majority of responding universities also provide rules and guidelines for written agreements between the candidate, supervisor and/or the university (64%), conflicts between supervisors and early-stage researchers (59%) and the minimum number of meetings with the supervisor(s) (52%). The survey gives a picture of doctoral supervision as a collective and well-regulated effort in many ways, with the majority of responding universities in line with the Salzburg Principles published in 2005, urging higher education institutions to have in place "arrangements for supervision and assessment [based] on a transparent contractual framework of shared responsibilities". Overall, supervisors remain the first among equals when it comes to doctoral supervision in Europe, but they increasingly work in tandem with supervisory teams consisting of colleagues from inside and (to a lesser extent) outside the same university.

Two other issues of interest are the questions of who can supervise doctoral work and how supervision is assessed. In most countries, supervisors must have a doctorate, usually the PhD, although some allow for secondary supervisors or advisors who do not have a doctorate but rather some other kind of specialised expertise relevant to the nature of the student's research project *and* for external industry or third sector supervisors on collaborative doctoral projects. The assessment of supervisors is not very formalized and is usually only considered during performance management, bids for promotion, or applications for institutional or national-level teaching and/or supervision and/or research excellence awards. It would seem that neither of these aspects of doctoral education are currently subject to reforming trends. However, a post-experience accreditation for supervisors is currently being piloted in the UK by the UK Council for Graduate Education. A number of US and some German universities award annually or biannually a best doctoral supervisor prize, based on a survey of doctoral advisees and submitted recommendation for outstanding supervisors.

Time-to-Doctoral Degree

Another widely reported reform has been a trend towards shorter timeframes under which the student must complete their doctoral degree. This reform (in which quality assurance has sometimes come to play a policing role) has been going on for much longer in some jurisdictions than others. It is largely driven by changes in government funding regimes, usually through mediating agencies in which academics play

active roles such as research councils or national research audit exercises. Commonly, governments and other scholarship-awarding bodies restrict doctoral funding to three or four years, although some countries have a maximum of five years. Part-time candidates have a pro-rata system in some countries, including the UK.

Types of Doctoral Research

Another aspect of structure under reform relates to the kinds of doctoral research being undertaken. There is a decided shift away from the more 'purely' academic focus and the single-discipline training model of earlier decades towards research that is more applied and/or more multi-disciplinary or inter-disciplinary, often requiring a team-based supervision model and including supervisors located in non-academic contexts such as industry or dedicated-focus research institutes. There is also some evidence of an increase in the collaborative provision of the doctorate between academic institutions and across more than one country (see the earlier mentioned co-tutelle model).

There are also reports from a range of jurisdictions about governments and research funding agencies steering an increase in applied STEM research with a concomitant reduction in funding available for humanities, social sciences and "blue-skies research," meaning curiosity-driven research. Related to these reforms are those towards the need to show societal and industrial impact of research. In some countries, such as South Africa, this impact is evaluated in relation to identified "country challenges"; in others, such as the US, declarations of such impact are required to be included in grant proposals by research funding bodies. Canada is experimenting at the University of British Columbia with a 'real world' doctorate where candidates must get involved in some public engagement work as part of their studies.

The EUA-CDE Report 2019 provides evidence of the changed nature of the doctorate from an academic degree that expresses above all the ability to conduct research conforming to academic standards and presented through a dissertation or published articles in collaboration with one or more senior academics to a much more institutionalized research work (supported by doctoral schools and similar structures) that answers also to new out-of-academia career aspirations and opportunities for graduates. This kind of structural change in doctoral education conforms more to the project-oriented research work of national science and engineering doctoral education and some social scientists criticize this type of project-oriented doctoral training as leaving too little initiative to the individual doctoral candidate.

Professional Development Training for Students

Yet another aspect of structural reform relates to the offering of professional development training for students by central university units (sometimes Schools of Graduate Studies). There is evidence of a shift away from relying on supervision/advising as the core mode of doctoral education to the provision of a

range of other supports for students. These are often related to efforts to prepare students for non-academic careers through (usually) non-mandatory workshops, courses and placements: for example, in generic/transferable skills/competencies training, career advising, internship programmes.

Related to the provision of training and development, we see the rise of institutional, pan-institutional tracking of doctoral employment patterns and career destinations, for example in Slovenia. In the US, individual universities, the American Association Universities (AAU), an association of 62 major research universities, and the NSF have been collecting doctoral career path data and employment patterns during the last 2-3 decades.

With the flow of non-English speaking international students into anglophone universities, and the dominance of anglophone journals and books in the academic publishing market, there is also a trend to providing more substantial English language training. This trend is also occurring in some universities within non-anglophone countries, especially in the sciences, where students are expected to be able to participate in the international research community.

Lastly, in relation to doctoral students, there is growing concern in many countries about their mental health and wellbeing – we can anticipate the emergence of more comprehensive structures to address this concern since it appears that the incidence of mental ill health is higher for doctoral candidates than even other highly educated individuals (Nature, 2018).

4. Discussion and Recommendations

> "The doctorate will almost certainly survive but it may no longer look like it does today" (Deem & Dowle, 2019)

In considering the evidence of doctoral reforms since the turn of the century, we identified four key questions for discussion and we address each in what follows. This discussion is followed by a set of core policy recommendations.

Doctoral reforms/changes as both solutions and problems?

Most of the reforms of the past decade or so have been a response to perceived problems, including those imposed somewhat arbitrarily for example by the rise of international rankings and by the doctoral-qualifications-equals- a-stronger-knowledge-economy equation. But many of the reforms have also had unexpected, even unwanted, side effects.

For example, changes in the dominant model of supervision towards being more transparent and involving more (interdisciplinary and international) team-work: this is seen to be good for young researchers (empowering, emancipating, stimulating), but also for supervisors and research communities, leading to enhanced mobility, innovation, surpassing known comfort zones. At the same time, it has sometimes meant that the practice of supervision has become more loaded with bureaucratic work, more under pressure (i.e. to ensure timely completions), as well as entailing more complex relational work (i.e. between supervisors as well as between supervisor and student).

In another example, research funding streams and, consequently, foci have changed (under the influence of market-driven and/or knowledge economy discourses) towards a more instrumental focus on problems with clear industry/wider society application/impact. This entails the problem of a lack of both valuing and funding for purely curiosity-driven, even so called basic research, and/or humanities research.

The move to submitting in a limited time has arguably led to some theses being submitted before they are ready to be examined and also a move from the 'knowledge'-driven doctorate to a research 'training' doctorate – for example, in the UK (1987 Winfield Report).

In countries where doctoral education is newer and continue to rely substantially on scholarship programs for doctoral studies abroad, there often is a tension between continuing to invest in such scholarships or investing instead in the development of local capabilities for doctoral education that may eventually reduce the need to send people abroad.

Is there a massification of doctoral education?

Almost all over the world the number of holders of doctoral degrees is rising, and participation in doctoral programmes is increasing, but we would not call it "massification" in the sense of being no longer limited to those who wish to reach the highest level of formal studies. Available data (including OECD and NSF Science Indicators) show that the increase in PhDs production is not uniform across countries and not per 1000 people in country populations. In many ways, doctoral education is still limited and selective: to reach the stage where an individual has the opportunity to participate requires a huge amount of economic, academic and, perhaps, social capital. Most notably, many countries that have strong levels of participation at the undergraduate level are reliant for growth at the doctoral level on incoming flows of international students. The future of these flows is unclear as the countries of origin build stronger higher education systems of their own.

In contrast, in middle-income countries, where faculty at universities generally lack a PhD degree, there is enormous potential demand for doctoral graduates. In these cases, academia remains by far the main source of employment for doctorates.

What is/should a 21st century doctorate (be) for? Should the doctoral education be different for those entering a non-academic labour market? If so, why? If not, why not?

Our evidence shows that there is a global trend towards "the introduction of structured programs, the move away from a single dissertation advisor to at least two, and the opening up of possibilities to study in an inter- or multidisciplinary context … a move away from the classical Humboldtian research model of one master professor who passes on specialized knowledge and the art of undertaking research to one student, in one discipline, in a hierarchical learning environment" (Nerad, 2020). At the same time, we are witness to a dearth of academic employment opportunities in many of the countries producing large numbers of PhDs. Although such opportunities are likely better in countries that are growing their higher education sectors, even then the picture is complex. In China, for example, there is now a dearth of opportunities for academic positions in the urban universities, which is where most doctoral holders want to be employed.

In our discussions, we were reluctant to consider a different model (beyond the new models we already see) or standard of doctoral education, particularly where the PhD is concerned. We maintain a strong commitment to the values underpinning a traditional doctoral education: the development of both autonomy as a scholar-researcher and the capacity for criticality and originality with respect to making a contribution to the discipline or field. We would rather see the capacities and attributes associated with doctoral-level work more explicitly articulated by institutions, supervisors and students alike, especially in relation to the strengths they furnish doctoral students with for future employment in a wide range of fields.

Open question: Will there soon be an *overproduction* of doctorates – as was said to be the case in the US in the 1990? Certainly, each country has a different need. Also, societies need people who can do research in all sectors of employment; societies also need people who can operate in complex situations, provide evidence, understand causal connections and relations. But we need not shy away from a discussion of employment of doctorates, and not simply postpone the discussion by creating more postdoctoral ('holding') positions.

Are we moving away from the educational aspects of the doctorate towards a sole focus on workforce-preparedness training?

Regardless of many differences globally, the doctorate is adding to mastering "the traditional academic competencies—critical thinking, knowing and applying research methods and design, undertaking

competent data analysis, academic writing and publishing within the rules of ethical and responsible research" competencies that are aimed and designed in a way that "doctoral students … acquire professional competencies, as well as intercultural communication understanding and skills … (… grant writing, presenting complicated scientific concepts and results to a diverse audience, working effectively in teams, applying for professional jobs, and managing people and budgets, ... and working effectively with people from different classes, races/ethnicities, cultures, religions, and perspectives" (Nerad, 2020). We need to be aware that competencies in academia are also changing along with changes in academic work (Musselin, 2013).

Such change is not new. The 19th and 20th century workforces were increasingly expected to be educated; the 21st century workforce is expected to have technical and scientific skills. We argue this *is* a positive development if the possession of scientific skills and cultures comprise more than just knowing about scientific research techniques. Doctoral education should also include being able to apply critical thinking in relation to ethical and responsible research, and a concern for the public good, social justice and human rights for the overall benefit of societies.

From a Latin American perspective, it seems that the trend away from the "traditional" PhD is more a phenomenon in mature systems of higher education, where job opportunities for new doctors are diminishing or very limited compared to the supply, or where industry hires PhDs. But that's not the case in Latin America, where (like South Africa) large numbers of people with PhDs are needed to replace university professors without that credential, and the industry isn´t much of an option.

We suggest finding the balance between efficiency and workforce preparedness, basic and applied research. A real problem lies not in the increased level of education of the workforce, but in the decline of interest in scientific research that has no immediately usable and commercialized value, that is done in order to pursue curiosity about the world and how it works, to improve society in its cultural as well as technical dimensions. A decline in the financing of humanities and social sciences research is something that should be a concern for all. Treating humanities and social sciences as only accessories in interdisciplinary research on important topics (such as environmental issues, use of new energies, technological development) is problematic and needs wide attention and discussion. In addition, in countries like Hungary, Poland and Brazil, and in parts of the Trump administration in the US, the social sciences are being attacked by right-wing political parties for being 'ideological' and not scientific.

5. Our Policy Recommendations

In closing, we make the following core policy recommendations:

1. We recommend that doctoral programme providers, individually and collectively including at national levels, engage robustly with the issue of where most doctoral students are heading for employment post-graduation and provide training and development opportunities that support them in making their skills visible, and in connecting with potential employers during candidature. The challenge here is to not reduce doctoral education to a narrow, utilitarian preparation solely for employment purposes, as doctoral recipients want to make use of the capacities they have acquired during their doctoral programmes. Doctoral education must also prepare for critical thinking in relation to ethical and responsible research, and a concern for the public good, social justice and human rights for the overall benefit of societies.

   We recommend that university faculty develop closer relationships with their alumni and employers to understand how to improve their programs and career mentoring to enhance career outcomes of their graduates. Universities, employers and governments must all work together to support thriving doctoral programs.

2. We recommend the strengthening of innovative North-South university doctoral programme collaborations, funded by the Global North, where countries with newer doctoral education sectors can draw expertise and wisdom from those with more established histories of such provision and in turn provide new ideas that can enrich and refresh established programmes.

3. We recommend that even more steps are taken all over the world to include in doctoral education those with the capability to do a doctorate, from all races, ethnicities and abilities, as well as those from disadvantaged backgrounds.

4. We recommend a review of the tight standardized doctoral completion time-frames imposed without respect for significant disciplinary differences in how research questions are generated and pursued.

5. We recommend that variation in doctoral programmes within and between countries is understood to be an important source of creativity as well as responsiveness to local conditions and histories including non-western epistemologies. Such variation should be encouraged for its potential to enrich, extend and challenge the blind-spots of existing disciplines and fields and its capacity to produce new disciplines and fields.

6. We recommend that supranational and regional data collection agencies provide detailed information on the kind of doctoral degree data that were used in reporting. We urge for careful international comparison undertaken by people who are knowledgeable of the different country systems and collection methods.

7. We recommend vigilance in protecting the core doctoral values of fostering autonomy and requiring originality. Among other reasons, the doctorate is still the only route to academic positions and, although these positions do not exist in many countries in numbers that match those of graduating doctoral students, renewal of the academic profession is ongoing and crucial

to the future of universities. The values of autonomy (allied to academic freedom) and originality lie at the heart of this profession.

