Factors affecting university commercialization: Evidence from Italy

La comercialización de la tecnología universitaria es un fenómeno creciente. Sin embargo, cada país tiene un planteamiento diferente sobre cómo lograr el nivel deseado de transmisión tecnológica. En Italia, país que fue líder mundial en el desarrollo de instituciones de enseñanza superior, la transferencia de tecnología solo ha adquirido importancia hace unos pocos años. Este artículo se centra en las peculiaridades, puntos fuertes y débiles del modelo italiano de transferencia tecnológica. Utilizamos para nuestro análisis un marco interpretativo funcional de actividades de comercialización, centrado en la comercialización de la tecnología universitaria y utilizando una óptica tanto interna como externa, tal como hicimos en evaluaciones anteriores (Breznitz, 2011; Breznitz y Ram, 2012). El artículo se centra en lo que afecta a la capacidad de la universidad para comercializar tecnología. En concreto, ponemos a prueba la hipótesis de que el entorno y la historia, así como factores internos de la universidad, afectan a la comercialización de tecnología universitaria. Realizamos este análisis utilizando el método del estudio de caso, con dos universidades tecnológicas especializadas en actividades de enseñanza e investigación en ingeniería y arquitectura: Politecnico di Torino y Politecnico di Milano. Aunque encontramos que una mezcla de factores internos y externos tuvo un cierto impacto sobre la capacidad de comercialización, los factores externos fueron más importantes.

Unibertsitate teknologiaren merkaturatzea hazten ari den joera bat da. Hala ere, herrialde bakoitzak lortu nahi duen teknologi transmisioaren maila lortzeko bere planteamendua du. Italian, goi-mailako irakaskuntza instituzioen garapenean mundu mailako liderra izan zen herrialdean, teknologia transferentziak orain urte gutxi batzuk hartu du garrantzia. Artikulu honek teknologia transferentzia italiarraren ereduaren berezitasun, indargune eta ahulguneetan jartzen du arreta. Arteragoko ebaluazioetan (Breznitz, 2011; Breznitz eta Ram, 2012) egin bezala, gure analisirako, unibertsitate teknologiaren merkaturatzean arreta jartzen duen, eta kanpoko zein barruko ikuspegia erabiltzen duen, merkaturatze jardunaren interpretazio-esparru funtzionala erabili dugu. Artikuluak unibertsitatearen teknologia merkaturatzeko gaitasunean eragiten duten arrazoietan jartzen du arreta. Zehazki, historiak eta inguruneak, eta unibertsitatearen barne faktoreek, unibertsitate teknologiaren merkaturatzean eragiten duten hipotesia aztertzen dugu. Analisi hori kasu azterketa eredua erabiliz egiten dugu, ingeniaritza eta arkitektura ikerketan eta irakaskuntza jardueran espezializatuak diren bi unibertsitaterekin: Politecnico di Torino eta Politecnico di Milano. Barne eta kanpo faktoreen nahasketa batek merkaturatze gaitasunean eragina izan zuela ikusi genuen arren, kanpoko faktoreak garrantzitsuagoak izan ziren.

University technology commercialization is a growing phenomenon. However, every country has a different approach to achieving the desired level of technology transfer. In Italy, a country that led the world in the development of institutions of higher education, technology transfer has become important only in the past few years. This paper focuses on the peculiarities, strengths, and weaknesses of the Italian model of technology transfer. Our analysis employs a functional interpretive framework of commercialization activities, viewing university technology commercialization using both internal and external lenses, as in previous assessments (Breznitz, 2011; Breznitz and Ram, 2012). The paper centers on what affects a university's ability to commercialize technology. In particular, we test the hypothesis that the environment and history, as well as factors that are internal to the university, affect university commercialization. We conduct this analysis using the case study method, with two specialized technological universities that are engaged in general teaching and research activities in engineering and architecture: Politecnico di Torino and Politecnico di Milano. Although we find that a mix of both internal and external factors had some impact on their commercialization ability, external factors were more significant.

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1. INTRODUCTION

The commercialization of research results has become a significant phenomenon at universities and research institutes.[1] However, in some countries, such as Italy, it is still relatively less so compared with other countries (Abramo and D'Angelo, 2009). This marks a strong contrast with countries in North America and the more general English-speaking world, where the term «technology commercialization» was coined even before World War II. In many cases, Italy continues to propagate the classical Humboldtian model of higher education in which the university represents an holistic model of education combining arts and science with research.

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[1] For an earlier discussion on the topic, see, for instance, Bozeman (2000), who argues «technology transfer is defined in many different ways, according to the discipline of the research, but also according to the purpose of the research» (p. 629).

To understand why Italy lags in technology commercialization, we employ an interpretive framework of commercialization activities. This framework views university technology commercialization through both internal and external lenses (Breznitz, 2011; Breznitz and Ram, 2012). The main research question asks: what affects the ability of a university to commercialize technology? In particular, we test the hypothesis that the environment and history, as well as internal university factors, affect university commercialization. We conduct this analysis through the case study method, using two technological universities (*politecnici*) in Italy: Politecnico di Torino (PoliTO) and Politecnico di Milano (PoliMI). *Politecnici* are specialized technological universities that engage in general teaching and research activities only in engineering and architecture. We chose the *politecnici* for our case studies for two main reasons. First, engineering is one of the disciplines with the strongest ties to industry and hence to commercialization (Grimpe and Fier, 2010; Landry *et al.*, 2007), and these universities are two of the three engineering technical universities in Italy.[2] Second, these universities were created from the start with a focus on technology and commercialization, hence their technology transfer activities are of high quality in terms of Italian standards (see NETVAL, 2012, 2013, 2014, 2015, 2016; Rossi *et al.*, 2015; Villani, 2013). Thus they form an ideal case study (Van Evra, 1997).

