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ESSAYS ON MARKET-BASED MECHANISMS IN HIGHER EDUCATION: CHALLENGES AND IMPLICATIONS FOR EUROPEAN UNIVERSITIES

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EXECUTIVE SUMMARY

In many European countries, a change from a public university model towards more responsible and procedurally autonomous organizations took place. The shift includes a strong emphasis on market, competition and related elements, like incentive steering, managerial capabilities, individual profiling and organizational learning, quality assurance and evaluation.

These recent higher education reforms have often been described as managerial reforms, which have moved the universities' governance regime towards a much more competition-driven and managerial arrangement. Yet, universities provide public services for which at least in most of the European countries no real market exists and their primary funding comes from public resources, hence these tendencies towards market and competition result at most in quasi-markets.

The introduction of quasi-market mechanisms led government to implement different policies to address these changes. They focused among others on three distinctive aspects:

(i) The cost sharing of higher education and the shift toward student tuition

(ii) The performance-based research funding mechanisms

(iii) The promotion of interaction with industry and the raise of academic entrepreneurship

This dissertation aims to investigate the main implications of the application of market-based policies to higher education, in terms of university managerial reactions. In relation to the diffusion of the cost sharing phenomenon, some universities decided not to modify their tuition price setting strategy, some have indiscriminately increased tuition fees, while others targeted for their recruitment strategy 'full fee paying' students more aggressively within the global higher education marketplace. Accordingly, the first essay of my dissertation investigates the dynamics of university competition on price setting decision after the 2008 financial crisis by relying on data from 59 Italian state universities over the period 2003-2014. Italy represents an interesting setting where to investigate the post-crisis dynamics of university competition as an example of both a Southern European country

strongly affected by the economic recession as well as cuts in public funds and a quasi-market where universities increasingly compete for attracting students.

Concerning the establishment of performance-based research funding mechanisms, universities adopted the strategy to position themselves at the top of the international rankings, as outstanding research institutions. The second essay of my dissertation investigates the issue of international competition and visibility. It provides an analysis of the impact of a specified policy intervention aimed to promote and select outstanding research active universities by allocating competitive additional public funds: the Excellence Initiative in Germany. In particular, it investigates (1) whether the policy approach is suitable to stimulate the system and the winners or not, (2) how the impact in terms of performance can be measured, and (3) whether the results are driven by country specific effects or generalizable.

Referring to the promotion of interaction with industry and the raise of academic entrepreneurship, universities became fully engaged in the spinoff activity. The third essay of my dissertation aims to contribute to the literature on the drivers of this kind of firms, by focusing on a specific university feature, the degree of internationalization. Academic spinoffs indeed are found to be more prone to internationalize than similar firms due to the essential role played by universities and in particular internationalized universities in offering networks and capabilities as well as dynamic and mobile human capital. University internationalization in this way contribute to the national economic growth by stimulating the international orientation of their affiliated firms.

As a whole, this thesis provides some insights into the main challenges that universities are experiencing in terms of marketization of Higher Education and their consequent managerial reactions. Hence, it discusses such reactions extensively, it outlines some theoretical and practical contributions and derives some policy implications.

1. INTRODUCTION

More and more frequently, market-like mechanisms have been introduced into Higher Education. Some market elements such as competition, freedom of choice, and customers' charge are injected into the system. Yet, government regulation and financing still remain important coordination mechanisms (P. Teixeira, Jongbloed, Dill, & Amaral, 2006).