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Section II

Quality Assurance in Research Training

The growth in the numbers of institutions, programs and individuals engaged in research training leading to doctoral qualifications has placed pressure on higher education providers to examine the quality of the graduates being produced. Even within institutions, and because of fundamental differences in the student experiences and models for supervision, it is hard to evaluate the relative quality of individual graduates. In contrast, it is possible to examine the processes that lead to graduation, and to test these processes against what is considered best practice. The elements that are most important can be considered against a rubric of Inputs, Throughputs and Outputs. In this Section, the authors contrast how quality assurance is conducted in 4 jurisdictions – the USA, China, Europe and Australia. The governance, accreditation and audit arrangements in these countries and regions differ and these differences impact what can be imposed at a national level and what is left to individual institutions to determine. The authors understand that different institutions, and programs in these sometimes very large systems, do things differently from the norm, but the purpose of reviewing the Inputs, Throughputs and Outputs at the national level is to highlight transnational elements of best practice, and to allow some benchmarking against systems that, though all different, are focused on improving the value of research training to the individual and their institution and country/region.

1.0 BACKGROUND AND GOVERNANCE

China

Doctoral education is internationally recognized as the highest level of formal higher education and is an important indicator of the level of education development and core competitiveness of a country. Doctoral education must suit the needs of the country's workforce needs, including academic institutions and industry. China's doctoral education processes have evolved over 30 years and while some development has been achieved, the doctoral training model in China is still evolving.

Since the implementation of the new degree system in China in 1981, doctoral education has developed rapidly. At the beginning of reform and opening up, China drew on the experiences of the US and European countries to inform the development of their doctoral education systems. In addition to colleges and universities, there are three other major systems that are engaged in doctoral education: research institutes, military and party schools. However, colleges and universities are the central bodies of doctoral education in China. From the development of doctoral education in colleges and universities, the spread of doctoral education in the university system experienced three stages: initial development (late 1970s to the early 1990s), rapid expansion (early 1990s to 2003) and now controlling growth and improving quality.

In the initial stage, the government was most concerned about the ability to cultivate internationally recognized doctoral graduates. Therefore, the doctoral training units, disciplines and professional degree programs, as well as doctoral supervision qualifications, are strictly controlled. The importance of quality as an essential principle was clearly stated, which meant that it was necessary for the Chinese

higher education system to train doctoral graduates based on the international standard. In particular, Chinese doctorates had to be equivalent to doctoral degrees in developed countries, and the doctoral qualification provided must be seen as internationally valid.

In 1995, the Academic Degrees Committee of the State Council decided to conduct a degree authorization review every four years. In the same year, the newly added units handled by the detachment were reviewed. Later in 1998 the doctoral supervisor's examination and approval authority were delegated to the training units rather than in central government. By the end of the expansion, China had become one of the world's largest producers of doctoral level graduates.

At present, China has implemented a doctoral education model with predominantly academic doctorates supplemented with professional doctorates. From the perspective of doctoral professional areas, academic doctors are mainly trained in the following 13 fields: science, engineering, agriculture, medicine, law, management, education, economics, philosophy, literature, art, history, military. From the perspective of professional doctorates, these are mainly in the following fields: engineering, clinical medicine, veterinary medicine, stomatology (dental medicine), and education. On June 16, 1982, the first six Chinese-trained students were awarded doctoral degrees. By 1999, the number of doctoral degree holders exceeded 10,000 for the first time. Today approximately 60,000 doctoral degrees are awarded annually. According to the Ministry of Education, there are total 2663 institutions of higher education, of which 344 are authorized to award doctoral degrees.

In China, several strategies have been adopted to manage the doctoral education and quality. For example, China has established a degree authorization review system. This system is designed for reviewing and granting authorization for universities and institutions to have rights for recruiting doctoral or master students and awarding these degrees in their proposed disciplines, which has become an important part of the degree awarding and quality assurance system in China. This system is a significant strategy for guaranteeing the educational quality in the operation of national macro-control level, which helps the reform of the economic society and higher education. The state council established a degree committee to be responsible for leading the national degree review system, which implements a centralized and unified evaluation. In 1981, the degree committee of the state council published "Academic Degree Regulations of the People's Republic of China", which officially started to manage the higher education degree system. Initially, the degree committee listed potential institutions that could apply for the right to award doctoral and master's degrees. Then the state council reviewed these applications to decide the final results. To simplify the examination and approval procedures, starting in 1986 the degree committee began to review and approve these applications rather than the state council. Since 1995 the degree committee has been fully responsible for the review and evaluation of doctoral awarding authorization and rights to establish doctoral training in a discipline.

Europe

The organization of doctoral studies in Europe is diverse as each European country has its own system of doctoral education and its own legal framework. We are speaking about hundreds of universities - the survey by the European University Association (EUA) mentions 1361 doctorate-awarding universities

from 32 European countries [EUA Survey 2019].[2] This survey clearly states the great diversity of structures across Europe – universities "have established diverse, often parallel structures for doctoral education that reside at different levels of university governance". However, some convergence of doctoral education developed due the "Salzburg Process" in the last 15 years - the process was instantiated in three central documents (2005-2015).

The Bologna seminar on ''Doctoral Programmes for the European Knowledge Society'', organized by the European University Association (EUA) in February 2005, summarized a discussion on key challenges of doctoral education and its role in Europe. Its main outcome was a set of 10 recommendations that should serve as a basis for a doctoral education reforms [Christensen 2005],[3] [Salzburg 2005],[4] [Salzburg Report 2005].[5]

These principles were further enriched in 2010 with so called "Salzburg Recommendations" [Salzburg 2010][6] – these recommendations convey three main messages: they reinforce research as the basis of doctoral training, they provide a set of clues for the concrete improvement of doctoral education and finally they involve issues such as sustainable funding of doctoral schools and the institutional autonomy.

In 2016, guidelines for the continued implementation of reforms was issued as the "Doctoral Education – Taking Salzburg Forward: Implementation and New Challenges" [Salzburg 2016],[7] [Salzburg Report 2016].[8]

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[2] Alexander Hasgall, Bregt Saenen, Lidia Borrell-Damian (co-authors: Freek Van Deynze, Marco Seeber, Jeroen Huisman): Doctoral education in Europe today: approaches and institutional structures. European University Association, 2019
https://www.eua.eu/resources/publications/809:doctoral-education-in-europe-today-approaches-and-institutional-structures.html (accessed on July 26, 2019)

[3] Kirsti Koch Christensen (2005): Bologna Seminar: Doctoral Programmes for the European Knowledge Society (General Rapporteur's Report)
https://www.eua.eu/component/attachments/attachments.html?task=attachment&id=1881 (accessed on July 26, 2019)

[4] Salzburg 2005 – Conclusions and Recommendations
https://www.eua.eu/resources/publications/626:salzburg-2005-%E2%80%93-conclusions-and-recommendations.html (accessed on July 26, 2019)

[5] Doctoral Programmes for the European Knowledge Society (Report on the EUA Doctoral Programmes Project)
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[6] Salzburg II – Recommendations
https://www.eua.eu/resources/publications/615:salzburg-ii-%E2%80%93-recommendations.html (accessed on July 26, 2019)

[7] Doctoral Education - Taking Salzburg Forward: Implementation and new challenges
https://www.eua-cde.org/reports-publications/51:doctoral-education-taking-salzburg-forward-implementation-and-new-challenges.html (accessed on July 26, 2019)

[8] Doctoral Education - Taking Salzburg Forward: Implementation and new challenges (Report)
https://www.eua-cde.org/downloads/publications/2016_euacde_doctoral-salzburg-implementation-new-challenges.pdf (accessed on July 26, 2019)

According to [Salzburg Summary 2010],[9] "Institutions must be able to develop their systems for quality assurance and enhancement independently within their national frameworks. They must have the **freedom to develop their own indicators for quality** that correspond with the standards of the individual disciplines as well as with the overall institutional strategy." (see 3.3)

The impacts of the "Salzburg Process" is documented in an extensive survey provided by EUA in its report from January 2019 [EUA Survey, 2019]; this report is based on the survey covering 311 responses from European universities (1 response per university; covering 21% of doctoral awarding institutions and 40% of doctoral candidates).

Based on findings published in [EUA Survey 2019, Figure 21), 83% institutions involved in the survey declare that they have established an internal quality assurance system for all their PhD programmes, additional 6% institutions ensure the quality of most doctoral programs. All or most doctoral programs are evaluated by some external body (as funding agencies or external quality assurance agencies) at 59% of the institutions.

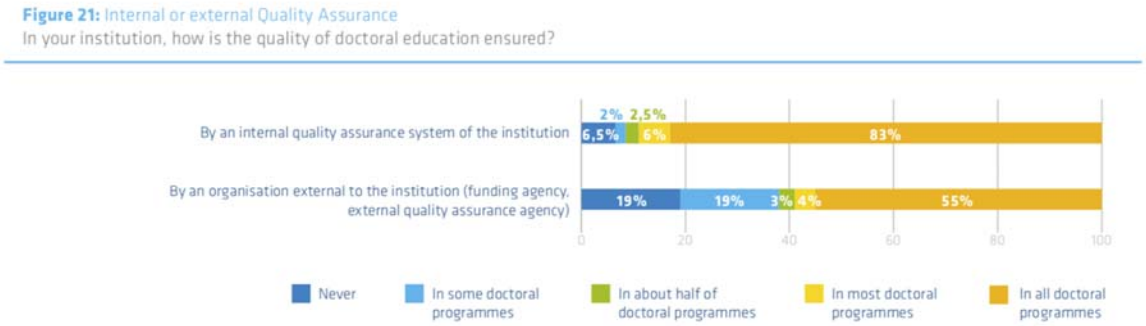

Figure 21 as published in [EUA Survey 2019, p. 31], see footnote 1 for the reference.

The EUA survey also summarizes main quality indicators used the evaluation of doctoral education [EUA Survey 2019, Figure 22] - it shows that 76% of the institutions monitor academic publications by doctoral candidates and use it as the most important indicator (for all or most doctoral programs). Further, completion rate of doctoral candidates (72%), staff qualification (66%), other qualitative indicators (as peer review, evaluation committees) (54%) and level of internationalization (53%). In addition, 54% of institutions indicate that satisfaction of doctoral candidates is used as an important quality indicator.

[9] Salzburg II – Executive Summary https://www.eua.eu/downloads/publications/salzburg%20ii%20recommendations%202010.pdf (accessed on July 26, 2019)

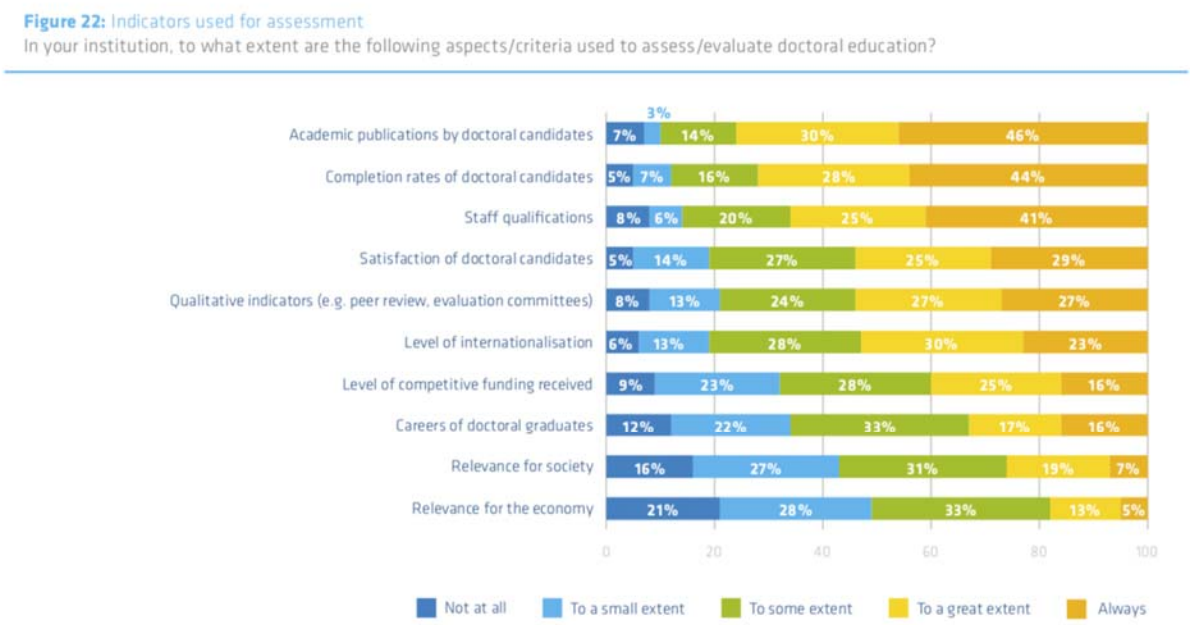

Figure 22 as published in [EUA Survey 2019, p. 31], see footnote 1 for the reference.
More convergence in the European Union is expected due to a new initiative called "European Universities". The European Commission intends to foster closer cooperation among European universities, i.e., transnational alliances of higher education institutions that have been established to "enhance the quality and attractiveness of European higher education and boost cooperation between institutions, their students and staff".[10] In June 2019, 17 "European Universities" involving 114 higher education institutions from 24 EU Member States were selected as "*role models for others across the EU*" (Tibor Navracsics, Commissioner for Education, Culture, Youth and Sport).

Australia

The Australian tertiary education system is comprised of 43 self-accredited "universities". Forty of these are Australian universities, two are international universities, and there is one private "specialty university'". Of the forty Australian Universities, 38 are public institutions and 2 are private. Australia has a national regulatory and *quality assurance agency* for higher education called the Tertiary Education Quality and Standards Agency (or TEQSA https://www.teqsa.gov.au/). TEQSA regularly audits Universities to standards, and the standards for doctoral education are defined by the Australian Council of Graduate Research (ACGR https://www.acgr.edu.au/), formerly known as the DDoGS, the Deans of Graduate Research, in the Australian universities. The rights of international students are further protected by the Education Services for Overseas Students (ESOS) Act, specific legislation to protect their interests, which impacts on various research training process parameters, including Supervisor qualifications. Dissertation advisors are termed Supervisors in documentation related to research training in Australia. There is also a national rubric for all post-secondary qualifications in Australia called the Australian Qualifications Framework, which covers the requirements for doctoral education (which is level 10, https://www.aqf.edu.au/).