The present paper is organized as follows. Section 2 presents the literature review on the role of universities in commercialization technology with a specific focus on internal and external factors. Section 3 gives a general overview of technology transfer in Italy. Section 4 describes the case studies, with the details of each university followed by the regional external and internal factors affecting commercialization. Section 5 compares the two cases, while the last section discusses strengths and weaknesses of the cases, and presents suggestions and lessons learned. Our findings strengthen existing literature and demonstrate that the universities ability to succeed in technology transfer depends on both external and internal factors. In particular for this case, we find that the existence of relationships with a rich and diverse industrial base is highly important.

2. COMMERCIALIZATION OF UNIVERSITY RESEARCH

2.1. External university factors

The transfer and commercialization of university technology are affected by two external factors: the national and regional history and legislative, industrial, and cultural environment (Lawton Smith, 2006; O'Shea *et al.*, 2005; Rahm *et al.*, 2000). These factors are evident in historical decisions regarding the role of the university, land use, relationships with state, national, and regional governments, and many of them are reflected in policy, which can directly influence technology transfer activi-

[2] The third *politecnico*, Politecnico di Bari, was founded in 1990 and does not have strong similarities to the other two *politecnici*. PoliTO and PoliMI date back to the mid-nineteenth century; the former took its current form in 1909, while the latter became a *politecnico* in 1927.

ties. The most famous and relevant example of policy intervention in technology transfer and commercialization is the Bayh-Dole Act (Mowery and Sampat, 2001; Sampat, 2006). The Bayh-Dole Act gave universities ownership of federally funded inventions. This in turn caused a further fostering of academic patenting activities in the United States. The impact of the regional environment on technology commercialization is analyzed in the work of Lawton Smith and Bagchi-Sen (2012), who study the role of universities as regional development agencies. The paper outlines four propositions, «setting out the reasons why universities might change from being latent assets to active agents» (p. 391) and then tests them using the case of the University of Oxford and Oxfordshire. The authors show that results depend on exogenous shocks, the local political agenda, and the characteristics of the region.

The environment in which universities operate has a direct effect on their ability to commercialize technology. This has been recognized by Audretsch *et al.* (2013), who, in their analysis, show the key role of small businesses «in providing a conduit for the spillover of knowledge from the organization in which knowledge is created to a different organization where that knowledge is used» (p. 60). An even more relevant theoretical approach for the present discussion is that of regional innovation systems (RIS). Asheim *et al.* (2011), in an overview on the topic, discuss the role of universities as one of the relevant assets enhancing the competitive advantage of RIS. In fact, «the rate of technological change and innovation is determined by the interaction –including firms, universities, research organizations…– that combine to create, develop, and diffuse new technology and innovation» (p. 883, *passim*). Moreover, «the extent of knowledge transfer is shown … also on firms' capabilities, absorptive capacity and their ability to renew capabilities over time» (p. 885, *passim*). Thus we can argue about the relevance of the context as a driver of technology transfer and commercialization *out of* universities. The importance of the local environment is enhanced when we explore the question of geographic proximity and innovation. Existing studies have shown that proximity enables knowledge spillovers, which contribute to the commercialization process. For instance, Santoro and Gopalakrishnan (2001) underline the relevance of spatial proximity as a crucial factor in technology transfer. Asheim and Gertler (2006) advocate «the central role of spatial proximity and concentration» (p. 292) in the innovation process. Howells (2002) studies the role of geographic proximity on knowledge spillovers, affirming that «knowledge spillover studies have confirmed that knowledge transfer is spatially constrained» (p. 880).

2.2. **Internal university factors**

Internal factors also play a part in university commercialization. The literature identifies three main factors: entrepreneurial activity and culture, technology transfer organization, and policy (Bercovitz *et al.*, 2001; Breznitz, 2011; Breznitz and Ram, 2012; Clark, 1998; Etzkowitz, 1998; Link and Scott, 2005; O'Shea *et al.*, 2005; Shane, 2004). University commercialization culture, together with history and tradi-

tion, was identified by O'Shea *et al.* (2007) as crucial to the ability of universities to bring technology to the market. Kenney and Goe (2004) assert that the embeddedness of scientists in the entrepreneurship environment is highly important for university commercialization. Clark (1998) emphasized the cultural atmosphere at an entire university, asserting that it has a vital role in fostering entrepreneurial activity that should be promoted not only by the leadership of a university but all departments, schools, and research centers. Bercovitz and Feldman (2007) affirm the importance of an atmosphere that supports and encourages entrepreneurship. Thus, a department in which peers, especially department chairs, commercialize technology and are involved with industry in collaborative projects and consulting work, will encourage scientists to take part in technology transfer activities. The role assigned to technology transfer in the mission statement of a university in many cases offers some insight into its commercialization culture and organization. The university's mission statement indicates its commitment to economic development and, in particular, to the commercialization of research results (Breznitz, 2011).

The organization and professionalism of the university's technology transfer office (TTO) have been found to influence commercialization (see Bercovitz *et al.*, 2001; Chapple *et al.*, 2005; Lockett and Wright, 2005; O'Shea *et al.*, 2005; Owen-Smith and Powell, 2001; Shane, 2004). In particular, O'Shea *et al.* (2005) stress historical background and past success in commercialization. The study emphasizes the experience that TTOs gain from commercialization and how past success predicts the future ability of the TTOs to replicate it. In addition, the quality and number of personnel involved in the TTO affect university commercialization (Balderi *et al.*, 2012; Clarysse *et al.*, 2005; Lockett and Wright, 2005; Muscio, 2010; Shane, 2004).

Commercialization performance is not influenced by the TTO alone. Several academic policies have a significant impact on the ability of a university to commercialize technology –in particular, intellectual property rights (IPR), royalties, equity in firms, leaves of absence, and the use of university facilities– (Di Gregorio and Shane, 2003; Link and Siegel, 2005; Shane, 2004). In Italy, as discussed in the next section, IPR regulations have influenced the ownership of inventions produced at universities.