A considerable number of governments are experimenting the use of market-like mechanisms as instruments of public policy, by stimulating market behaviour among public institutions with the aim of maximising the social benefits of national higher education systems (De Boer, Enders, & Schimank, 2007). Accordingly, the marketization of Higher Education has influenced state funding strategies and mechanisms as well as the way of evaluating and supporting universities. Two apparently contrary but mutually complementary strategies were adopted. The first reaffirms the nature of Higher Education as a public good, while the second subjects education to the disciplines of the business by redefining it as a competitive private good' (Marginson, 1999). The second strategy led to promote the growing financial dependence of Higher Education on third-party revenues, including contract research, student tuition fees, consultancy, income from third mission activities such as intellectual property and knowledge commercialisation revenue streams (Etzkowitz, 2002). Overall, these strategies boost universities to produce 'winner takes all' dynamics with strong polarizing effects by promoting research often to the detriment of teaching. They also guide efforts to deregulate higher education to allow the entrance of actors from private sector into the academic market place (Jessop, 2017).

This has important consequences for university governance (Amaral, Meek, & Larsen, 2003; Braun, 1999; Toonen, 2007), such as changes in internal management organization, quality assurance mechanisms, differentiated career tracks and new intermediary bodies for managing and transferring knowledge internally and externally (Slaughter & Cantwell, 2012). Reflecting this reorientation, practitioners are drawn into curriculum development, private sector managers are involved into

educational governance and agenda setting, accountants and financial managers increasingly influence formulation of university strategies, and mobility between the academy and non-academic worlds is fostered. Thus, the traditional model of university governance is being challenged by a strong emphasis on market, competition and related elements, like incentive steering, managerial capabilities, individual profiling and organizational learning, quality assurance and evaluation.

To sum up, market-based policies were introduced into Higher Education in an attempt to reduce inefficiencies, to generate additional revenues and to create innovative organisational models, leading to new institutional dynamics. The changes have affected management practices (Amaral et al., 2003), resource allocation within institutions and the internal evaluation of procedures and services. It has been a difficult process, even because most of these changes occurred in a context of decreasing resources. The assessment of these changes is complex, and sometimes highly controversial. Whereas promoters of marketization of Higher Education voiced that there have been significant achievements in terms of cost reductions and increases in teaching and research output quality, the sceptics voiced concerns over these developments, maintaining that they have contributed to organisational fragmentation, increased administrative bureaucracy or even led to an identity crisis (Barnett, 1990).

Discussing the contribution of these changes to Higher Education systems is worthy. The debate is built upon the awareness that governments and universities may have contradictory substantive goals. Indeed there is a potential contradiction in the production, circulation and valuation of knowledge seen as intellectual commons or as intellectual property (Jessop, 2007) promoted by the governments and university traditional commitments to free circulation of ideas, innovative products and practices as well as the evaluation of positive externalities from knowledge diffusion. This is what led some scholars to claim that markets cannot be fully established in higher education (see for example Hemsley-Brown, 2011; Marginson, 2013). Recent OECD discourses on universities reflect these tensions, switching uneasily between their role in providing public goods or private

benefit for students and other stakeholders (Hunter, 2013). My dissertation aims to investigate the main implications of the application of market-based policies to higher education, in terms of university managerial reactions by focusing on three distinctive aspects that mainly characterize the marketization of Higher Education:

(i) The cost sharing of higher education and the shift toward student tuition

(ii) The performance-based funding mechanisms to promote research excellence

(iii) The promotion of interaction with industry and the raise of academic entrepreneurship

In the next three subsections, it will be outlined what we know so far about these three concepts, the main research gaps in literature as well as how this thesis aim to contribute to, and the main research questions leading to the following analyses.

1.1 The cost sharing of higher education and the shift toward student tuition

The emergence of market mechanisms within higher education systems is particularly evident in the area of funding. The application of market-based policies to higher education led to the diffusion of cost-sharing phenomenon, consisting in direct charging for education services to students. During the last two decades, the governments of many countries around the world have shifted the cost of higher education from the state to the student. This effect is known as "cost-sharing" effect (Johnstone, 2003). By 2005, Australia, Canada, Italy, Japan, the Netherlands, New Zealand, Spain and the USA all had some form of student fee system contributing to the funding of higher education (Miller, 2010). This trend has occurred partly due to the ideological shift of conservative economists and politicians, partly due to the establishment of the liberal model and the liberal economists and partly due to the growing pressures on public budgets globally (Altbach, 2007). Several countries in Western Europe, such as Germany and Sweden, resisted the introduction of tuition fees in higher education until very recently, in some cases even for international students. Around the world, public undergraduate higher education is still provided free to "home" students in only a handful of

countries, such as Argentina, Austria, Denmark, Finland, Norway, Qatar and the United Arab Emirates.