[10] http://europa.eu/rapid/press-release_IP-19-3389_en.htm (accessed on July 26, 2019)

The ACGR have described six (6) Good Practice Principles that provide the minimum Australian University compliance requirements for key components of the doctoral training process from admission to examination, being:

1. Admission requirements and processes for entry to graduate research programs are transparent and clearly documented.
2. Support for graduate research candidates focuses on facilitating a successful completion within a reasonable timeframe.
3. Graduate research candidates are supported to undertake original research and scholarly activities whilst developing key research and employability skills for academic and non-academic careers.
4. Graduate research candidates have access to information on the resources available to help facilitate the timely completion of a quality research project and have an opportunity to engage with scholarly communities both within the university and globally.
5. Supervisors must provide guidance to graduate research candidates in the design, conduct and timely completion of the research project, support in publication and dissemination of research findings, and advise on the acquisition of a range of research and other skills as appropriate to the discipline and the background of the candidate.
6. Thesis examination is conducted by at least two experts of international standing in the discipline who are external to the enrolling institution, independent of the conduct of the research, and without any real or perceived conflict of interest in reaching their decision.

   Each of these key principles is supported by several Sub-Principles that speak to the specific aspects of the doctoral education journey from admission to completion.

USA

In the United States, the vast majority of post-secondary colleges and universities are accredited by one of seven regional accrediting agencies that are recognized by the national government through its U.S. Department of Education. While accreditation is voluntary, virtually all public and private non-profit colleges and universities, as well as many for-profit institutions, participate. Until very recently, the focus has been on undergraduate education exclusively. In the past 10 years, two of the seven regional accrediting agencies have begun to require student learning outcomes for master's and doctoral students as well. For the past five years they are becoming more stringent on enforcing these requirements and some universities have been told to make improvements before the next accreditation cycle or risk not being accredited. It is not clear if or when these requirements will expand to the other five regional accrediting agencies.

There are 4324 postsecondary institutions that are included in the Carnegie Classification of Institutions of Higher Education, of which 418 are classified as doctoral granting universities[11]. There are some universities outside of this classification that grant doctoral degrees, but the number is below the threshold needed to be classified as a doctoral university. Most universities have their own internal quality assurance processes that generally have titles such as "academic program review." These are typically administered from a central office within academic affairs and may be done on a department level, including undergraduate and graduate programs within that department, or on an individual program basis that considers undergraduate and graduate programs separately. These reviews most

[11] From the Carnegie Classification of Institutions of Higher Education "2018 Facts and Figures Report" available from http://carnegieclassifications.iu.edu/index.php

often require the unit being evaluated to prepare a self-study report that will be reviewed by external visitors and internal committees. When done correctly, these reviews can drive changes in programming, budgets and space. Often the academic program review process will feed into the external accreditation.

The U.S. Council of Graduate Schools has been a leading voice in the discussions on quality standards for doctoral education. They have received funding from the National Science Foundation and private foundations to engage member universities in examining appropriate measures and metrics for inputs, throughputs and outputs. There have been sessions dedicated to the topic of quality assurance at their national meetings and at meetings of their regional affiliates.

Some discipline-based professional societies have accreditation or quality assurance standards that are in addition to what is done more broadly at the university level with the regional accrediting system. These are often in disciplines such as clinical psychology where graduates will engage in professional practice.

2.0 INPUTS

USA

Most universities in the United States require the following information from applicants to their doctoral programs: statement of purpose, transcripts from all post-secondary coursework completed and letters of recommendation. Until recently most doctoral programs also required scores from the GRE General Test (https://www.ets.org/gre/) and some disciplines required scores for GRE subject tests. Applicants who are from countries where English is not the language of university instruction are also required to submit scores from an English language proficiency test such as TOEFL (https://www.ets.org/toefl) or IELTS (https://www.ielts.org/en-us) (there are other accepted tests but these two are the most common). Universities set minimum passing scores on English language tests, with some disciplines within a university having higher required scores than the university as a whole. Universities take steps to verify the authenticity of transcripts and letters of recommendation. Transcripts from US universities must be sent directly from the university to the admissions office. Transcripts from universities outside of the US may be hand carried by the applicant for an admissions officer to review and authenticate. Some universities require the use of a third-party transcript evaluation service such as World Education Services (WES) (https://www.wes.org/).

In most cases, doctoral admissions are reviewed by the faculty in each individual graduate program. It is rare that these faculty are given formal training on how to conduct admissions. The prevailing assumption is that faculty will recognize quality when they see it. Often faculty are reviewing applicants to determine which students they want to work with directly and are willing to fund on their research grants. There are some doctoral programs that admit a group of students as a cohort with assignments to faculty advisors happening later. Both approaches can lead to high quality applicants, however there is some evidence that the cohort approach produces better outcomes.

Over the last decade there has been much more focus on the racial, ethnic and socioeconomic diversity of applicants and students who enroll in doctoral programs. The graduate community has engaged in exploration of how to review application materials in a more holistic way to understand the applicants as more than just numerical scores such as coursework grade point average (GPA) and GRE standardized test scores (https://cgsnet.org/holistic-review-graduate-admissions-report-council-graduate-schools). The GRE test was initially established to bring more fairness into the admissions process by providing a common benchmark across all applicants so that there would be less reliance on the review committee's knowledge of the quality of individual universities. However, application review committees in many universities were using the scores in ways that were not intended by setting cutoff scores or ascribing more significance to score differences than was appropriate. There has been a pattern that students from families with higher incomes and those who attended more prestigious colleges and universities for their bachelor's degrees tended to score higher on the test. The net effect is that doctoral programs were not achieving the level of diversity that they desired for their applicant pools or their enrolled students. Rather than adopt appropriate uses of the test scores in a holistic process for reviewing applications, universities are moving toward making GRE test scores optional or not considering them at all. Some universities have introduced pre-admissions interviews with applicants, and sometimes with those who write reference letters, or have added additional materials to the application packets in exchange for the loss of the test scores. Others have just eliminated this information from the application packets. It is disappointing to hear some in the graduate community claim that their faculty who do admissions know how to evaluate transcripts from different universities when there is such variety that this is practically impossible. Furthermore, studies have shown that the top-ranked private universities have higher average grade point averages than lower-ranked public universities for their undergraduate programs. This gives applicants from the top universities a real advantage in admissions.

In the United States the completion rate of doctoral students is estimated to be a little over 50%. Historically faculty blamed the "inputs" to their programs rather than the "systems" at their universities and within their programs for this low completion rate. National efforts such as the PhD Completion Project sponsored by the Council of Graduate Schools (CGS) have helped shift this perspective so that more attention is being paid to the experiences that students have in their programs.

China

China has multiple modes for admission into doctoral education: 1) entry exam recruitment, 2) master-doctoral package study, 3) bachelor-doctoral direct study, and 4) application-assessment. Doctoral students usually obtain national scholarships funded by central government. Supervisor's research funding may be also used as supplemental support. However, self-funding is necessary for some professional degrees (e.g. EdD). The entry exam recruitment (Figure 3) is the dominant mode for doctoral students.

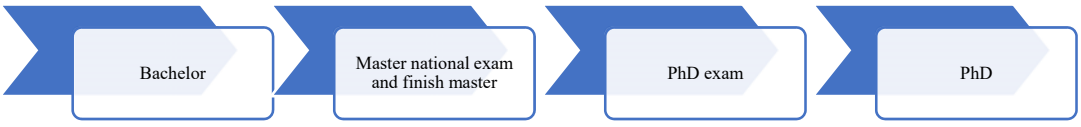

Figure 3. Entry exam model

Admissions is open to all candidates who have obtained the master's degree. The entry exam recruitment of doctoral students was established in 1981, recognized as a key element of the development of the doctoral education system in China. The inception of the exam required the development of recruitment plans, which are submit centrally, i.e. to the Ministry of Education where after universities organize exams and assess results.

The recruitment examination generally includes the initial test and an interview. The initial test is a written assessment, including foreign language and professional subjects. The schools or universities organize the foreign language test. The professional subjects are generally basic courses in the discipline proposed by the doctoral supervisors. Most universities use an interview, often in combination with a written test. Academics from a discipline usually establish a panel to assess the candidates' admission materials and to examine their professional knowledge, research ability, innovation ability and other related abilities and qualities of the candidates. The use of the entry exam mode has been questioned as to whether the qualities selected by the examination are well aligned with the aims of doctoral education, i.e. to select and foster genuine talents. While the exam-based selection process has some shortcomings, the process is uniform and procedurally rigorous that ensured some fairness in selection and promoted the development of doctoral education in China.

There is a certain degree of similarity between master-doctoral package study and bachelor-doctoral direct study. Students are required to apply according to the regulations of the admissions unit and pass the entrance examination or assessment of the doctoral students organized by the admissions unit. Outstanding bachelor’s degree graduates may be able to enter as doctoral students in some universities. The enrollment must reflect an excellent bachelor’s degree and a recommended exemption from the master’s degree. The number of students enrolled shall not exceed 20% of the enrollment of doctoral students in this major.

These two methods generally adopt the method of “student self-application and comprehensive school evaluation”, according to the overall performance of the applicants, including university achievements and awards, comprehensive foreign assessments, foreign language proficiency, scientific research, and participation in comprehensive practice activities. From the actual situation, the specific practices of many colleges and universities are also inconsistent, but most of them will be selected for these two modes. It is not difficult to see that these two modes, respectively, focus on outstanding master’s and undergraduate students, aiming to explore an effective mode of doctoral training. Most of the key universities in China currently have such doctoral enrollment methods. From the overall design of doctoral education objectives of the student training system, it can be targeted and cultivated, which makes up for the shortcomings of the single method of recruiting doctoral students in China, and promotes the quality of doctoral students to a certain extent.

Finally, the "application-assessment" system is a kind of doctoral student recruitment method that has emerged in China in recent years. This method has been used in the UK, the USA, and Australia. In this "application-assessment" mode, students usually need to submit their application first to the target university. The admissions unit assesses the student's application documents and conduct interviews. If the student is qualified, the school and university will offer a place. In this process, the training unit and the supervisor play an essential role. This model can circumvent the rigidity of the written test scores.

The comprehensive evaluation of a student, combined with an interview, assists universities to select the best candidates. Many colleges and universities in China have begun to adopt the "application-assessment" system, tested in some disciplines and then promoted throughout the university.

The China admissions systems are therefore in transition, moving from test scores to application and interview-based assessment, which is recognized as a practical way to select doctoral students from world-class universities. The “application-assessment” approach will further expand the autonomy of recruiting and training units and bring competition to admission, but it will require enrollment and training units to provide competitive offerings.

For entry into professional doctorates, students are required to pass an English language exam offered by either national education department, or prospective universities, and a professional knowledge exam, which is usually administered by the universities and related faculty. Finally, they need to pass an interview. Importantly, most of professional doctoral students need to have a minimal level of work experience. For their doctoral training, they also need to complete several courses, write a thesis, and then generate some publications to obtain the degree. Different from the PhD, many professional doctoral students study part-time and usually take longer time to complete this journey.

European perspectives

Universities set up their own applications and admissions criteria which typically focus on the research potential of doctoral candidates [EUA Survey, Figure 16]. The admission procedure is typically comprised of an interview (applicable to all or most doctoral programs for 73% universities participated in the EUA Survey), applicants must typically submit their research proposals and/or present research ideas (required by 64% and 52% universities for all or majority of doctoral programs, respectively). Roughly half of the universities organize some type of entrance tests/exams for at least some of their doctoral programmes.

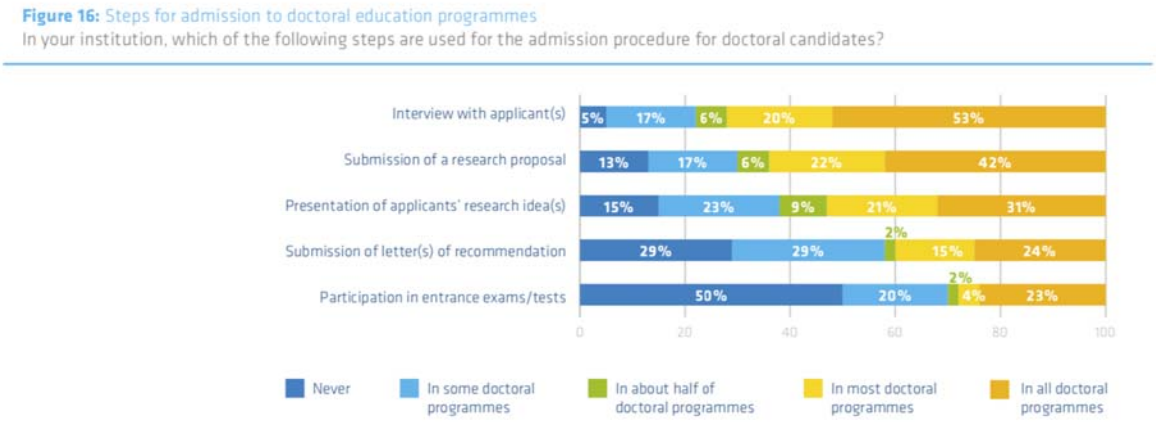

Figure 16 as published in [EUA Survey 2019, p. 25], see footnote 1 for the reference.