3. TECHNOLOGY TRANSFER IN ITALY

As discussed in section two, the framework of this study is based on an analysis of both external and internal factors for technology transfer. While internal factors are specific to each university, external factors here will be analyzed on two levels: first, the national level for Italy, and second, while analyzing the specific case studies, the regional level where each university is located, i.e. Piedmont for PoliTO and Lombardia for PoliMI. We start with the analysis of the national level external factors for Italy.

3.1. External factors at the national level in Italy. Historical and legislative changes

The commercialization of academic inventions developed in Italy later than elsewhere, in contrast to the country's pioneering efforts in higher education. Italy is home to some of the world's oldest universities, such as the University of Bologna, founded in 1088 –the oldest one in Europe–. However, during the 1960s, when the number of students and the number as well as size of universities expanded throughout Europe in general, the Italian government made no organizational changes.

Changes in the Italian university system began only in the 1990s with the passage of the 168/1989 Act (1989), which, as Reale and Potì (2009) state, introduced «important structural changes to the higher education sector in terms of the distribution of authority, the degree of autonomy of the institutions, and mechanisms of co-ordination. Firstly, the establishment of the Ministry for Universities and Research…; secondly, the acknowledgement of the autonomy of the universities, which goes with the establishment of an evaluation system» (p. 84). Subsequently, further laws allowed financial autonomy and then application of the «Bologna model».[3] The rationale for the reforms was influenced by the theory of New Public Management,[4] adapted to the Italian context. According to Reale and Potì (2009), the reforms did not have as thoroughgoing an impact as hoped, because the state did not cede power and responsibilities linked to key aspects of the higher education system. The reforms did not shift the locus of power from a central structure to the universities. The universities adapted to government rules slowly and only partially, and professors were allowed to maintain most of their privileges and influence.

Examining Italian intellectual property regulations finds that in 2001, Italy introduced the «Professor's Privilege» policy, in which university professors can retain the IPR of their inventions created at the university while they were engaged in research activities there.[5] Lissoni *et al.* (2013) show that while academic ownership on patenting grew «the decline of academic contribution to patenting is quite visible» and that «regional differences are quite large» (pp. 413–416, *passim*). According to the authors this may be due more to lower industrial collaboration than to funding.

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[3] The «Bologna Process» is designed to ensure comparable standards and quality among the systems of higher education across the member countries of the European Union. Subsequently, in 2010, the European Higher Education Area was launched. For a description of the financing system of Italian universities, see also Geuna and Sylos Labini (2013).

[4] New Public Management aims to introduce management techniques typically adopted in the private sector in order to increase efficiency to the public sector. See, for instance, Lane (2000).

[5] The most recent act discussing the topic is the Decreto Legislativo no. 30 of February 10, 2005 (Industrial Property Code), http://www.uibm.gov.it/attachments/codice_aggiornato.pdf (in Italian).

University technology commercialization is also managed through NETVAL (Network per la valorizzazione della ricerca universitaria; Network for the Valuation of University Research). NETVAL is an association of Italian universities and public research bodies with the aim of valorizing research results via commercialization activities. Its mission is the appraisal of research results, through the network of TTOs. The goal is to act as a strategic bridge between research at universities and public research bodies and enterprises engaging in innovation, and is supporting growth in market competitiveness. NETVAL also organizes courses and seminars to foster the culture of technology transfer and to train university personnel; it publishes an annual survey of activity on patenting, licensing, and spinoff creation.

3.2. **Italian technology transfer environment for commercialization**

Studies reviewing technology transfer in Italy indicates that its performance is lower that of other countries. NETVAL reports an average of 8 inventions patented by its 54 member universities in 2013. By comparison, the AUTM average for a North American university in 2013 was 30 patented inventions (AUTM; STATT, 2013). These results are not surprising. Though highly regarded academically, Italian universities do not have the same level of resources as many universities in other developed countries. For example, MIT, one of the leading US engineering schools, has a staff of about 1,000 and, in fiscal year 2014, had 744 invention disclosures (MIT, 2015a). The MIT research budget that year was $1,521,411,000 whereas research expenditures for the same year at PoliTO were estimated at $70,143,756 (AUTM, 2016; MIT, 2015b; PoliTO, 2014). University-industry relationships are underdeveloped, university spinoffs show less activity, and TTOs are often less than optimally equipped to work on commercialization. Chiesa and Piccaluga (2000) ascribe these facts to faculty's lower tolerance for failure, which, together with the employment stability offered by the university system in Italy, reduces the likelihood of engagement in commercial activities.

An examination of university spinoffs in Italy highlights the unfavorable Italian industrial environment (Salvador and Rolfo, 2011), which includes low capital intensity, low growth, and low sales performance among university spinoffs. Moreover, investment in innovation is low, and spinoffs tend to engage in consulting and R&D more than other activities (Iacobucci *et al.*, 2013). A study of the spinoffs of the National Research Council (CNR) finds similar results, in which firms have low turnover and are involved in R&D rather than in productive activities (Finardi and Rolfo, 2015). Cerrato *et al.* (2012), in a study of co-patenting between firms and universities in Italy, find evidence that it is driven by the demand for innovation among local (regional) industry. The greater the innovative ability of the regional industrial system, the greater the contribution of universities to regional development. Within the same scope, Algieri *et al.* (2013) show that the probability of success varies significantly depending on location: much higher in northern Italy than in the central and southern region of the country.

The review of the Italian external factors indicates that Italian universities produce high level research, which is evident in patent ownership. However, Italy's technology commercialization is based on a system with limited resources directed toward technology commercialization and with the main push for commercialization depending on the regional industrial environment.