Indeed, higher education is a mixed blessing: it can promote equality of opportunity, foster educational and socioeconomic upward mobility, contribute to countries' knowledge production and economic growth, and even lead to higher levels of health and life satisfaction. However, higher education also can be a tool of the reproduction of existing elites, it can plunge students into lifelong debt, and it can cause "negative redistribution" from the poor to the rich because the better-off are more likely to benefit from publicly funded college. Thus, depending on the composition of an existing education system, higher education can either mitigate or reinforce prevailing social, economic, and educational inequalities.

In this regard, a crucial matter is the well-known debate about the nature of higher education. Considering higher education as a private good is due to the rationale that students are the main beneficiaries of the degrees, hence they should bear a larger part of the costs of its provision. Considering higher education as a public good is based on the concept that the state should entirely fund it. While the state would have a limited role when higher education is intended as a private good, it would entirely fund it when Higher Education is understood as a public good. It is however difficult to assess which perspective should prevail as both of them might raise issues. In the first case (private good) higher education could become extremely expensive limiting itself to be an elite service, while in the second case (public good) higher education risks to completely loose its autonomy becoming a mere instrument of the state, not properly serving and developing the society. Along with this tricky balance, states have implemented different funding schemes where state allocated funding generally represents an important asset to ensure a large participation of students at the higher levels of education leading single institutions to mitigate their level of tuition fees.

As a systematic comparative descriptive overview on the variety of tuition-subsidy regimes across the advanced democracies, Garritzmann (2016) provides a huge comparative dataset on

tuition-subsidy systems in 33 advanced democracies (OECD countries), covering more than 70 characteristics of the respective tuition-subsidy systems. The main takeaway is that the advanced democracies fall in to "four world of student finance". In some countries (mainly continental Europe), tuition fees are low, but financial student aid is also largely non-existent (low-tuition-low-subsidy regime). A second group (comprising Nordic Europe) is characterized by the absence of tuition fees but very generous public subsidies (low-tuition-high-subsidy regime). The Anglo-Saxon countries form a third group, where most students are charged considerable tuition amounts but also often receive public grants or publicly subsidized student loans (high-tuition-high-subsidy regime). Finally, there is a combination of high tuition fees accompanied by sparse public subsidies in Japan, Korea and other Asias countries, as well as some Latin American countries (high-tuition-low-subsidy regime).

How do the tuition-subsidy systems differ across the advanced democracies? Why do countries' higher education finance systems differ so considerably? This question is particularly puzzling, because when one goes back to the immediate post-World War II period, all of these countries' tuition-subsidy systems look very much alike: systematic public subsidies were non-existent in all countries and tuition was comparably low (Eicher, 1998b; Nakata & Mosk, 1987).

Some important contributions have been made to the literature about higher education funding, by investigating the key determinants of tuition fees. Researchers have been investigating the drivers of tuition fees since at least 1970s (see Serna, 2017 for a review of the main studies). Extant studies mainly focused on the American context and suggested mostly economic reasons for the pricing of higher education. Accordingly, tuition fees strongly depend on the level of government subsidies. In U.S., states with relatively low levels of support tend to charge higher tuition and vice versa. Similarly, institutions where the rate of increase in public funding exceeds that in tuitions, student charges are among the lowest in the nation, while in institutions receiving a smaller percentage of state budgets the tuition came to represent a slightly larger portion of institutional

