Introduction: Innovative industrial doctorates: issues and prospects

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From an international and comparative perspective, the emergence of innovative doctoral programs has gained increasing attention over the last 20 years. Under the label of 'innovative' doctoral program, we include different experiences featuring the closer cooperation between universities and businesses to better match the needs of the labour market (Borrel Damian, 2009; Kottmann and Weyer, 2011; Meek et al., 2009; Perkmann and Walsh, 2007).

Professional doctorates and industrial PhD are the most studied and developed typologies falling into this category. Professional doctorates have been around in the UK since the early 1990s. The aim of these programs is to integrate professional and academic knowledge, allowing students to make an original contribution to both theory and practice in their field, and to develop professional skills by the means of (professional) knowledge. These programs differ from the so called engineering doctorates (EngD) not only because of the sectoral specialisation, but also because the first ones can vary from abstract/theoretical to applied industry research, while EngD research usually concerns a specific topic, related to the business activities of the industrial sponsor. Similar to EngD on this side, but with a wider extension in terms of sectors and disciplines concerned, are the Industrial PhDs. As pointed out by the European Commission (2011a), the notion of 'industrial PhD' should be given the widest possible interpretation: "The term 'industry' is used in the widest sense, including all fields of workplaces and public engagement, from industry to business, government, NGOs, charities and cultural institutions".

The vast amount of literature produced so far on these programs has reported the experiences of many countries and the concurrent evolution of their regulatory framework (Jones, 2013), detailing the main issues and theoretical implications (Harman, 2008; Nerad, 2010). Several institutional, economic and social factors have been identified as drivers of the diffusion of innovative doctoral programs, starting from the

growing demand for research-related skills in a knowledge economy. Workplaces are more and more populated by people with hybrid skills – i.e., who are both researchers and 'managers of change' in production and organisational processes – as work is performed as a formative and research process where theory and practice are combined in order to 'learn how to do things', to solve problems and to innovate. Innovative PhDs are an essential component of these new business patterns, because they combine work experience, learning, research and planning activities by generating high added value and enabling constant innovation in production processes and/or in the way of delivering services. They are also crucial for the development of the ever-changing 'intermediate labour market' of research (Auriol et al., 2013; Lanciano-Morandat and Nohara, 2006) and its evolution in a more organised and structured way, being the latter extremely fragmented. In the report *Mapping Exercise on Doctoral Training in Europe – Towards a common approach* (European Commission, 2011a) and in the *Principles for Innovative Doctoral Training* (European Commission, 2011c), the European Commission (2011b) provides member states with a conceptual framework as well as operational tools not only to ensure the mobility of researchers and skills transfer but also to outline a common approach to the development of innovative doctoral research in Europe.

The analysis of innovative PhDs devised in Europe shows a fragmented picture. The Danish case is worth a mention; here more structured industrial PhDs programs were introduced for the first time 40 years ago and are acknowledged in both legal and contractual terms (The Danish Agency for Science, Technology and Innovation, 2012). What characterises 'industrial PhDs' in Denmark is that PhD candidates conclude an employment contract; this aspect, coupled with the establishment of an academic plan, is the mainstay of the relationship between the student and the external entity involved in training and research. Although the students' activity is mainly focused on their research project – also thanks to generous public subsidies ensuring an effective collaboration between employers and universities – working time is traditionally and equally distributed between the time spent at the company and at the university (Kolmosa et al., 2008). This seems to be the main success factor of industrial PhDs in Denmark and Northern Europe (Thune et al., 2012; Wallgren and Hägglund, 2004). The same happens in France, where generous subsidies make it possible for employers to recruit students and contribute to define their research project (ANRT, 2012). Similar cases in other countries proved less effective as doctoral candidates are legally qualified as mere students. The way these programs are delivered in the UK (European Commission, 2011b), Ireland (Higher Education and Training Awards Council, 2010), and Germany (Enders, 2002; Ori, 2013) are a halfway house between the approaches adopted in Northern Europe and in France; the student presence in the company is the result of an internship or a work placement of variable duration (from three to 18 months), and no employment contract is concluded for a joint training and research project.