4. **THE CASE STUDY**

This section discusses the external and internal factors at PoliTO and PoliMI. We find both similarities and differences. Both universities were established at around the same time in the same industrial environment and in collaboration with industry. PoliMi is larger and amid a diverse industrial environment while PoliTO services a smaller region, mainly specializes in automobiles, controlled mainly by one firm, which has been in decline over the past twenty years. They share similar origins, but with some historical differences. Both institutions developed mechanisms for promoting technology commercialization, patenting, licensing, and spinoff companies. However, internal policies at PoliMI are better aligned with best practices for technology commercialization as seen in the academic literature.

4.1. **Politecnico di Torino**

In the 2013/2014 academic year, PoliTO had 28,863 students (MIUR, 2014) and 813 faculties, making it a medium-large university by Italian standards.[6] The number of scientific publications produced at PoliTO has grown steadily over the past 15 years, as reported in Table 1. PoliTO spinoffs comprised about 6% of the national total in 2013 (NETVAL, 2015); as of 2014, PoliTO was the Italian public research organization with the highest number of surviving spinoffs (NETVAL, 2016).

In 2004 PoliTO ranked eleventh in Italy in the number of patents and fourteenth in the index of university patenting intensity (Della Malva *et al.*, 2007). As of June 2016, the PoliTO patent portfolio consisted of 476 patents.[7] According to the Patiris (Permanent Observatory on Patenting by Italian Universities and Public Research Institutes) database, as of 2016, PoliTO ranked sixth in the country in the number of patent families, 244.[8] The number is consistent with the number of patents in the portfolio mentioned above. Table 2 reports the average number of patent applications and patents granted by the Italian universities that are members of NETVAL in 2014. The report shows that PoliTO ranks at the top among universities in Italy.

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[6] Major universities have more than 40,000 students, and small universities have fewer than 10,000.

[7] http://www.swas.polito.it/_library/downloadfile.asp?id=103051/, accessed June 2016.

[8] The Patiris database (http://patiris.uibm.gov.it/home/, accessed June 2016) contains information on the patent families produced by Italian research institutions and universities; it is designed and developed by researchers at the University of Bologna and University College London in collaboration with the Ministry of Economic Development and with technical support from Epoca Ricerca. Patent data are supplied by Orbit.

Table 1. **PUBLICATIONS AND CITATIONS, 1996-2013**

YEAR	SCIENTIFIC PRODUCTS	CITED	AVERAGE NUMBER OF CITATIONS
1996	465	7,318	15.74
1997	530	9,221	17.40
1998	496	10,983	22.14
1999	546	9,906	18.14
2000	618	8,755	14.17
2001	686	11,411	16.63
2002	772	13,683	17.72
2003	845	14,322	16.95
2004	971	15,710	16.18
2005	1,180	15,468	13.11
2006	1,282	14,119	11.01
2007	1,455	17,404	11.96
2008	1,520	16,413	10.80
2009	1,835	18,345	10.00
2010	1,879	14,604	7.77
2011	2,012	14,472	7.19
2012	2,082	11,354	5.45
2013	2,208	7,770	3.52
TOTAL	21,382	231,258	10.82

Source: Scopus, http://www.scopus.com, accessed September 2015.

Table 2. **AVERAGE PATENT APPLICATIONS AND PATENTS GRANTED PER UNIVERSITY, 2004-2012**

	2004	2006	2008	2010	2012
Average patent applications per university	3.2	5.4	5.4	5.2	5.7
Average patent applications per university among the top five	13.2	21.8	20.2	24.6	23.8
Average patents granted per university	1.6	1.8	2.3	6.8	3.9
Average patents granted per university among the top five	8.0	8.8	11.4	37.8	18.2

Source: NETVAL, 2014.

4.1.1. External university factors at PoliTO

The history of PoliTO explains the strong ties between the institution and the local industrial environment. PoliTO was founded in 1859 following the Casati Act, which overhauled the school system of the Sardinian kingdom. The founders of the new school promoted an experimental, practical approach (Mele, 2006). In 1906, the Application School unified with the Regio Museo Industriale Italiano di Torino (Italian Royal Industrial Museum of Turin). This museum, established in 1862, was conceived as an institute for industrial education, including several technical schools. Thus, from its inception, PoliTO was conceived of as an educational institution with a strong practical orientation.

After World War II PoliTO needed relocation, as the building it was set in had been bombed. The relocation was made possible thanks to generous financing collaboration of the local government and industry. Unione Industriale (Turin Association of Industrial Employers) funded the initial 300 million liras. Further financing eventually came from several sources: an additional 600 million liras from the national administration, the city of Torino offered 500 million liras, the Province of Torino 200 million liras, the Unione Industriale further 100 million liras, and the chamber of commerce 40 million liras. Interestingly, the main private sponsor has been Fiat.[9] The (then) Turin-based automaker gave 700 million liras, which financed the construction of the main building. The new location was opened November 5, 1958.

During the 1990s, the university began a series of initiatives: doubling its physical space, collaborating with firms, opening branch campuses, and reorganizing departments. This phase ended in 2005-2007 with the implementation of a strategic plan (Minelli and Turri, 2009). This plan was developed under four main axes: research university, internationalization, collaborative relationships with the surrounding economy, and enhancing the quality of university life for students and professors by improving physical structures and procedures. During those years, the ability to attract funding grew, both in competitive research projects created by the regional and national governments and the European Union (EU) and in industrial contracts (Cuttica, 2012).

The regional government of Piemonte, with EU funding, created several programs to promote university-industry links and commercialization. Among the most relevant ones was DIADI (Diffusion of Innovation in the Industrially Declining Areas in the Piemonte Region).[10] Operated from 1996-2008, DIADI spearheaded several initiatives, including the creation of a database of research projects conducted at universities and public research institutions and intended to foster collabora-

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[9] Fiat (Fabbrica Italiana Automobili Torino) is now part of the Italian-controlled Fiat Chrysler Automobiles (FCA).

[10] Diffusione dell'Innovazione nelle Aree a Declino Industriale della Regione Piemonte.

tion with enterprises. Research projects were codified in order to be easily exploited by enterprises, and the database was freely accessible online.