incomes (Rusk & Leslie, 1978). Nonetheless, tuition fees increase with students' willingness to pay for education at each university. This includes per capita income, as tuitions are higher where students have more resources (Lowry, 2001). Historically in the U.S., tuitions tended to rise roughly in accordance with increases in per capita income. States with higher per capita incomes have been more inclined to raise tuitions (Rusk & Leslie, 1978). However, per capita incomes only tell part of the story. Student aids reduces the net price recipients must pay, and thus such subsidies must also be considered. There did appear to be a direct correspondence between state students aids and tuition prices at the state universities, namely tuitions were high where aids were high and tuitions were low where aids were low. According to the Bennett (1987) hypothesis, increases in financial aids enabled universities to raise prices without feeling the consequences of reduced demand or lower-quality students, trusting federal government to subside high price with high student loans. Moreover, tuition prices should be related positively to institutional quality – or presumed quality, as students should be willing to pay more to attend campuses with better academic reputation (Lowry, 2001; Rusk & Leslie, 1978). Clotfelter (2014) and Winston (1997) recognize the relevance of reputation for setting tuition price as well by explaining tuition fees as a signal of institutional quality.

The debate surrounding university financing has been reanimated in recent years as many higher education systems experienced sharp tuition increases following the global financial crisis (European Universities Association (EUA), 2016). Evidence has been provided for U.S. (Best & Keppo, 2014; Gu, 2015; Serna, 2017) for U.K. (Bowl & Hughes, 2016; Bunce, Baird, & Jones, 2017; Delaney & Kearney, 2015; Esson & Ertl, 2016; Wilkins, Shams, & Huisman, 2013) as well as for Europe (Moulin, Flacher, & Harari-Kermadec, 2016 for France; Teixeira & Coimbra, 2014 for Portugal; Pigini & Staffolani, 2016 for Italy).

The financial crisis affected both supply and demand sides of higher education market. On the supply side, universities experienced cuts to multiple revenue sources especially government support as higher education budgets unrelentingly became a target for policy makers' austerity (Donald,

Glasmeier, Gray, & Lobao, 2014; Kitson, Martin, & Tyler, 2011). In terms of demand side, the downturn of the economy affected incomes and unemployment rates thus influencing both the probability of enrolling in universities and family's willingness to pay for tertiary education (Long, 2014).

Universities similar to many critical social and economic institutions suffered then the consequences of the global economic crisis beginning in 2008. However, whereas some universities have indiscriminately increased tuition fees, others targeted for their recruitment strategy 'full fee paying' students more aggressively within the global higher education marketplace and others continued to remain free from charge (Hotson, 2014; Martin, 2012). Universities indeed revised their tuition fees setting yet their strategic responses can diverge, as they do not face a homogeneous competitive pressure (Cattaneo, Malighetti, Meoli, & Paleari, 2017). Extant literature emphasises the emerging of spatial dynamics among the competitors in detecting the effect of competition in university price setting (Gu, 2015; McMillen, Singell, & Waddell, 2007). Nonetheless, whether the substantive economic upheaval caused by financial crisis changed competitive dynamics is still to be investigated (Serna, 2017).

The first essay of my dissertation aim to address the following research question:

How does financial crisis affect university price setting strategy?

1.2 The performance-based funding mechanisms to promote research excellence

Performance-based funding are defined as "*funds that flow to institutions where performance is manifest: 'performing' institutions should receive more income than lesser performing institutions, which would provide performers with a competitive edge and would stimulate less performing institutions to perform. Output should be rewarded, not input".* (Herbst, 2007, p.90)

In the case of performance-based research funding, additional funds are allocated according to certain research performance. Several are the countries implementing this funding scheme (Hicks, 2012) yet, the rationales behind change according to the perspective of analysis. Assuming the point of view of higher education scholars, it is part of a global reform of government management and represents the effort to improve performance and production and to reduce costs (Kettl, 2005). By contrast, research performance is widely regarded by policy makers as being a major factor in economic performance, as improving the capacity and quality of university-based research is expected to be essential for innovation. Moreover, the economic dimension of university-based research in terms of expected economic and societal benefit explain the concern for quality and excellence in research, for transparency, accountability, comparability and competition, and for performance indicators and assessment (E. Hazelkorn, 2010; HEFCE, 2011).