This special section on 'The evolution of doctoral education towards industry and the professions' contains three contributions addressing the issues above sketched from three different points of view. In her paper, Fumi Kitagawa describes the positive experience of EngD in the UK, where a long tradition of innovative doctoral training exists and the labour market demand for graduates coming from this path is high, focusing on graduates' mobility as a catalyst for knowledge dissemination and exploitation. Annamária Inzelt and László Csonka present the results of a quantitative and qualitative analysis of PhD graduates in the *Social Sciences and Humanities* (SSH), showing how different contextual factors (nature and contents of 'traditional' PhD programs, labour

market demand, economic situation) can hinder the doctorate holders' inclusion in the business sector and their a greater intersectoral mobility. Lilli Casano provides a preliminary analysis of a pioneering experience of innovative doctoral program in Italy, combining work-based training and research activities by the means of internships and apprenticeship contracts, showing how the attempt to transfer the model of industrial PhD has found both institutional and cultural barriers. In the Italian context, the labour market demand is low and doctoral training is still viewed mainly as a precursor to academic paths.

Those three different cases show how different elements – like labour market demand, institutional and legal framework, cultural aspects, PhDs career's orientations – can all act alternatively as push factors or as obstacles to the diffusion of innovative doctoral programs and can also influence their functioning and their impact where established.

In Kitagawa's study, the nature and the impact of intersectoral mobility in the UK EngD schemes is analysed, by identifying organisational forms and skills' development's mechanisms in view to provide insights for institutional and individual actions. In the UK, collaborative industrial doctoral schemes established in engineering and physical sciences proved to produce highly qualified graduates by contributing at the same time to a positive knowledge exchange between industry and the academia. The results of three industrial doctorate centres case studies show that knowledge exchange and interaction between research and industrial and social practices can assume differentiated organisational forms, depending on the nature of technology and industry sectors, the geographical location, the nature of collaboration between industry and university, with all those factors influencing also careers' path and mobility trends.

The contribution by Inzelt and Csonka shows how a negligible demand from the private sector and a traditional orientation towards academic research influence characteristics and occupational results of Hungarian *SSH* PhDs, with employment in non-academic position remaining still modest and movement between different sectors (intersectoral mobility) representing a major challenge. In these career's paths, the coordination between work experience, study and research is informal and limited to economic reasons: given the low availability of scholarships, PhDs often try to coordinate the attendance to the PhD program with work. However, in the absence of a deliberated strategy of interrelation between research and work experience, there is a higher risk to put them in a difficult situation. The analysed sample shows that intersectoral mobility, which is crucial for better employment perspectives and knowledge cross-fertilisation among different sectors, is experimented in few cases and it is not related to the formal PhD path, even if the graduates often profit a lot from the skills and knowledge accumulated during the doctoral program.

Tellingly, Italy cannot be counted among the foregoing countries when it comes to innovative PhD programs. In this country, a tendency has arisen either on the part of lawmakers or educational providers to disregard the needs of the labour market and the promotion of a more effective collaboration with businesses at the time of planning academic programs. Over 12,000 graduates enter a PhD program (Rotisciani and Vitucci, 2013) in Italy, each year with the intention of pursuing the academic career. However, statistics show that only about 2,000 individuals succeed in entering the academic career after a long transition made up of work often provided on a voluntary basis, post-doctoral scholarships, research grants and temporary contracts. Working in industry is seen as a

second-best alternative to academic career, nor as a resigned response to the cuts in public funding in the self-referential market of academia. It is in this context that the contribution by Lilli Casano analyses the pioneering experience of the Doctoral School in Human Capital Formation and Labour Relations at the University of Bergamo (Italy), co-promoted by the Association of International and Comparative Studies in Labour and Industrial Relations (ADAPT), which has been a forerunner in providing agreements with employers to fund work-based doctoral programs, anticipating the move made by the Italian Legislator with the formal recognition of industrial PhD in 2013. The approach adopted by the doctoral program stood out since its establishment as being similar to that used in other European or non-European countries where work-based doctoral programs have been established for a long time, but the analysis prevents from underestimating legal and cultural complications, underlying the role of experienced actors and of a well established cooperation framework in assuring the success of the studied experience.

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