The second project was the creation of the regional industrial liaison office, ILO [Industrial Liaison Office]-Piemonte (Cuttica, 2012). This publicly financed office served PoliTO and the other two universities in Piemonte (Università degli Studi di Torino and Università degli Studi del Piemonte Orientale), together with regional government and other local agencies. ILO-Piemonte operated for only two years (2008-2010), with only partial success, as it was not able to create strong links among the participants to enhance technology transfer.

In 2008, the regional government began to focus its efforts on supporting university-industry collaboration with the creation of two different types of programs: technological platforms and innovation poles. Both programs are financed by the EU Regional Development Fund. Platforms are conceived of as «strategic projects» of interest to regional industry in aerospace, automotive, agribusiness, and biotechnology. Platforms involve large firms, small and midsize enterprises (SMEs), and research centers. Their goal is to concentrate resources on strategic topics, fostering private co-financing of applied research projects, driving university research to industrial targets. By contrast, poles are identified in specific fields, such as renewable energy, raw materials, and green chemicals. They aim to foster continuous collaboration among firms and between firms and universities and public research agencies.

4.1.2. ***Internal university factors: Commercialization organization at PoliTO***

In 1996 the university adopted an entrepreneurial approach, which came to effect through the creation of (1) the Istituto Superiore Mario Boella, in 2000, in a partnership between Compagnia di San Paolo[11] and Motorola, SKF,[12] and STMicroelectronics; (2) a new center for automotive technologies (financed by Fiat); (3) a multimedia project for distance learning; and (4) further partnerships with Motorola and General Motors that established joint research centers (Minelli and Turri, 2009). Moreover, and in accordance with the investment in entrepreneurship, faculty and staff increased their ability to build strategic connections with industry and society.

The main PoliTO branch dedicated to technology transfer and commercialization was SARTT (Supporto alla Ricerca e al Trasferimento Tecnologico, or Research and Technology Transfer Support). Its goal was to manage all research-related activities in two main areas: competitive research projects (at the international, European, national, and regional level) and technology transfer and commercialization ac-

[11] Compagnia di San Paolo is a charitable foundation created in 1563 in Turin. That year, it founded Banco San Paolo, which has merged with Intesa San Paolo, the principal Italian banking group. Compagnia di San Paolo is still the main shareholder of Intesa San Paolo.

[12] The name of the company derives from Svenska Kullagerfabriken AB. SKF produces ball bearings and has huge plants around Turin.

tivities. As of May 2014, SARTT had a staff of 30. The specific office for technology transfer at SARTT was TT&IL (Technology Transfer Division and Industrial Liaison), founded in 2000. As of 2012, TT&IL had a staff of ten. Employees hold a bachelor's or master's degree, and the director has a Ph.D. in the sciences. Today, SARTT has been split to three different offices: TRIN (Trasferimento tecnologico e Relazioni con l'industria, Technology Transfer and Relations with Industries) responsible for industry partnerships and contracts, as well asspin-off licensing; and LabTT (Laboratory for Technology Transfer), managing patents commercialization and projects with the aim of research valorization; moreover there is also ARI (Area Ricerca, Research Area office) giving support to research. TRIN has a staff of six with law background; LabTT has a staff of seven with either a Ph.D.s or an MA in Management engineering.

As previous studies show, the strength of a TTO can be seen in its reporting levels within the organization (Bercovitz *et al.*, 2001; Bercovitz and Feldman, 2006). PoliTO had four levels of reporting between the TT&IL and the rector. The director of TT&IL reported directly to the SARTT director, and the director of SARTT reported directly to the general director of the university, who reports directly to the rector. Hence PoliTO had a rather long chain of command in technology transfer activities, which might imply that its interest in commercialization strategies is tepid. That said, the history of PoliTO indicates that it was structured around a mandate for commercialization and collaboration.

PoliTO has several channels of industrial collaboration. For example, it had strong research collaboration with Fiat, which attracted many of the institute's engineering graduates. In 1999 PoliTO created a new degree program in automotive engineering, in collaboration with the firm (Belingardi *et al.*, 2012). Moreover, as indicated by Macii (2011), between 2007 and 2009, funding from industry accounted for 47.7% of total research funding at PoliTO; the remaining 52.3% came from the EU and the national and regional governments. Moreover, between 2007 and 2009, industrial collaboration totaled 1,858 contracts with multinationals, such as General Motors Europe, Fiat, Microsoft, Pirelli, and Avio. Lastly, we can point to several joint ventures, such as ST-PoliTO S.c.a.r.l., a joint venture created with ST-Microelectronics.[13]

PoliTO created other offices dedicated to technology transfer and commercialization. The Innovation Front End is a contact point for businesses that wish to cooperate with PoliTO in general and with the Mario Boella institute in particular. Its goal is to collect and understand requests for collaboration from industry and to properly connect them to faculty and researchers at PoliTO. In 2007 PoliTO launched a venture capital fund (Polo del Venture Capital, or Venture Capital Focal Point). This office is intended as a contact point between venture capital, business angel funds, and entrepreneurs (Rossi *et al.*, 2015).

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[13] A multinational that produces semiconductors.

I3P (Incubatore di Imprese Innovative del Politecnico di Torino) is the *politecnico*'s incubator.[14] Founded in 1999, I3P is the oldest Italian academic enterprise incubator. It is a joint-stock company of PoliTO, the government of the Province of Torino, the Turin Chamber of Commerce, Finpiemonte (Piemonte Region's Financial Institutions), and the city of Turin. The investment by the province and the city indicate that they view PoliTO as a central player in the local economy. I3P won the 2004 «Best Science-Based Incubator» Award from the Technopolicy Network (Technopolicy, 2004).[15] It ranked eleventh in the world in 2013 and fifteenth in the world and fifth in Europe in 2015 on the University Business Incubator Index (UBI Index, 2016).[16] As of June 2016, the number of incubated companies was 197.