The EUA Survey [EUA Survey, Table 1] shows that selection of candidate(s) is primarily made on the level of sub-institutional units (92% of all institutions) and highly depends on supervisor`s point of view (57%).

Also the structure of the selection procedure is highly influenced by sub-institutional units (84%), with a higher role of the institution (47%); surprisingly, supervisors can decide on elements of the selection procedure (as submission of research proposal, interviews required) to relatively great extent (46%).

Table 1: Decision making procedures
Who participates in the decision-making process regarding the following issues? You can choose multiple answers per issue

	National level	Institutional level	Institutional sub-units	Supervisor
Elements of the selection procedure (e.g. submission of research proposal, interviews required)	16,2%	46,9%	84,1%	45,8%
The selection of the candidate(s)	5,0%	16,5%	91,7%	56,8%
Contract conditions between doctoral candidate and supervisor/organisational unit	21,9%	66,0%	60,0%	27,5%
Supervision rules and guidelines (e.g. regarding meetings, reporting, feedback)	12,3%	58,7%	77,9%	42,8%
Required topics of doctoral training	11,6%	37,8%	86,2%	52,0%
Required tasks of doctoral candidates (e.g. teaching, administration, etc.)	14,0%	39,9%	86,3%	50,9%
Examination rules and guidelines	32,8%	69,7%	69,0%	15,7%

Table 1 as published in [EUA Survey 2019, p. 27], see footnote 1 for the reference.

Case example – Czech Republic

Admission

Czech universities provide doctoral programs in Czech or in English (programs in other languages are very rare). Applicants interested in the English programs have to typically prove their English language proficiency (standardized tests as e.g. TOEFL, IELTS or Cambridge ESOL tests; this requirement is usually waived for applicants from universities from English speaking countries with English as the language of instruction).

Each doctoral applicant submits either a short project proposal prepared together with a potential supervisor or a more detailed proposal prepared on their own (a prior approval of a potential supervisor is highly recommended as well). One or two letters of recommendation are also required. Further, necessary abilities for research are tested in most programs - the admissions are reviewed by faculties (in cooperation with subject area boards, which are responsible for doctoral programs as mentioned above), entrance exam (possibly via Skype for foreign students) with short project presentation typically forms an integral part of the admission process.

All applicants must acquire a Master's degree before they are accepted to a PhD program and allowed to enroll (a Master's degree is not required for application).

Supervisor

According to the Czech law and accreditation standards, each professor or associate professor can supervise doctoral students; other (academic) researchers must be approved as a supervisor by the scientific board of the university (at some universities/faculties, each pair of a student / non-professor supervisor must be approved individually by the faculty scientific board). Members of the Czech Academy of Sciences or other external experts can also supervise doctoral candidates if approved by a faculty/university.

Australia

It is generally accepted that the two points where quality assurance has the most impact on doctoral education at the institutional level in Australia are admission, where the quality of the candidate is of fundamental importance, and completion where strict adherence to process helps assure quality.

Most Australian institutions have minimal entry standards, and these will include undergraduate or postgraduate qualifications achieved at a high level. In Australian terms, this is often between a B+ to A average. Some consideration will be made for research experience demonstrated through publications or relevant professional experience. Applicants will generally be classed as "domestic" or "international" as the funding arrangements for these two classes of students differ. There is no national requirement for master's qualification for admission into the Australian doctorate though having completed a master's qualification with a significant research component, especially with publications, is frequently viewed as a positive input signal. The quality of the previous institution will typically be considered, and the ranking of applicants can, in additional to grades, include whether prizes were won, letters of recommendation and where an applicant finished within their cohort. There will likely be differences in entry requirements between, and within, institutions e.g. writing samples are required for many Humanities, Arts and Social Sciences (HASS) disciplines, and access to Fine Art Programs may be based on a folio. In the STEM-M[1i] Virtually all Australian doctoral programs are delivered in English and if the applicant cannot demonstrate that their previous qualifications were taught and examined in English, international applicants will usually be asked to sit a language test. The two most common tests are TOEFL and IELTS and scores of >85 and 6.5 (overall) would be expected. The HASS[2] disciplines can require higher language test scores. Very rarely, doctoral programs may use the GMAT or GRE scores in selecting applicants.
The admission to doctoral education in Australia will usually require the prospective identification of a dissertation Supervisor, i.e. before the candidate commences. This is because the funded training period for a doctorate is truncated and fixed to 3-4 years and there is no requirement for coursework in many discipline areas. Candidates commence research from the day of entry into the Program. At least two Supervisors are appointed, a Primary Supervisor, and a Co-Supervisor(s). Supervisors are usually required to hold a qualification equal to, or higher than, that sought by the candidate, have employment tenure at least as long as a typical candidature (i.e. 3-4 years), and have typically co-supervised a successful candidate, prior to being appointed as a Primary Supervisor. Supervisors are usually required to keep within Supervisory load limits and Supervision is seen as a normal 'obligation' of faculty appointed into tenured positions, or long dated employment contracts.

In short, quality assurance of the inputs includes assessment of the applicant and compliance with minimal academic standards, Supervisor training and registration, and assessment of the research environment. The universities can increase or decrease the size of various disciplines by strategic allocation of resources, and the funding for research training that is received is both retrospective and binary. No support is received for students who fail to complete their research qualifications.

3.0 THROUGHPUTS

Australia

Research training candidatures are usually 'actively managed' in Australia. The enrollment is registered, the Supervisors are appointed, and candidature may be probationary until the end of the first year when a review process, known as Confirmation, occurs. Candidates on entry into the institution agree to abide by the various University Policies that relate to all aspects of candidature from academic integrity, to IP to record management, and appropriate workplace behaviors. The admission document in many cases is a formal contract that also asks the institutions to make warrants regarding access to Supervision and research infrastructure. While not providing quality assurance, the admission documentation process provides the legal foundation from which subsequent decisions can be taken.

The Confirmation process is institution- and discipline-specific but usually requires some form of public or private presentation of the research question, the research conducted to-date and any outcomes. The purpose of the Confirmation process is to provide the institution with a level of quality assurance over the research problem and candidate. Ideally, the process will assure the University that the infrastructure necessary to answer the question is available and that the Supervisory 'team' has the experience and expertise sufficient to support the answering of the research question(s).

The degree to which this Confirmation process is independent of the Supervisors is institution and discipline-dependent. Some institutions use a candidature oversight committee, which may have an independent chair, the Supervisors and other members with additional skills, to make this decision. Terminating of candidature through the Confirmation process is an expected outcome for a minority of candidates; in such circumstances it is often a failure of due diligence of the Inputs prior to enrolment, and the subsequent fit of candidate and Supervisor. The quality assurance brought through the Confirmation process will depend on a number of factors – the willingness of all to engage in a thoughtful and honest conversation and the readiness of Supervisors and candidates to take advice, and the process can be subverted by power imbalances between committee chairs and senior Supervisors. Active candidature management does not end at Confirmation and, assuming that the candidate is confirmed into their doctoral qualification, there will be a requirement for at least annual reporting. International candidates are required to report more frequently under the ESOS Act. The annual report is an opportunity for the candidate to impress the assembled committee as to their progress, for the committee to provide assistance with additional resources, for the candidate to report on additional training needs (e.g. writing skills) and their responses to any deficits they or the committee identify. The sanctions available to committees responsible for monitoring performance can include placing the candidate under closer scrutiny through setting specific tasks, through to recommendations for candidature termination. The latter will usually require formal action from a senior academic officer, like a Dean.

Candidatures are managed through web-based university student record systems though the complexity of the research training environment means that many of the available systems, which are often designed for coursework students, are sub-optimal and require the development of bespoke sub-systems or off-system records. Because government reporting requirements vary between countries, and local/institutional rules can be quite different (e.g. requirements for coded (national Field of Research and Field of Education codes) discipline enrolments, completions, consumed candidature), this is not an issue that will be readily addressed by international software suppliers.

The mid-term of candidature often coincides with the development of mental health issues in candidates – the so-called "2nd year blues". The candidate can become despondent that the research is not generating their expected outcomes, that the end of funding is approaching too rapidly, and/or that the next steps in career planning need to be addressed. Many universities are developing programs to help candidates and Supervisors recognize and respond to these issues, which are surprisingly common and can be seen through disengagement e.g. poor attendance, through changed hours and behaviors. Access to a student peer group can be very important at this time for candidates, where experiences can be shared and social contact provided to support the student. It can be a greater problem for HASS students whose research programs can be isolating and very individualistic, rather than the laboratory experience enjoyed by many STEM-M students.

Part of the quality assurance brought through *active candidature management* is somewhat passive and is provided through the "paperwork" required of every candidate and Supervisor I at least an annual process. The forms that inevitably must be completed, where they are skillfully constructed, can provide a touchpoint for self-reflection on skills development, exit strategies and general acquisition of the 'doctoral attributes' – areas such as independent research planning, execution and reporting.
As candidates near the end of candidature, quality assurance focuses on Outputs. The examination and publications, the latter the currency of the academy. As the candidate nears completion, is often an opportunity for the committee overseeing the candidature for a final meeting and to work through a publication strategy, and to ask questions about career plans. There will be opportunities for the candidate to seek career planning advice from the members of the committee, who may also act as referees. In most Australian Universities, central career advice is usually limited.

China

While it is gratifying that the quality of doctoral education in China has increased, Professor Zhou Guangli of Huazhong University of Science and Technology pointed out in the "China Doctoral Quality Survey" that the quality of doctoral training in China has not progressed significantly in the past ten years, and there may even be downward trends, with increasing numbers. Quality may be increased by accelerating the reform of the training model, where Universities examine all aspects of the process: students, teachers, research funds, equipment and facilities, training systems and technical norms. The quality of doctoral education could be monitored using instruments like assessment of student quality, courses, academic training, research topic, essay writing, essay defense and other aspects that are controlled throughout the process. Taken together, resource conditions, training systems and technical norms, and process control are the three core factors directly related to the quality of doctoral education.

From a training perspective, and although many universities in China have begun to explore using Advisory Committees with more than one Advisor advisors, most universities still use a single supervisor to guide doctoral students. It generally requires three to four years for doctoral students in China to obtain a degree. Politics and foreign languages are amongst the compulsory courses. Other disciplinary classes are determined by the doctoral supervisor and depend on the specific circumstances of the student. Generally, the coursework component is determined by the needs of the student and the research project. In cultivating doctoral students, participating in research is deemed an integral part of

doctoral training. In the first year of enrollment, and under the guidance of the supervisor, students will gradually assume responsibility for their research direction, though some students will undertake part of their research on the supervisor's research topics. The research topics are mostly consistent with the dissertation, and some subjects are selected for scientific research needs. Ethical committee assesses research proposal and data collection methods for doctoral students.

European perspectives

The EUA survey 2019 of 311 universities (covering 21% of doctoral awarding institutions and 40% of doctoral candidates) gives also great insights on how doctoral education is structured. We highly recommend taking a closer look into the report for details.

62% of the universities reported to a great extent or always that “doctoral education is managed through an organisational unit doctoral school, which oversees the development of programmes, ensures quality, develops regulations and guidelines, etc” [EUA Survey 2019, Figure 2].

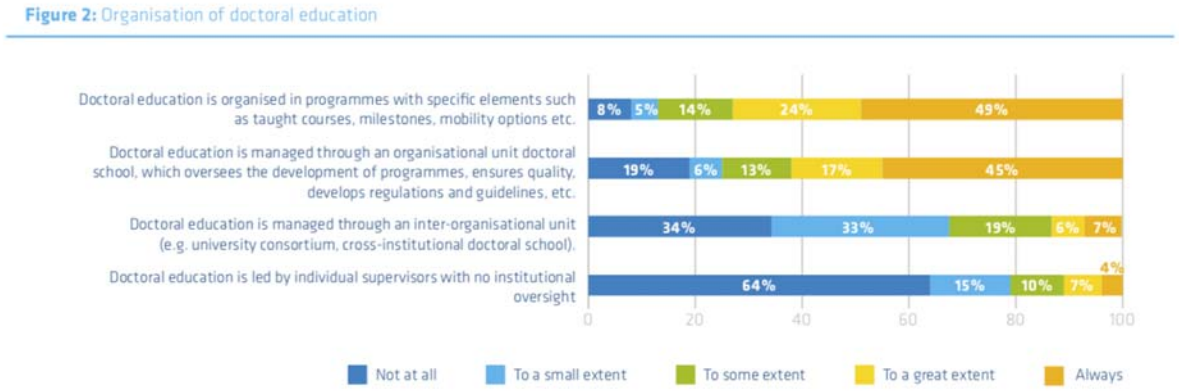

Figure 2 as published in [EUA Survey 2019, p. 13], see footnote 1 for the reference.

However, universities report that doctoral education is more likely organized around a disciplinary than a faculty level (64% vs. 52%; Figure 3, p. 13). 85% percent of the universities reported that at least half of the programs/schools define required courses [EUA Survey 2019, Figure 4]. The training mainly focuses on specific research competencies (75% extremely important) than teaching (11% extremely important) or management/leadership (6% extremely important) [EUA Survey 2019, Figure 5].

