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Doctoral Dissertation
Doctoral Program in Energy Engineering (38th Cycle)

Proof-of-Concept Programs: bridging the gap between research inventions and commercial applications

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Politecnico di Torino
2026

Abstract

Although universities and public research organizations are increasingly involved in the valorization of research inventions, the early stage of this process is still characterized by high levels of uncertainty and complexity, exhibiting a high failure rate, with the vast majority of research inventions falling into the "valley of death". Importantly, the high uncertainty associated with the early stage of the valorization process is not uniform across research inventions, differing between inventions grounded in fundamental sciences and those in applied research domains. Specifically, fundamental inventions are characterized by more complex, lengthy, and less linear valorization processes than those for applied inventions, which generally face fewer challenges. In this context, Proof-of-Concept (PoC) programs have been introduced as one of the technology transfer instruments aimed at addressing the early stage of the valorization process of research inventions. While prior literature has demonstrated the effectiveness of PoC programs in fostering the valorization process of early-stage research inventions and their subsequent commercialization, as well as their role as instruments supporting scientists' entrepreneurial learning, the literature still lacks an understanding of the learning mechanisms activated within teams of scientists through their PoC project execution and whether and how these learning mechanisms differ according to the types of research inventions underlying the PoC projects. This dissertation aims to address this gap by studying PoC project execution over time, focusing on three points – namely, at its outset, during implementation, and at its conclusion – which correspond to the three empirical studies presented. These studies drew data from a unique database developed to collect primary data on two PoC programs implemented within five Italian universities between 2016 and 2021. The sample includes 98 projects that obtained funding from the two considered PoC programs to develop 94 unique early-stage research inventions.

Study 1 examines the configurations of learning mechanisms activated from the outset of PoC projects and that underlie such projects in the valorization of different types of early-stage research inventions. We developed a conceptual framework at the intersection of dynamic capabilities and PoC literature, from which we derived these learning mechanisms, which are related to sensing and seizing capabilities within scientific teams and to the characteristics of their

external networks – i.e., geographical location and timing of contact. By adopting a micro-foundational perspective and employing a fuzzy-set Qualitative Comparative Analysis (fsQCA), our results revealed that their combination is required for science valorization. We obtained two relevant configurations for the technological maturity advancement of inventions that differ depending on the research invention type. Study 2 investigates the valorization process of different PoC research inventions through which teams learn during PoC project implementation. By identifying the micro-level activities teams engaged in during their PoC project and by using an fsQCA, our results revealed distinct science valorization processes in PoC programs. Fundamental inventions follow a theory-guided process, while the valorization process of inventions within applied sciences and engineering aligns with the lean startup approach. Study 3 investigates the process leading scientists to the final decision to enter the market through the establishment of spin-offs based on different types of research inventions developed through PoC projects, specifically examining their science-to-market pathways. Drawing on an fsQCA, we identify the pre-entry actions scientists undertake within phases of the entrepreneurial process and analyze the relevant configurations shaping their entry decisions. The results highlight systematic differences between fundamental and applied inventions, particularly in the types of feedback generated through experimentation and in how scientists acquire essential knowledge and resources.

This dissertation contributes to both theory and practice. Theoretically, it advances the PoC literature by uncovering the configurations of learning mechanisms underlying PoC projects and by providing a more comprehensive understanding of their execution over time and role in science valorization and commercialization. It further contributes to the science valorization literature by reconciling theory-based and lean startup approaches, showing that they reflect distinct valorization processes associated with different types of research inventions. Moreover, this dissertation highlights the heterogeneity of entrepreneurial entry pathways in science valorization. From a practical perspective, our results suggest the need to move beyond a one-size-fits-all approach to PoC program design and tailor support mechanisms to the type of research invention.