The number of PoliTO spinoffs, as of June 2016, totaled 56. Hence, not all 197 startups that were incubated at PoliTO's I3P are official PoliTO spinoffs. Others fall under one of the following categories: the founder was a student, a former student, or an employee or the startup is based on university intellectual property. This indicates that I3P is a regional economic player.

4.1.3. ***Internal university factors: Commercialization policies at PoliTO***

PoliTO's mission statement expresses a positive view of technology transfer: «Politecnico has among its goals the transfer of technology, of innovation and of knowledge to the economic and production system» (PoliTO, 2011).[17] This statement shows the importance the institution places on collaborations with the entrepreneurial environment. The first intellectual property rights (IPR) policy at PoliTO was published in 2001 and updated in 2007 (Rossi *et al.*, 2015) and then again slightly in 2009, 2012, 2014, and 2015. Article 2 of the IPR regulations describes the importance of monetizing research results via economic exploitation, patenting, and knowledge transfer to enterprises. IPR regulations assign the researcher (either tenured or temporary) with the title of inventor. That is, if the invention is made at PoliTO labs and during research activities (work time), professors may choose to patent on their own or to patent through PoliTO, which will cover the costs of patenting. In the case of a commercial exploitation, royalties are divided equally between the inventor and PoliTO (50% is the minimum share for the academic inventor, according to national IPR law). The portion assigned to PoliTO is shared between the administration (40%) and the inventor's home department (10%). Previous studies indicate that royalty distribution in favor of the university encourages spinoff activity over licenses. However, this is not the case here.

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[14] Turin Politechnic's Innovative Enterprises' Incubator.

[15] Technopolicy Network is an international, Dutch-based network for the exchange of knowledge and experience on science-based regional development.

[16] UBI (University Business Incubator Global) is a Swedish-based company specialized in benchmarking and indexing university business incubators. See http://ubi-global.com (accessed June 2016).

[17] «Il politecnico pone fra le proprie finalità il trasferimento tecnologico, dell'innovazione e delle conoscenze al sistema economico e produttivo».

The first policy discussing spinoffs dates back to 2003. According to this policy, PoliTO spinoffs must derive from research activities performed at the university. This status is granted after a preliminary evaluation by a PoliTO spinoff committee, composed of members (from both inside and outside PoliTO) appointed by the rector. Founders must be tenured or temporary personnel at PoliTO; spinoffs can use the PoliTO logo, and PoliTO can be a shareholder. PoliTO spinoffs must undergo continuous assessment of their performance by the PoliTO spinoff committee. PoliTO takes between 5% and 40% of the firm's equity. In return, the firm's founding documents must contain clauses that protect PoliTO against changes in property and a representative on the board of directors. The agreements allow PoliTO IPR access for educational or research purposes, for a period of five years from the date of the firm's founding. Finardi and Rolfo (2015) analyze data for 32 of the official PoliTO spinoffs. Data on the industrial sector show that 40% of such spinoffs are small (1-2 employees) and focus on consulting and software.[18]

4.2. **Politecnico di Milano**

By the academic year 2013/2014, PoliMI had 40,110 students and 1,313 professors. It is considered a major Italian university thanks to its location in the region of Lombardia, whose population is more than double that of Piemonte, where PoliTO is located.[19] The total number of its publications has grown steadily in the past few decades (see Table 3). Considering that PoliMI has 60% more faculty than PoliTO, the number of publications and citations of the two institutes is comparable.

*4.2.1. **External university factors at PoliMI***

PoliMI was founded in 1863 as Regio Istituto Tecnico Superiore (Royal Higher Technical Institute) following, as PoliTO, the 1858 Legge Casati (Gobbo, 2006; Morosini, 2012; Ricci, 2008; Silvestri, 2010). Many schools and laboratories were also created with the contribution of local and national industry (Gobbo, 2006; Morosini, 2012; Ricci, 2008).[20] The institute moved to its new location at the end of 1927, converging with several other higher education institutions to form the University of Milan (Balboni and Corradini, 2013) and in 1937 the name of the university was officially changed to Politecnico di Milano. During the 1980s, the decision was made to move the institute to the post-industrial area of Bovisa, in the western part of the city, and between 1994 and 1997, the institute relocated to either new buildings or

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[18] ATECO, an Italian industrial classification, adopted by ISTAT (Italian National Statistics Institute), follows the most recent revision of the EU industrial classification NACE (rev. 2).

[19] More than 9 million inhabitants vs. more than 4 million.

[20] For instance, in 1907 the Laboratory School for the paper and textile fiber industry was founded with the contribution, among others, of the Papermakers' Association and the Cotton Industries Association; in 1909 the School for fat materials was founded by the initiative of a group of soap makers (Gobbo, 2006).

renovated industrial buildings. Over the following decade, further buildings were added in the same area to further expand PoliMI's scientific and teaching activities.

Table 3. **NUMBER OF POLIMI SCIENTIFIC PRODUCTS**

YEAR	SCIENTIFIC PRODUCTS	NUMBER OF CITATIONS	AVERAGE NUMBER OF CITATIONS
1996	760	18,780	24.71
1997	793	16,442	20.73
1998	738	13,493	18.28
1999	702	14,643	20.86
2000	784	19,288	24.60
2001	870	17,137	19.70
2002	859	16,425	19.12
2003	1,082	19,249	17.79
2004	1,280	22,148	17.30
2005	1,646	21,555	13.10
2006	1,893	22,396	11.83
2007	2,139	23,852	11.15
2008	2,224	26,297	11.82
2009	2,426	24,925	10.27
2010	2,718	24,529	9.02
2011	2,839	21,023	7.41
2012	3,209	17,345	5.41
2013	3,549	12,578	3.54
TOTAL	30,511	352,105	11.54

Source: Scopus, http://www.scopus.com, accessed September 2015.