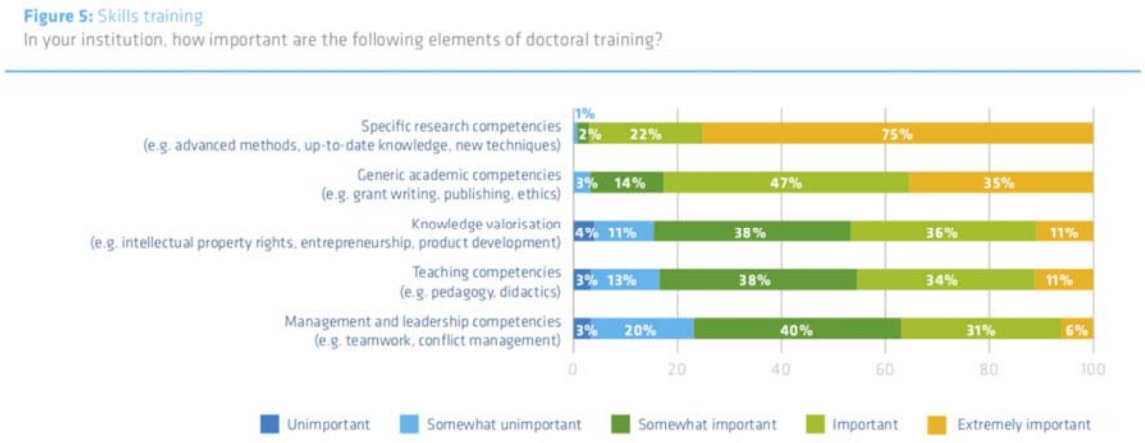

Figure 5 as published in [EUA Survey 2019, p. 15], see footnote 1 for the reference.

Case example - Germany

At universities, initiated by Excellence-Initiative 2006, more and more graduate schools and structured doctoral programs were established. While every university now has a graduate school that provides courses and services, only a small fraction does their dissertation in structured programs (circa 20%, see p. 147).[12] Originally, the German Research Foundations (DFG; national research council) expected that the Excellence Graduate Schools initiated in 2006 will be the spark for structured programs as the new standard. However, the limited governance of German universities due to powerful professorships (freedom of research and teaching) allows every discipline to keep their own dissertation regulations. This is usually facilitated via the faculties within the universities.

Interestingly, the non-university doctoral researcher networks established their own quality assessment of doctoral education by running large surveys. For instance, the 2018 Max Planck PhDnet had more than 2,500 participants which is a participation rate of 50%.[13] The surveys include questions about mental health, supervision, training offers and access to graduate schools. In the non-university research organizations most of the doctoral researchers have access to a graduate school (e.g., 72%, N = 1,399, Helmholtz Juniors Survey 2017, p. 41).[14] Furthermore, 65% of doctoral researchers in the Leibniz PhD Network Survey 2017 answered to have a supervision agreement (N = 991, p. 47).[15] Furthermore, the Max Planck PhDnet published a position paper on power abuse and conflict resolution in 2018 to claim for mandatory thesis advisory committees and the separation of payment and supervision to break up structural dependencies.[16]

[12] https://www.buwin.de/dateien/buwin-2017.pdf
[13] https://www.phdnet.mpg.de/61974/2018_PhDnet_Report.pdf
[14] https://www.helmholtz.de/fileadmin/user_upload/HeJu_survey_2017_results_report.pdf
[15] https://www.ssoar.info/ssoar/bitstream/handle/document/61363/ssoar-2019-arcudi_et_al-Doctoral_Researchers_in_the_Leibniz.pdf?sequence=1&isAllowed=y&lnkname=ssoar-2019-arcudi_et_al-Doctoral_Researchers_in_the_Leibniz.pdf
[16] https://www.phdnet.mpg.de/news/2018/power-abuse-statement?c=3839

The “Wissenschaftsrat” (independent consulting agency for the national government) published in 2011 requirements for the quality assessment of the doctoral degree. Most of the recommendations are not yet widely established, e.g. supervisors should not grade the dissertation.[17] However, there a driving forces like the Technical University of Munich which implemented a comprehensive quality management for their doctoral education.[18] Their quality measures include mentors, supervision agreement, good scientific practice, etc.[19] but also organizational processes like internal and external evaluation as well as personnel development.[20] Since each faculty decides independently about dissertation regulations, a top-down reform possibility would be to change the higher education laws in each federal state. However, there are also 16 federal states.

One recent push on the national level for internationalization and quality are the Max Planck Schools that connect universities and non-university research organizations on a national level. They have in common that they start with an orienting phase as Master’s program or lab rotation and are fully funded for 4 years, e.g. Max Planck School of Cognition.[21]

USA

Doctoral programs in the United States are structured. They all have some set of courses that are required of all students in the program plus elective courses that are selected by the student in consultation with his/her faculty advisor and, in some cases, with input from the dissertation committee. Most have a comprehensive exam, either oral or written, or a comprehensive portfolio that measures the student’s mastery of the core material in the program and readiness to move on to the research stage of the program. These exams or portfolios are usually completed within the first 2 years of the program. The next stage is the dissertation proposal that comes after completing some research. Most often this will consist of both a written document and an oral defense. The dissertation proposal is evaluated by a faculty committee that will often become the final dissertation committee. For some disciplines this proposal stages comes very early. For others, the student will be close to completing the dissertation before doing a formal proposal. The final stage is the dissertation and its defense. The dissertation is typically a book length document with multiple chapters that include an explanation of the unique contributions by the candidate. In most cases the defense includes a presentation that is open to the public and a closed session with the dissertation committee. Most universities require dissertation committee members to undergo some level of review to determine that they are qualified to teach and mentor graduate students. This is referred to as “graduate faculty” membership. At some universities there are additional requirements for a faculty member to chair a dissertation committee, such as first serving on another committee all the way through to completion so that they have knowledge and experience of the process.

[17] https://www.wissenschaftsrat.de/download/archiv/1704-11.pdf?__blob=publicationFile&v=5
[18] https://www.gs.tum.de/en/tum-graduate-school/quality-management/
[19] https://www.gs.tum.de/en/tum-graduate-school/quality-management/quality-assurance-during-the-doctorate/
[20] https://www.gs.tum.de/en/tum-graduate-school/quality-management/organizational-processes-at-tum-graduate-school/
[21] https://www.maxplanckschools.de/en/schools/cognition/program

The CGS PhD Completion Project and other national initiatives have focused attention on these program milestones, including keeping track of student progression and providing support for students to meet program milestones in a timely manner. One quote from a faculty member at a participating university that demonstrates the importance of this monitoring is that "every student I can think of who started our program has completed the program." When given a list of students who had started but not completed, he was dismayed that he never knew those students were in his program. So it was true that every student he "knew" had graduated and those who didn't never connected with a faculty mentor. Conducting formal annual reviews with each student in the program plus monitoring time to each milestone by the Graduate School, can have significant positive input on student retention, success and graduation.

Doctoral education in the US hasn't changed much over the past decades. The changes that have happened are relatively minor when looked at in the bigger picture but may have had profound impact on individual students. For example, some programs are moving away from the comprehensive exams that usually come near the end of the coursework phase. Traditionally there has been an exam that was intended to measure mastery of core course concepts. When done well, the exams can integrate concepts across the courses and ask the student to demonstrate a higher-level understanding required to integrate material across the courses. However too often the exams are comprised of questions created by faculty in isolation and are based on individual courses. These are often viewed as a second "final exam" for the courses. If someone did well in the courses they would also do well on the exams. Therefore, the exams really weren't providing new measures beyond what was already known from the course work. Some graduate programs have adopted more holistic portfolios that include performance in courses and early research with at least one faculty member. This has three important positive outcomes:

1. It gets students connected with a faculty research mentor earlier in the degree program. Research has shown that this is key to retention and success. Students who are not "known" to the faculty can sometimes exit the program without anyone noticing.
2. Some students who do very well in the coursework phase can struggle when they start to do research. Getting started in research early and getting feedback and evaluation on performance is more likely to lead to identifying difficulties early and having a smoother transition to the dissertation phase.
3. Students, particularly part-time students, do not spend excess time reviewing for an exam that may or may not improve their performance as a doctoral student.

4.0 OUTPUTS

USA – Outputs, Outcomes and Impacts

Outputs

In the United States there are well-established statistics that are reported by all bachelor's degree programs that can be compared across universities. These include number of graduates after 4 years or 6 years (or longer), time to degree, student satisfaction/engagement and demographic information that

allows comparison along these metrics by gender, race/ethnicity, age, and family income (on a basic level). Data reported at the post-graduate level groups together master's degrees, research doctorates and professional doctorates so it is difficult to use in a meaningful way. The CGS PhD Completion Project attempted to set some standards for measuring time to degree and to encourage universities to make the data public. The National Academies of Science, Engineering and Medicine conducted a multi-year data collection effort to produce the 2010 report, "A Data-Based Assessment of Research-Doctorate Programs in the United States" (http://sites.nationalacademies.org/PGA/Resdoc/). They selected the weightings of various categories of data based on a survey of what graduate faculty viewed as most important in assessing the quality of a doctoral program. While many found it useful, there was not agreement that the methods used were the best approach moving forward, and it is likely that this approach will not be used in future. The Association of American Universities (https://www.aau.edu/) is a group of the US universities that produce the most PhD students. They are working on a common data set that all member universities will use to report enrollment and graduation data. The Coalition for Next Generation Life Science (http://nglscoalition.org/) is a group of universities that have agreed to report data for PhD students and graduates as well as postdocs in the life sciences disciplines.

A recent and evolving change is that more graduate programs are adopting student learning outcomes (SLOs) that explain what they expect their graduates to know or be able to do. This has been common at the undergraduate level and is driven by external accrediting agencies. Now some of the accrediting agencies are starting to require student learning outcomes at the graduate level. Developing SLOs can have a positive impact on the quality of programs by focusing on what is expected at each stage of the process (https://cgsnet.org/publication-pdf/4923/ArticulatingLearningOutcomesinDoctoralEducationWeb.pdf). These SLOs must be measured and used to feed back into the program to make further improvements. Specific questions on a comprehensive exam can measure SLOs that are based on mastery of core knowledge. A survey at the time of the student defense can measure SLOs for the whole program. Attached is an example of the types of questions that can be posed on a survey of how well the student has met the learning outcomes.

Outcomes

Historically it was assumed that most PhD recipients were preparing for careers in academe. In fact, the National Academies report mentioned previously gave higher points for graduates who were in academic positions than for those who were working in other sectors such as companies, government research laboratories or non-profit organizations. The longitudinal data shows that in all broad fields except the humanities, the majority of PhD graduates are not pursuing careers in academe (*get reference*). The Council of Graduate Schools has been working with the graduate community to give more attention to the career pathways of our graduates. Their report "Understanding Career Pathways for Program Improvement" (https://cgsnet.org/understanding-phd-career-pathways-program-improvement-0) led to a current study that involves dozens of universities in a data collection effort and surveys of current students and alumni https://cgsnet.org/understanding-career-pathways.

Groups like the Coalition for Next Generation Life Science (http://nglscoalition.org/) want to have career data available for prospective students so that they can understand what types of careers they can expect from each degree program. The University of Michigan has been collecting and publishing these

data for more than a decade (https://tableau.dsc.umich.edu/t/UM-Public/views/RackhamDoctoralProgramStatistics/ProgramStatistics?:embed=y&:showAppBanner=false&:showShareOptions=true&:display_count=no&:showVizHome=no&FOSDParameter=All+Rackham)
The annual Survey of Earned Doctorates asks each graduating student about their career destinations. This information is tracked for a portion of PhD degree holders every few years throughout their careers. Some universities provide detailed data about their PhD graduates on their websites so that the public can see those career destinations. This is important information for those who are considering pursuing doctoral degrees. Many universities ask graduate programs to provide this information for periodic external reviews of program quality. Reviewers may be asked to evaluate the performance of the department based in part on the careers of their graduates

Two of the five regional organizations that accredit the US universities are now requiring student learning outcomes (SLOs) for graduate programs. It is likely that the others will start requiring them soon. In the beginning they were fairly lenient with the materials provided by universities in their self-studies and during the visits. Now they are requiring each program to have established SLOs and to demonstrate that they are measuring the SLOs and using them for program improvement. Several prominent universities have received negative findings for not having adequate SLOs and/or processes in place to measure and use the feedback. Ultimately this institutional accountability will become standard at the post-graduate level as it is at the bachelor's level.

Impacts

Fifteen years ago, many people in the US still assumed that most doctoral graduates pursued careers in academe. That was not true then for physical sciences and engineering and it is not true today for most disciplines. Many employers have found value in the education provided at the doctoral level. But since so many people who decide to pursue the PhD do so planning a career in academe, some have started to question whether the degree is worth pursuing given the number of years needed to complete the degree. Articles abound in newspapers, magazines and blogs aimed at both higher ed and general audiences. They quote the low number of graduates in academic careers but often do not go beyond that to discuss the satisfying careers that people have. Sometimes they will mention that those with PhD degrees have had the lowest level of unemployment, even during the great recession that started a decade ago.

Many employers outside of academe need to have people who can circulate in and around the world of academic researchers to understand and extend the basic research to the applied research and advanced development needed by the employers. This is needed by large and small companies and organizations to be competitive and on the cutting edge of new technologies and ideas. Some companies and organizations like to be near a university to have access to the faculty and student talent. Others have realized the benefit of having PhD level researchers in their own companies to focus specifically on the needs of the employer. As a result, many universities have developed research parks or incubator centers that allow companies to interact with university faculty and students. Regions of innovation tend to be located near universities, one of the most famous being Silicon Valley. When Amazon.com was looking for a location for its second headquarters, the quality of area universities was high on the list of characteristics they were considering. Each government agency that makes grants must also set aside funding for Small Business Innovation Research (SBIR) grants. Often these will go to

companies that have researchers with PhDs or partnerships with universities. There are also several grant initiatives to develop closer collaborations between companies and universities.

China

Assessment of the doctoral journey in China generally requires that students need to 1) complete compulsory courses, 2) pass the comprehensive qualified examination, 3) pass their thesis proposal defense, 4) pass thesis pre-examination, and 5) the final defense to obtain a doctoral degree. In the finial defense step, doctoral students usually need to give a presentation to an examination panel, that will include two to three external examiners, the supervisor, and a chair. In most cases, external examiners have reviewed the dissertation before the final defense. The review process is also double blinded.