The RIS in Lombardia includes some factors that affect the technology commercialization strength of PoliMi. First, Lombardia contributes 20% of Italian GDP and has low unemployment. Muscio (2006) points out that «the regional economy largely depends on … SMEs … tightly networked in a highly urbanized territory, which shows evident territorial clustering of firms producing similar products» (pp. 777–778, *passim*). Moreover, «Lombardy accounts for the greatest part of Italy's R&D and patent activity» (p. 778).

Second, the regional government promotes and evaluates collaboration between research centers and industry. In 1974 the regional government of Lombardia created the Regional Research Institute (IReR), which conducts studies on institutional, economic, territorial, and social assets and processes. In 2004, it established QuESTIO (Quality Evaluation in Science and Technology for Innovation Opportunity), a

system to foster collaboration between research centers and enterprises and to track the state of the art in technology transfer in the region. In 2011 IReR changed its name to Éupolis Lombardia.

4.2.2. ***Internal university factors: Commercialization organization at PoliMI***

Technology commercialization at PoliMI began in 1986 with the creation of the University Consortium MIP, which targeted education and applied research for innovation management and exploitation of new technologies. Established after the creation of the PoliMI Master in Engineering and Enterprise Management, the consortium aims to support the transfer of research results to enterprises and subsequently evolved into the PoliMI School of Management (Piccaluga, 2001, pp. 259-265). MIP is a not-for-profit consortium limited company, with a mission to manage PoliMI's school of Manaement (see also MIP, 2015).

The Servizio Valorizzazione della Ricerca (Research Promotion Service) is PoliMI's TTO.[21] As of 2016, the office has a staff of six: five engineers and one administrative assistant. Its mission includes the diffusion of the culture of intellectual property and technology transfer, extending research benefits to society as a whole, encouraging partnerships with industry to generate returns, and supporting the creation of new spinoffs. In 2001 the TTO became part of the university's central administration. Its director is delegated by the rector to oversee matters relating to intellectual property and enterprise creation, so its governance is connected to the top organizational level more directly than is the case at PoliTO (Conti and Bianchi, 2012). The main duty of the TTO is to support PoliMI professors in their IPR activities.

PoliMI's official webpage reports that 1,216 patents have been granted as of June 2016.[22] According to the Patiris database, as of 2016 PoliMI ranks second nationally and is the top-ranked university in the number of patent families –757 (the top national institution is the National Research Council of Italy)–. As seen in Table 2, like PoliTO, PoliMI is among top patenting universities (if not the top one) in Italy, but compared to top international actors, its level is low.

In addition to the TTO, the most relevant other organization dedicated to commercialization is PoliMI's incubator, PoliHub,[23] called Acceleratore d'Impresa (Enterprise Accelerator). Established in 2001, PoliHub is a joint stock company between

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[21] See http://www.polimi.it/ricerca-scientifica/brevetti/servizio-valorizzazione-della-ricerca-staff/, accessed June 2016.

[22] See http://www.polimi.it/en/university/figures/#c22010/, accessed October 2016.

[23] http://www.polimi.it/ricerca-scientifica/polihub-incubatore-dimpresa/; http://www.polihub.it, accessed January 2016.

Fondazione Politecnico di Milano (which holds 50%),[24] the MIP, CEFRIEL (a consulting company), and POLI.design (a consortium between PoliMI and some professional associations, performing arts, and design education), which hold 16% each. Someone delegated by the rector of PoliMI leads PoliHub, together with an advisory board and a board of directors. In 2015 PoliHub ranked fifth in the world and second in Europe on the UBI Index (2016).

Although PoliMI's spinoffs are entitled to be incubated at PoliHub, not all of them are, and many choose not to do so. Data on official PoliMI spinoffs from the national database of academic spinoffs «Spinoff Italia»[25] list 37 as of December 2015. Only 15 of these university spinoffs were incubated at PoliHub, which, like I3P, accepts other regional players. As of early 2016, the university owns shares in 12 spinoffs[26]: five in manufacturing[27], two in editing (one in telecommunications and one in software), three in consulting, and three in R&D.

4.2.3. ***Internal university factors: Commercialization policies at PoliMI***

The mission statement of the university highlights the importance of technology transfer: «The first target of Politecnico is the elaboration and transmission of knowledge in the fields of science, technology, liberal arts, and socio-economy, to promote and organize research, the training of students and professors in the fields of architecture, design, engineering and all the other boundaries of engineering culture promoted by the Politecnico».[28] In addition, technology transfer is cited as a departmental requirement.

The role of the TTO is described in the 2011 «Regulations on university industrial property».[29] The document discusses the duties of the TTO: supporting inventors before the start of the patenting process; supporting inventors in evaluating patent exploitation; managing contacts with IPR professionals in order to patent inventions; strategically managing the technology transfer of the patent portfolio identifying per-

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[24] http://www.fondazionepolitecnico.it/en/; according to the website its mission is "«to support the university's research projects and contribute to innovating and developing the economic, productive and administrative environment. Fondazione Politecnico is committed to building a more effective relationship between the university, industry and public administrations».

[25] See http://www.spinoffricerca.it/ (accessed June 2016). The database is maintained by the Università Politecnica delle Marche, NetVal and the Scuola Superiore Sant'Anna.

[26] http://www.polimi.it/ricerca-scientifica/brevetti/spin-off/elenco-spin-off/, accessed January 2016.

[27] The specific fields are manufacturers of computers, electromedical equipment, electrical engines and generators, instruments and measuring tools, and other parts and accessories for motor vehicles.

[28] «Il Politecnico ha per fine primario l'elaborazione e la trasmissione delle conoscenze scientifiche, tecnologiche, umanistiche ed economico-sociali, la promozione e l'organizzazione della ricerca, la formazione di studenti e docenti nel campo dell'architettura, del design, dell'ingegneria e degli altri ambiti della cultura politecnica promossi dall'Ateneo».

[29] The regulations were first issued in 2008.

spective buyers/licensee; performing all the formal steps needed for technology transfer of inventions; and supporting PoliMI's IPR. Those rights are assigned as follows. If licensing is transferred to PoliMI, royalty shares are divided, between the inventor (60%) and PoliMI (12% to the department and 28% to the administration). If the invention derives from an externally financed research activity, 80% is assigned to the inventor and 20% to the administration. Thus, the proportion of shares assigned to the inventor is slightly more than the minimum stated in the law (50%).

The most recent spinoff regulations date to 2011. The first part details the responsibilities of the major parties in the commercialization process. The rector (or someone delegated by him) promotes entrepreneurial initiatives while the TTO grants PoliMI spinoff status to applicants. The accreditation procedure of the new spinoff is carefully described, as are the procedures for determining the proportion of PoliMI's share. In particular, prospective entrepreneurs must show the spinoff commission a three to five-year business plan, explaining why their firm should be accredited as a PoliMI spinoff.

5. DISCUSSION AND CONCLUSION

The descriptions of the factors at the two universities show similarity as well as differences. As Guagnini (1988) describes, the two universities have similar origins, as engineering «schools», established in the same years in response to the same law. Moreover, both universities were created with the aim of offering engineers more practical education, in the context of industrialization in the aftermath of Italy's national unification, and thus both were part of the local industrial context. The two universities have also shown a strong commercialization push since the end of the 1990s, which was a critical period in the development of university commercialization in Italy. In Table 4 we compare the two institutions' resources and output side to side. As can be seen, PoliMI is larger and has more resources. The traditional output of publication and citations at both institutions is at the same level as the available resources. However, when we examine the commercialization resources and output we find that PoliMI has stronger industrial relations than PoliTO, which are reflected in their industrial commissioned research. Moreover, their technology commercialization output, in particular patents, is larger than PoliTO. The only area in which PoliTO has an advantage is in the number of spinoffs. This difference in output can be explained by the royalty share policy of PoliMI, which favors licenses over spinoffs.

Our examination of the environment in which both institutions operate shows that programs supporting technology transfer are created by the regional governments. With some differences, both universities show a good deal of embeddedness in the local industrial context. Industry in Piemonte is predominantly mechanical, especially automotive and aerospace, while Lombardia has a more diverse industrial base. Although both receive industrial funding at globally comparable levels, PoliMI is capable of competing with leading institutions such as Harvard and UCLA (NSF, 2014).

Table 4. **COMPARING POLITO AND POLIMI**

	PoliTO	PoliMI
Students	28,863	40,110
Faculty	813	1,313
Research expenditures, 2014 (estimated)	74,246,098	116,132,244
Publications, 2013	2,208	3,549
Citations, 2013	7,770	12,578
Patents, 2014	475	1,212
Revenues deriving from commissioned research and technology transfer, 2014	18,740,935	42,662,200
Spinoffs	56	37

Sources: MIUR 2014; Scopus; PoliTO and PoliMI balance sheets.

An analysis of internal university factors that affect technology commercialization finds institutions that have dedicated resources to technology transfer but through different agencies and with different approaches. The TTO at both institutions have a similar size and structure with one difference: the director of the TTO at PoliMI reports directly to the university's rector, but PoliTO has four levels of reporting. Both universities have nationally and internationally acclaimed incubators. In addition to working with university spinoffs, both incubators accept regional firms with no official connection to the universities. At the policy level, both cases demonstrate substantial reception and acceptance of national policies regarding IPR.

To evaluate the universities in international terms, we compare the technology transfer output of the two institutions with that of a comparable engineering school, the Georgia Institute of Technology (Georgia Tech). Established in 1888, Georgia Tech now has 1,140 faculties and 25,034 students. The research, grants, and contracts budget for 2015 was $648.2 million, of which 11.3%, or $73 million came from industry (Georgia Institute of Technology, 2015). PoliMI can compete with Georgia Tech in terms of funding by industry, but its total research budget is one-fifth the size. In this context, and considering the commercialization output for the level of funding, the two Italian polytechnics perform very well in comparison to their international counterparts.

A comparison of the two cases to each other as well as globally reveals an interesting story regarding the impact of specific universities' policies and approaches to technology commercialization. Although Italy established some of the oldest universities in the world, the country came late to commercialization. Moreover, Italy still does not provide the same level of funding support for its university research budg-

ets as many of its international competitors. Here is where the history of the polytechnics becomes relevant. These institutions, created to provide their students with technical skills and collaborate with industry, have been working hard to accomplish their mission and stay competitive in the global economy. Their publications, patents, citations, commitment to collaboration with industry through their spinoffs and incubators show the importance of the approach and the dedication of specific institution.

PoliMI uses its diverse industrial base to increase its industrial support for research. This support translates to publications and patents. The institution's dedication to commercialization is evident in the central role of the TTO in the university's organization. PoliTO, which is smaller and has a less diverse industrial base, is also very active in commercialization. However, it does not attract the same level of industrial funding nor does the number of reporting layers of the TTO director indicate its importance in the university's organization, though the mission statement of the university gives commercialization a prominent role. The choices made by these two institutions, coupled with their environment, affect their level of technology commercialization.

The goal of this paper is to investigate the factors that affect technology transfer and commercialization at Italian universities. In particular, this paper considered the effects of environment and history, as well as internal university factors. It does so through a review of technology commercialization in Italy in general and a case study of two technological universities: the Politecnico di Torino and the Politecnico di Milano. Our findings strengthen existing studies and indicate that the success of a university in commercializing technology depends on both external and internal factors. The importance of the local industrial base is as important as the individual institution's approach and resources dedicated to technology commercialization. But in the case of the polytechnics in northern Italy, having a stronger and more diverse industrial base nearby, compared to the shrinking automotive industry of PoliTO's environment, has played a large part in PoliMI's ability to commercialize technology.

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