At the same time, most institutions require students to publish several publications at a specified journal level as a necessary condition for applying for a doctoral degree; for instance, at least two academic publication in ranked journals as a compulsory requirement for graduation. However, the system has begun to change in some institutions. For example, in 2019, Tsinghua University issued a new standard, which eliminated the traditional requirement that doctoral students must publish in academic journals to graduate. The reform aims to reduce the pressure on doctoral students during their studies, and at the same time give doctoral students full freedom to conduct academic exploration rather than to meet the rigid requirements. Although the doctoral training and assessment have been subject to some level of systematic reform, there are still a series of problems that need to be improved.

Firstly, China's primary doctoral training model is a combination of a supervisor and curriculum system. After establishing the academic degree system in 1981, doctoral supervisors must be a “Professor” in terms of academic title, who may not hold PhD degrees, but who usually has practical experience in specific fields. Initially, the State Council Academic Degree Committee was responsible for assessing and nominating doctoral supervisors. From 2003, some universities (e.g. Peking University and Tsinghua University) reformed their doctoral supervisor structure. After this, some universities and research institutions that have been provided rights to award doctoral degrees and to assess and nominate supervisors. “Professors” and “Associate Professors” can act as supervisors. Today, if an academic department can host doctoral students, it can assess and nominate supervisors. Different from western systems, in China, professors and associate professors can supervise doctoral students whereas lecturers or assistant professors usually cannot be doctoral supervisors.

The current Chinese doctoral education system is mainly based on mentorship. The core of the system is that a single supervisor is responsible for the training of doctoral students. This single supervisor has primary responsibility for guiding doctoral students in academic activities, research methods and research norms, and instills the doctoral ideology and moral ethics. Although this supervisor-centric method has played an essential role in the doctoral education in China, there are many drawbacks, such as paying too much attention to the status of the supervisor and emphasizing the authority of the supervisor. There is still arguably too heavy an emphasis on theory, examinations, and the process tends to work against interdisciplinarity.

Secondly, the doctoral taught curriculum lacks depth in many universities. The proportion of practical courses is insufficient. Some of the courses are outdated, with little access to frontier technologies. Cross-school, cross-faculty, and cross-level courses are relatively rare. The coursework for doctoral students is limited to the school or the department. Although curriculum learning and scientific research training units have been emphasized in the doctoral training process, compared with some other countries, the structured doctoral training model is still not mature in China.

Improvements could be managed though paying increased attention to the integration of doctoral students' training and scientific research, the degree of standardization and institutionalization of doctoral students participating in scientific research, the quality assurance system for scientific research funding, increased recognition of the academic guidance responsibilities of the supervisor. Other areas requiring attention include the addition of co-supervisors and standardization of curriculum. Consideration should also be given to increasing the number and quality of courses and the degree of internationalization. At present, there are no standard requirements for the specific amount of course study required.

Finally, the increase in scale in Chinese Universities has brought some challenges. With the continuous expansion of enrollments, colleges and universities have experienced an overall shortage of teachers, which is more problematic within smaller universities. The ability of doctoral supervisors away from major centers in some disciplines needs to be improved but there are concerns around critical mass and research infrastructure in these smaller institutions. The problem may not be solved by the injection of younger supervisors who may add vitality but who lack experience, especially classroom teaching experience and the teaching and training of doctoral supervisors, especially the younger generation, should be strengthened.

Another important strategy to enhance the quality assurance is the doctoral dissertation and master thesis sampling (re)check mechanism. Each year, state council academic degrees office will organize a national level assessment. The examination of the dissertation is conducted once a year with a random inspection of the doctoral and master's thesis awarded in the previous academic year. The sampling rate of the doctoral dissertation is about 10%, and the sampling rate of the master's thesis is about 5%. Each of the selected dissertations is sent to three peer experts for review, and the experts commented on the papers according to the requirements of different degree types. The expert review reports are fed back to the degree-granting unit for evaluation. If a university has been found that it has problematic doctoral or master works within two consecutive years, department of education will assess the doctoral awarding rights, which means that the university may lose the doctoral point. In this case, the university and department need to make certain changes and enhance the quality of doctoral education. Meanwhile, this assessment will also influence the evaluation of potential research funding application and supervisors' qualifications. Finally, no university or individual can interfere with the reasonable conduct of sampling inspection in any way. Experts involved in the evaluation work should be fair and impartial, and the evaluation work should be completed independently and objectively.

There has been a long-standing argument over the quality and scale of doctoral education in China. At present, there is no conclusion. As mentioned above, the quality of doctoral education is influenced by various aspects. To enhance the quality, government and universities still need to develop new strategies in the development of doctoral education. The balance between supply and demand here not

only refers to the balance of quantity but also means the improvement of quality. Specifically, it is important to enhance the quality of professional degrees in terms of the demand and requirement of society and market. For research doctoral education, it is essential to enhance the creativity and originality rather than heavily focus on publications. At the same time, according to the different value orientations of doctoral training, universities should establish new standards and new models for the evaluation of doctoral education quality, and further improve and implement the evaluation system for doctoral education.

Australia

The primary output from Australian doctoral education processes is the dissertation, usually described as a thesis. The thesis is typically 60,000-100,000 words though this varies with discipline norms. Mathematics dissertations may be much shorter whereas many HASS theses will be nearer the upper word limit. The candidate must assert to the institution that the dissertation is their own work and most universities either use plagiarism testing software, or reserve the right to use such software, as a test of the candidate's integrity. In some institutions, candidates can submit a dissertation without signoff from the Supervisor. Usually however, the primary Supervisor is required to sign off on the dissertation as an original work that meets the standard for the qualification for which the thesis is offered.

Australia has evolved a means of testing the quality of the dissertation, that is different from many other countries. It was argued when the original PhDs were submitted to Australian universities in the 1940s and 1950s that the thesis examination would be external and independent. The physical "tyranny of distance" between Australia and other countries where the Humboldt traditions of the modern PhD were well entrenched meant that, for reasons of quality assurance, Australian PhDs were, and are, examined externally to the enrolling institution. In Australia this can mean one or two international examiners read the dissertation as they would a monograph or large paper, and make comments that are sent back to the examination board. The composition of the board, the selection process for examiners, the rules regarding examiners from the same state or city, and what constitutes a conflict of interest are decisions taken by individual institutions as elements of quality assurance. The overarching concept though is that the examiner should have no academic or personal relationship with the candidate, nor be a future employer, and should assess the thesis as an unbiased 'peer'. As a consequence, doctorate examiners are usually selected from external academics, often from overseas, who have at least the same qualification, and experience in supervising doctoral candidates.
The university can request multiple examiners be nominated and make the final choice, but the candidate is often blinded to the decisions taken concerning examiners, which will largely be made by the primary Supervisor, with the approval of the Chair of Examiners, usually the Head of Department or School.

The thesis is sent to examiners with an understanding that they will return the comments within 4-6 weeks. The responses are usually vetted by the Chair of Examiners and Supervisor, before being passed on to the candidate. The candidate can be asked to make amendments, or to less commonly re-write the dissertation. Even more rarely, the examination deem that the thesis fail outright.
Where is the oral examination in this atypical examination process? Up until recently, very few oral exams (using a *viva voce*) were conducted as part of the examination of the doctorate in Australia. Increasingly, Australian universities are using creative technical solutions to overcome the problems created by the necessity to travel to Australia to meet with the candidate. These solutions for virtual

oral exams allow the Australian universities to maintain the core elements of the Australian doctoral examination – independent and external.

There is no central requirement to publish as a component of the doctoral examination in Australia though there are provisions for examination of published works through a Thesis With Publications, or Thesis By Publication, at many Australian universities. The rise of "vanity" publishers where authors pay for the full publication costs in for-profit journals of dubious quality has created issues around quality of publications when they are used in this regard, and the strict use of Impact Factors and other metrics to determine publication quality are fraught.

The other output that can quality assure the research training process is an assessment of the level to which the doctoral education process prepares the candidate for employment. Australia like most other countries, New Zealand aside, has a poor tracking capability for doctoral graduates. While the periodic national census determines whether doctoral qualification have been obtained, there is no capacity to interrogate the census database to determine whether the doctoral qualification was fit for (employment) purpose. Some Australian Universities have joined the US Council of Graduate Schools study (Closing Gaps in our Knowledge of PhD Career Pathways) to attempt to answer this question but definitive results will not be available for several years. The experience with tracking activities conducted to-date suggests that those students who land in the academy are generally served well, those in industry sometimes slightly less well, and the candidates who are not trackable, are possibly the group served least well by the research training experience, as the views of these individuals are not readily accessible, especially if they are not part of the paid workforce and do not use portals such as LinkedIn.

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[i] Science (including Chemistry, Physics, Biology), Technology, Engineering, Mathematics and Medicine

[ii] Humanities, Arts, Social Sciences (including Law, Education, Architecture/Design, Fine Art, Music)

European perspectives

Time to Completion

The EUA survey 2019 (covering 311 European institutions) shows that a majority of doctoral candidates (65%) on average take between 3.5 and 4.5 years to complete their full-time doctoral studies [EUA Survey 2019, Figure 12]; rather strong tendency to decrease the average time of completion (43%) or at least to keep it (42%) can be seen [EUA Survey 2019, Figure 13, p. 22].

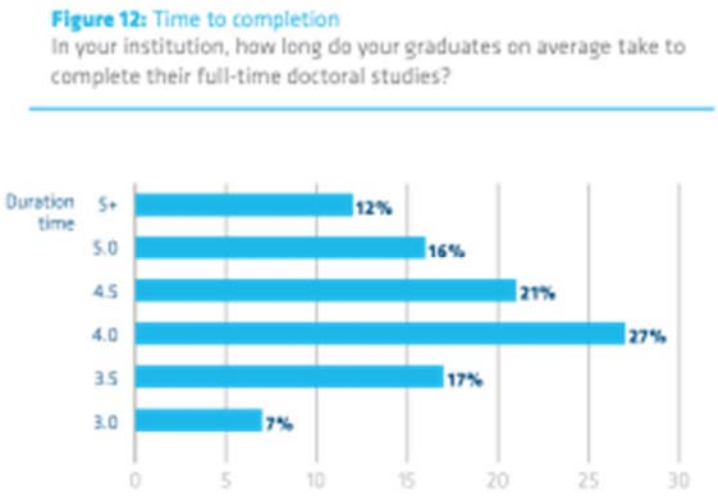

Figure 12 as published in [EUA Survey 2019, p. 22], see footnote 1 for the reference.

Completion Rate

The universities involved in the EUA Survey reported that two thirds of their doctoral candidates manage to complete their doctoral dissertation within six years, albeit with significant differences between the different countries [EUA Survey 2019, Figure 18, p. 28]. The completion rate is rather stable within last decade (half of the surveyed universities); however, more than twice as many universities reports an increasing time (35%) as those reporting decreasing time (16%) [EUA Survey 2019, Figure 19, p. 28].

Career Development

[EUA Survey 2019, p. 17]: “Asked to what extent doctoral candidates are prepared for a variety of career paths, 78% of responding universities replied that doctoral education is “always” or “to a great extent” preparing the future generation of academics/scholars (cf. Figure 7). Importantly, career paths outside of academia are also taken into consideration, with 53% underlining the importance of preparing highskilled knowledge workers, and 52% preparing for research positions outside academia. Preparing the future generation of leaders/managers is noticeably lower on the radar, although 29% of higher education institutions still report that they “always” or “to a great extent” prepare doctoral candidates for this type of role.”

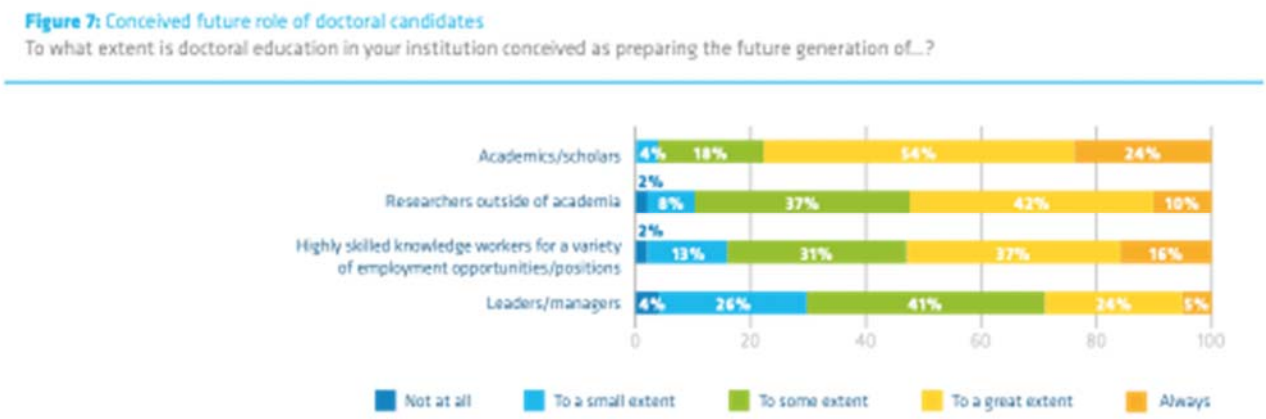

Figure 7 as published in [EUA Survey 2019, p. 17], see footnote 1 for the reference.

The EUA Survey reveals that almost all higher education institutions allow their doctoral candidates to continue their academic career at the same institution after completing their doctoral studies (94%). No institution indicated that this is not possible due to national law [EUA Survey 2019, Figure 8, p. 18].

The institutions also reported that almost half of them (45%) track the career paths of their doctorate holders for all or most doctoral programmes, 29% for some doctoral programmes. 26% of the surveyed institutions do not track their successful doctoral candidates at all [EUA Survey 2019, Figure 9, p. 19].

Summary and Conclusions

We have witnessed an increase in enrolment, degrees granted and disciplinary breadth in doctoral research programs across most countries. With this expansion there has been a corresponding need for more formal quality assurance processes and measures. In this section we have provided a snapshot from the China, Europe Australia, and the U.S. The differences in types of doctorates and student experiences within individual universities and across universities makes comparison of individual candidates very difficult. Nevertheless, candidate selection, supervision, systematic candidature monitoring, and examinations are the obvious points where quality can be assessed. The examples shared in this section should provide a starting point for additional discussion on what is most effective, as the processes used for these elements can lend themselves to quality assessment. Most importantly, any interventions must be careful to preserve the essential nature of the research doctorate—supervised, original research and the important relationship between candidate and advisor/supervisor, and **not** make doctoral education (another) highly managed training endeavour.

Appendices

Appendix 1 Data

Table 1: Doctoral Recipients by Available Countries 2005 and 2017

from the Workshop Country Survey

Information from F+F 2019 workshop participants' country survey 2019

Please note: when information was not available for the years 2005 and 2007, we used the next available years.

Country	Year	No. of doctoral degree recipients	Year	No. of doctoral degree recipients	%Growth/decrease
Australia	2005	5,245	2017	9041	72%
Bulgaria	2005	5,079	2017	6,738	33%
Canada	2005	5,600	2013	7,059	26%
Chile	2004	232	2017	725	213%
China	2005	27,677	2016	59,649	116%
Czech Republic	2005	1,968	2017	2,388	21%
Germany	2004	23,100	2017	28,404	23%
Japan	2005	17,396	2014	15,024	- 14%
Malaysia	2009	750	2017	4,556	507%
Mexico	2010	3,033	2017	6,970	130%
Netherlands	2005	3,000	2016	4,900	63%
New Zealand	2010	1,170	2017	1,500	28%
Russia	2005	10,650	2017	2,320	- 78%
Slovenia	2005	369	2017	514	39%
South Africa	2005	1,189	2017	3,057	157%
UK	2007	19,470	2017	28,455	46%
USA	2005	43,385	2017	54,664	26%

Appendix 2: PhD Forms – Some country details

Australia: PhD is 100% research-based; professional doctorate is more structured (with the addition of course-work).

Bulgaria: The predominant model of doctorate education is structured (with courses and thesis).

Canada: PhD is a structured study with courses and thesis; disciplinary differences (social science and humanities programs tend to have significant coursework requirements, and the sciences have many fewer, if any). There is a growing conversation about the purpose, structure, and content of the dissertation.

Hong Kong: PhD is in transition from a British-based mentor model with no coursework requirement to a more US-based model with some coursework during the first year.

Japan: Most degrees are PhD and, since 2003, J.D. as a professional degree is newly established.

Malaysia: All universities award doctorate degrees such as PhD (100% research), industrial as well as professional doctorates offered in a mixed-mode programme such as DBA and EdD.

Mexico: At least 60% of new doctoral students are enrolling in face to face programs; there is a main doctoral adviser, but students are typically taking classes from other professors. Once they are done with coursework requirements, they can start their dissertation work under the guidance of a doctoral committee. The structure of the program is determined by the federal higher education standard, universal for all universities and research institutes and all fields of research. Approximately 1/3 of coursework are foreign language courses (e.g. academic writing), courses on the history and philosophy of science, techniques and methods of teaching. Another 2/3 of coursework are field courses.

Netherlands: PhD, PDEng (in technical universities) and MD/PhD (in medical schools), PhDArts (Leiden).

New Zealand: PhD is 100% research-based and is overwhelmingly the most common doctorate but there is a proliferation of professional and named doctorates, including those in education, health, medicine, clinical psychology, clinical dentistry, midwifery, nursing, social work, business, music, musical arts, and fine arts.

Russia: The curriculum of the doctoral program consists of 180 ECTS for 3-year programs and 240 ECTS for 4-year programs (including 30 ECTS of coursework with compulsory attendance at lectures or seminars and interim assessment, with the remaining 141 ECTS, for 4-years program 201 ECTS, include research related activities and teaching).

Slovenia: PhD and Doctorate in Art.

South Africa: Has both the traditional PhD, and a professional doctorate (but latter not common).

Turkey: Offers PhD and Doctorate in Art. PhDs typically follow a very structured process (several courses, seminars and exams to a total of 240 ECTS credits); a preparatory class at the beginning of programme; doctorate courses are offered for the first two years; the proficiency exam as a condition for continuing the doctorate studies; assessments every six months by a follow-up committee; a public thesis defence.

UK: Research doctorate, a Professional doctorate with a shorter thesis aimed at mid-career professionals who want their research studies to reflect on their professional practice, a Doctorate by Publication (a doctorate by prior publication or a doctorate by concurrent publication), an Arts and Humanities Practice Doctorate, and an Integrated Doctorate. The first year of full-time study in the PhD (or first two years of part-time study) generally includes research methods training (which may involve taking taught Master's degree modules) as well as some generic skills training.

US: PhD; The Majority of the Doctorates are PhDs. The professional Medical Doctorate (MD) and the Law (jurisprudence) Doctorate (JD) existed early on the history of the doctorates in the beginning of the doctoral degrees, joined by the doctorate in business, and education.. New professional doctorates are developed primarily in the health-related fields.

Appendix 3: PhD Structures – Some country details

Australia and New Zealand: In principle, two or more supervisors are required; in practice, there are many differences. Many universities have central graduate schools, some of whom advocate for and provide services to doctoral candidates across the university, professional development and training to both supervisors and candidates. Smaller regional universities, where doctoral candidate numbers are lower, may only have a Dean of Graduate Studies rather than a formal graduate school.

Bulgaria: At the University of Sofia, there are two training centers – for humanities and for natural sciences and humanities, which provide extra training (to the major field) – in project writing, gender issues, political science.

Canada: Almost all Canadian universities have a central Graduate School (for both master's and doctoral students, often for postdoctoral fellows as well); an increasing focus on graduate supervision, and most universities now have relevant professional development, resources, and recognition venues for faculty.

Hong Kong: PhD courses taught from both the graduate school and the specific school/faculty.

UK: At least two supervisors; Graduate or Doctoral Schools now purely focused on research students.

Appendix 4: National Concerns – Some country details

Australia: government officials and policy makers seeking to increase the role of industry in doctoral education policy and programs and focus funding on the STEM disciplines, rather than developing a more comprehensive strategy to enhance the funding of Australian universities, protect the industrial rights and full-time career trajectories of academics, value the work of Humanities and Social Science researchers and work in more innovative and collaborative ways with not-for-profit organisations and community groups and representatives for the good of a broader cross-section of the Australian community.

Bulgaria: New, competitive programs in ICT, culture, and arts.

Canada: CAGS advocating for more individual federal fellowships, more holistic assessment of students and research projects, establishment of training programs that involve multisectoral and

multidisciplinary collaborations, and separate funding for students for use in knowledge mobilization, research projects, or professional development.

Italy: A problem of persisting perception of the innovative programs as exceptional cases among the majority of **t**raditional doctorates, even at the founding institution.

Japan: The most burning issue in doctoral education is the shrinking university sector because of decreasing number of eighteen-year age cohort. The number of doctoral students have been decreasing since 2008 and the number of master degree holders who enter doctorate courses has decreased. Research jobs in academia have decreasing and many posts for young academics has become fixed term jobs. The research productivity in natural science and engineering fields has declined. In this situation many academics are conscious about the future for Japan's knowledge economy.

Malaysia: Entry level among the international students; discussions on introducing a Certificate to supervise doctoral students; funding for tuition fees and living expenses; a need to train PhDs for careers beyond academia.

Mexico: High levels of insecurity, infrastructure for STEM graduates and low-paying employment for faculty members. However, CONACyT also has a supplementary salary program for which doctorate holders may apply to become part of this national network of researchers.

New Zealand: Most burning issues facing doctoral programmes include the well-being and mental health of candidates, ensuring best practice supervision, and the desire for more structured approaches for professional development and career planning. Other common issues include supporting international candidates, especially those with English as an additional language, managing the large number of applications for study in New Zealand, and maintaining the domestic fee arrangement for international PhD candidates.

Russia: Low quality of dissertations; Low attrition rates; Poor financial support of students and high student employment rates??? Meaning few full-time doctoral students????; Weak academic market with widespread inbreeding; Massification of Higher Education.

South Africa: The main issue is student quality and dropout, which have been affected by the push to increase the number of graduates in the face of low supervisory capacity. There is also a more widespread concern about transformation of both demographics and the curriculum within SA higher education.

Turkey: The present political pressure over academia (dismissing number of academics, shutting some universities for political reasons, declined academic freedom and freedom of speech) is the most important problem that has huge impacts on existing PhD programs and students in Turkey. The alarming situation in Turkey have led the growth of already existing problems like nepotism, ideological pressures, lower quality and so on.

UK: From the servant of academia to the motor of the knowledge economy – a radical transformation during the last three decades that has radically altered the purpose, form and organisation of doctoral education such that it now serves society in a predominantly economic, marketised way. Nevertheless, debates about doctoral education's contribution to the public good have not been lost entirely from view. Doctoral researchers as neo-liberal agents; that is, self-interested, economically motivated individuals versus the role that doctoral education plays in nurturing a fair and just society. Some UK policy documents still acknowledge that doctoral education does not just

fulfil a solely economic or instrumentalist function. Doctoral education is considered to contribute toward a more open, intelligent and just society in which debate is valued. In summary, the UK doctorate retains links with its epistemic origins. The degree remains rooted in the production of new knowledge and supplies academia with its future workforce. Nevertheless, the advent of the knowledge economy and resultant policy interventions have reformed the contemporary doctorate. Greater emphasis is now placed on applicable, impactful knowledge and multi-skilled doctoral researchers as the desirable outcomes of a doctoral education. This has sparked debates about the very nature of the doctorate, the form it should take, and the efficacy of the examination process. Against this economic imperative, there is recognition that the doctorate performs a public good, particularly in regard to social mobility and its contribution to a just society. Supporting doctoral candidates wellbeing and mental health has become a top national priority since 2018 with national funding schemes available to help.

US: Among CGS member universities and deans, one of the most burning issues is graduate student

health and wellness, with a real concern about stress and mental health. This also is highlighted in the National Academies report listed above. This is one of the major changes since 2005.

Appendix 5: China- more on Background

The first stage of increased doctoral education in China was from the late 1970s to the early 1990s. This stage mainly used doctoral graduates returnees from overseas and the small number of postgraduates trained after the founding of the People's Republic of China. At the same time, China drew on international experiences and established a doctoral education system consistent with China's national tertiary education conditions. The most crucial strategy was the division of the three-level degree and the measurement of the quality of the degree. In the initial stage, the government was most concerned about the ability to cultivate internationally recognized doctoral graduates. Therefore, the doctoral training units, disciplines and professional degree programs, as well as doctoral supervision qualifications, are strictly controlled. What types of disciplines and professional graduate students should be trained is mainly based on educational conditions.

The importance of quality as an essential principle was clearly stated, which meant that it was necessary for the Chinese higher education system to train doctoral graduates based on the international standard. In particular, Chinese doctorates had to be equivalent to doctoral degrees in developed countries, and the doctoral qualification provided must be seen as internationally valid. In 1981, the first batch of doctoral degrees approved by the state was 151, the number of doctoral degree programs and professional programs was 812, and the number of doctoral supervisors was 1,155. Since then, three consecutive degree authorization examinations have been carried out. Each new authorization had fewer new units, disciplines and programs added: in 1984, the second batch of 45 newly added doctoral authorization units, 316 authorized disciplines and professional programs; in 1986, the third batch of doctoral degree granted was 41, the number of authorized disciplines and majors was 675, and the number of doctoral supervisors was 1,791. In 1990, there were only ten new doctoral granting units in the fourth batch, 277 new doctoral programs and 1509 new supervisors. During this period, 33 universities were allowed to pilot graduate schools to train graduate students.

The second stage was the rapid development period from the early 1990s to 1999 before the massification of higher education. During this period, the government proposed to increase enrollment of doctoral students and establish a domestic goal of producing as many graduates as possible. From 1992 to 1999, the average annual growth rate of doctoral students was 20.6%, far exceeding the average annual growth rate of masters students (@12.3%). In 1993, the fifth batch of newly added doctoral units was granted 24, with 274 authorized disciplines and professional programs. In 1995, the Academic Degrees Committee of the State Council decided to conduct a degree authorization review every four years. In the same year, the newly added units handled by the detachment were reviewed. The sixth batch of newly added doctoral degree-granting units and 147 doctoral programs; four years later, in 1998, in the seventh batch of examinations, there were 49 new doctoral units and 341 doctoral programs. At this stage, 33 pilot graduate schools were officially approved, and the doctoral supervisor's examination and approval authority were delegated to the training units rather than in central government. Since 1996, the first-level discipline has been piloted.

The third stage occurred after the expansion of higher education (from 1999 to 2003, the average annual enrollment of doctoral students increased by 26.6%), and when China grew to become one the world's largest doctoral education countries. During this period, 22 new colleges and universities across the country tried to establish graduate schools. In terms of enrollment, in 1999, the number of doctoral students enrolled in the country was nearly 20,000. In 2003, 49,000 people were recruited. In 2004, 53,000 people were recruited. In 2007, 58,000 people were recruited, and the number of students in graduate schools reached 220,000. In terms of doctoral degrees granted, 4 million people received doctoral degrees in 2007, a number greater than for the doctoral degrees awarded in the United States. According to the 2009 National Statistical Report on Education Development released by the Ministry of Education, China recruited 61,900 doctoral students and 48,700 graduate students nationwide in 2009. The number of doctoral students studying in China increased from 54,000 in 1999 to 246,300 in 2009, an increase of 4.56-foldover10 years. In the 40 years from 1978 to 2017, the number of new places for doctoral students in China increased from 18 to more than 84,000 (Figure 1).

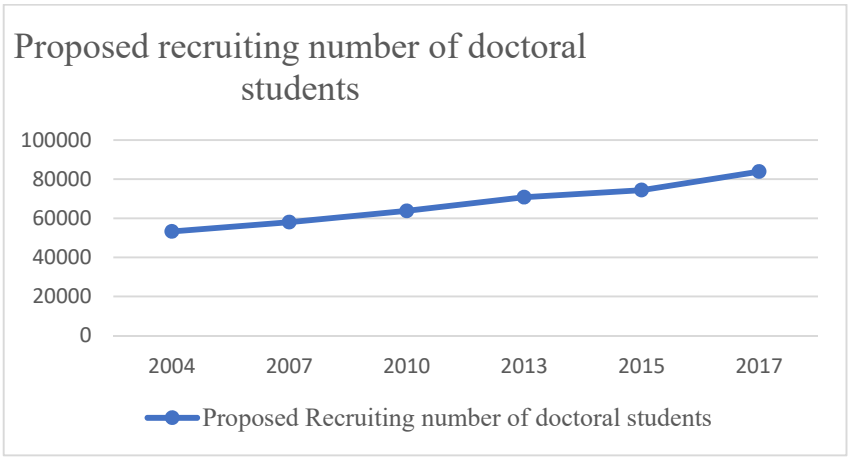

Figure 1 Proposed recruiting number of doctoral students

According to Ministry of Education, there are total 2663 institutions in higher education level. By 2018, a total of 344 institutions had approximately 4000 units authorized for doctoral education (Figure 2).

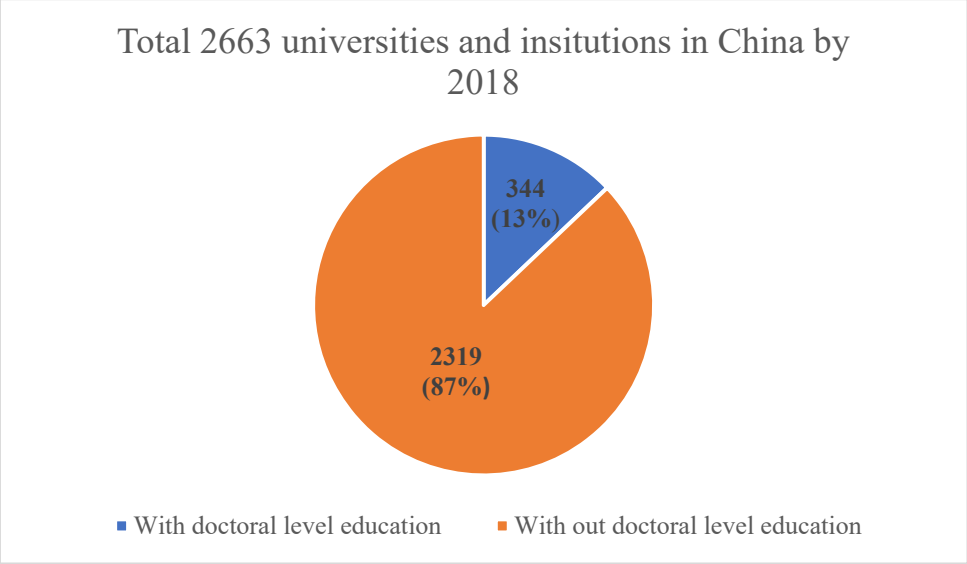

Figure 2. Doctoral training units in China

On June 16, 1982, the first six Chinese-trained students were awarded doctoral degrees. By 1999, the number of doctoral degree holders exceeded 10,000 for the first time. Since 2011, the number of doctoral degrees awarded each year has been roughly 50,000 (Figure 3).

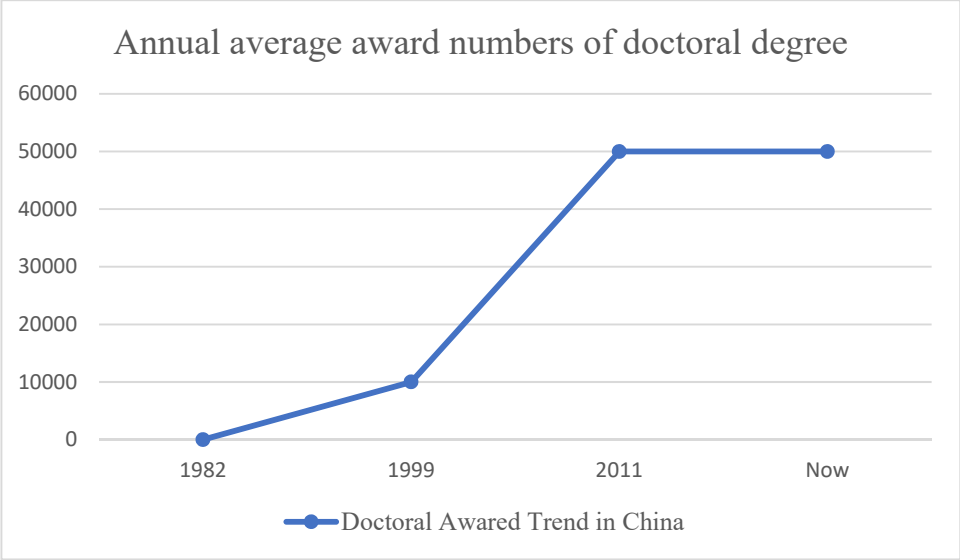

Figure 3. Doctoral awarded trend in China

At present, China has implemented a doctoral education model with predominantly academic doctorates supplemented with professional doctorates. From the perspective of doctoral professional areas, academic doctors are mainly trained in the following 13 fields: science, engineering, agriculture, medicine, law, management, education, economics, philosophy, literature, art, history, military. From

the perspective of professional doctorates, these are mainly in the following fields: engineering, clinical medicine, veterinary medicine, stomatology(dental medicine) , and education.

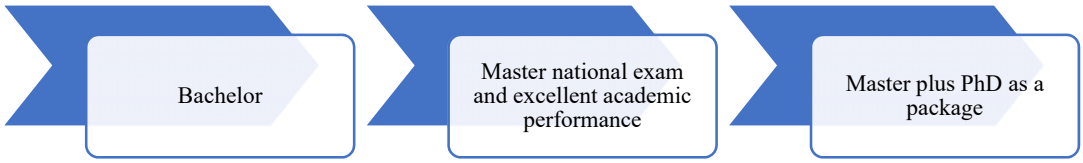

Figure 4. Master-PhD package model

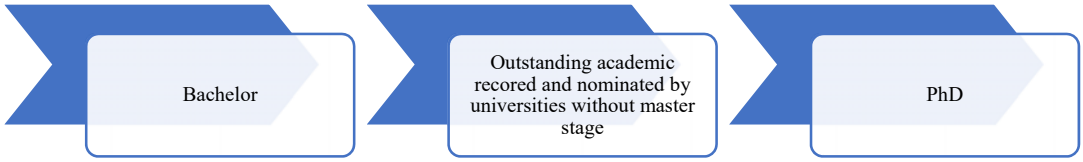

Figure 5. Bachelor-PhD model

Figure 6. “Application-Assessment” model

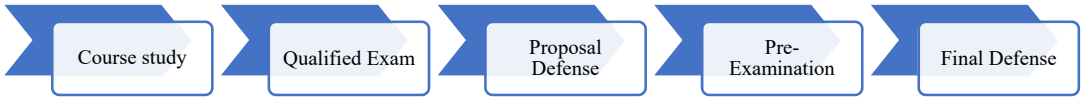

Figure 7. Doctoral assessment model

China Perspective

Following some of the characteristics of the planned economy era, most of the types of examinations in China are permeating the prescriptive sense. It should be said that the dominant macro-control power of the state in the field of enrollment examinations has stable rationality in China. It operates in the era of higher education popularization. With such an extensive education system, the scientific and rational regulation of the government has specific positive significance for realizing the rational allocation of

social resources. In the process of recruiting doctoral students in China, the government has usually played a role, as a leader and supervisor, in making related policies. However, it does not participate in the process of recruiting activities. The universities and colleges have greater autonomy in recruitment.

The government generally only approves the enrollment plan submitted by the universities. Due to the situation of the enrollment unit's school scale, school conditions, development goals, supervisor availability, and research funding, the approval process seems to be full of formal process. The responsibility for recruiting and cultivating students is more borne by the universities. The universities decide the enrollment plan, the method of enrollment, and the admission criteria. With the diversified recruitment methods, especially the extensive application of the "application-assessment" system, the enrollment unit has autonomy.

At the same time, the supervisor began to have greater enrollment rights. With the continuous improvement of the autonomy structure, and drawing on the recruitment model of the top western universities, the universities will decide the total number of enrollments according to the needs of the society and its situation. The number of enrollment candidates will be determined based on scientific research projects and research fields, which may be the trend of future development.

In the process of expanding the scale of doctoral education in China, it does not pay attention to the establishment and improvement of the quality assurance system. It is basically “strict entry and extension” rather than “wide-in and strict out”. In the admissions system, the doctoral students’ enrollment in China still mainly passes the examination. To a large extent, this kind of test-taking method cannot select the students with the most scientific research potential. At the same time, the screening of doctoral students in China still basically stays at the initial entrance, and the next comprehensive examination, opening report and thesis defense. The assessments are not very well linked, and it does not play a significant role in selecting outstanding students. Also, the doctoral supervisors in China still do not have sufficient autonomy in the selection of doctoral students, and more are subject to administrative instructions.

With regard to the curriculum system, the number of doctoral programs in China is still too small. There are few or no specialized courses for doctoral students, but a curriculum system is used together with master students. The doctoral programs are too monotonous in content. Relevant research shows three types of knowledge that doctoral students may lack are research methodological knowledge, interdisciplinary knowledge, and professional frontier knowledge. At the same time, the traditional teacher-centered learning mode has not been fundamentally changed. In the mentoring system, China mainly implements a single supervisor system. A doctoral student is responsible for a supervisor, which is not compatible with the trend of interdisciplinary. At the same time, a supervisor is responsible for many doctoral students. Research statistics show that the average doctoral supervisor in China usually supervises 5.77 students. The number of doctoral students is significantly higher than the average ratio of 2 to 3 students per supervisor in foreign countries. This issue will lead to an insufficient investment of individual doctoral students and pose a threat to the quality of doctoral education.

In the selection and evaluation of the supervisors, in the 1990s, the examination and approval authority of doctoral supervisor in China was delegated to the doctoral degree-granting units, and the number of doctoral supervisors increased rapidly. However, at the same time, there was no strict selection and evaluation of doctoral supervisors. The system, together with the essential zero elimination practice of doctoral students in China, has a very low responsibility and risk. This low accountability brings the low

elimination rate and low update rate of doctoral students. It can be seen that compared with developed countries, China's doctoral education. In the process of its scale expansion, there is no perfect internal guarantee system, and it can even be said to be missing.

the role of doctoral education is not only to adapt to and support the development of the economy, but it is more important role is to guide and create. Furthermore, supervisors and universities need to pay attentions to cultivate students' ability to find and solve problems. To assess students' outcomes, universities and supervisors should have more focuses on learning and research process rather than only focus on result (e.g. numbers of publication). Considering the international competitiveness, universities also need to propose strategic plan for doctoral education to recruit more international students. To sum up, quality assurance relies more on establishing and improving the internal and external security and assessment system of doctoral education. The scope of protection needs to include the input-process-output process.

Appendix 6: Australia - on Funding

Other *Input* parameters that can be considered locally include the quality of the research environment. While such an assessment is relative and subjective, the Australian government has attempted to capture discipline quality within Institutions through analyzing research outputs, in a regular evaluation process known as Excellence in Research for Australia (ERA). ERA may be a means used by smaller Australian Universities to focus research training within areas of research strength. The quality of the research environment is not limited to the intellectual capital. Each university builds research infrastructure that supports its strategic research directions and Australia has national programs to build research infrastructure (NCRIS), and also contributes to international research infrastructure consortia such as CERN (in particle physics) and the Square Kilometer Array (in astrophysics).

The funding of research training candidates in Australia is a blend of national and institutional support. All research training candidates are placed in notional fee places, but the fees paid are usually minimal regardless of where the candidate is from. "Domestic" students are funded under a federal program known as RTP which provides support for the costs of the places occupied by domestic students. The RTP funding envelope is fixed and universities win a share of the RTP "pie" through audited reporting of research degree completions, and research income. This RTP funding, which is based on retrospective data, is used to maintain a research training cohort which, in theory, is consistent with the research income received by the institution. International students usually have their fees offset by either sponsorship from their home countries, by enrolling institutions, or by the Australian federal government. Most full-time students in Australia are paid an indexed tax-free living stipend of approximately $20-25,000 (USD). This funding will be provided for the length of the candidature, usually 3.5 years at least, and to both domestic and international students, if they are not sponsored. This support can be supplemented by income received for teaching undergraduate students. Federal RTP funding is paid to institutions and intuitions can shape the discipline mix of their research training cohort by allocating more or less of this funding to individual academic units (Colleges Faculties, Schools or Departments).

The additional casual University work performed by doctoral candidates in Australia is usually remunerated and forms an important training experience for those individuals who ultimately seek a position in the education system. Depending on the discipline, the access to these teaching

opportunities may be equal for all students; where resources are limiting, domestic students, or those students with English as a first language, may be given preference. The nature of the teaching roles may be limited to small groups - practical classes and tutorials but, in the HASS, graduate students may have key roles in the delivery of content through lectures. The funding that is obtained through casual teaching is supplementary only. The rules that govern living stipends require that candidates work "full-time" on their research to obtain the stipend. This can create issues where e.g. parental or carer's leave is sought and a change to candidature fraction.