National governments themselves seem to uniformly aspire to achieve research excellence through performance-based research funding. The most debated policy intervention in this direction is the Excellence Initiative in Germany. The German federal government pursued the goal of international excellence, by awarding some centres of excellence to universities based on assessment of proposals (Huisman, 2003). Similar initiatives raised in other countries such as France (Benito & Romera, 2011), UK (Rebora & Turri, 2013a), Spain (Seeber, 2017), Nordic European countries (Elken, Hovdhaugen, & Stensaker, 2016) and Russia (Yudkevich, 2013); by Asian countries such as China, South Korea, Japan and Taiwan (Hou, Ince, & Chiang, 2012).

The search for excellence is not an end in itself but has the ultimate goals of enhancing the competitiveness of a given research system in a perspective of international competition, and improving the quality along with the reputation of universities. At least, these are the expectations of the policy makers, but how can they ensure that universities will behave according to their desires?

The so-called 'principal-agent model' addresses this issue. A principal with a mission and money (government in this case) engages one or more agents (universities) to perform certain tasks the principal cannot easily accomplish on its own. Agents are supposed to represent their principal's interests only in presence of positive incentives to do so. Hoenack's (1983) formulation of the principal-agent model identifies three ways by which agents can divert:

1. *Regulatory.* The principal may restrict the agent's freedom of action: for example, by requiring prior approval for decisions that involve resources. Tight control prevents resource diversion, but at the cost of efficiency. Transaction costs become greater as the tasks get more complex and the organisational distance between principal and agent increases. It is foolhardy to believe that a university's internal efficiency can be maximised from the outside.

2. *Formulaic*. The principal may use direct financial incentives to overpower the agent's intrinsic objectives. Such formulas become less effective as the difficulty of performance measurement increases. Designing appropriate is challenging as they must be precisely targeted to prevent unintended consequences. Formulaic control presents difficult challenges because the two parties' basic objectives remain out of alignment.

3. *Persuasive*. The principal may try to align the two parties' objectives by persuading the agent that whereas diversion may be attractive in the short term it will be eventually dysfunctional in the long term. This strategy minimises transaction costs, but it does not always work – especially in cases where there is no credible threat that the principal will switch agents - as in government control of education.

The performance-based research funding belongs to the second method. Incentives adopted by governments can be both financial and non-financial. Indeed, universities are often interested in aligning their behaviour to government's expectations for reputational motives. Universities are sensitive to the public judgment of their prestige. Accordingly, the attention of universities to international rankings is justified by the fact that their prestige increasingly depends on them. Indeed, students use rankings to decide where to enrol, and money follows students. In addition, the star scientists – more productive, grant-raising faculty – seek to work at more highly ranked institutions.

As this dual level of incentives is concerned, performance-based research funding mechanisms are difficult to evaluate because costs and benefits are not easy to disentangle. This is however not the only criticism around them. Hicks (2012) summarizes the most common. This incentive mechanism creates tension between autonomy and control. Governments can limit the autonomy of disciplines in peer review evaluation processes by dictating the criteria reviewers must use. Second, there is a tension between complexity and practicality. Peer review is held in high esteem as it is well accepted by the academic community in every country yet it is expensive and time consuming. By contrast, metrics enable broader scale and more current results to be used in funding decision though they are not transparent and easily intelligible.

The second essay of my dissertation aims to investigate whether the government expectations in terms of research excellence and higher education advancement are fulfilled by the introduction of performance-based research funding mechanisms. By adopting the German Excellence Initiative as a case of study – that can be however generalized to at least those countries adopting the centre for excellence approach – the research question leading the analysis is:

Does the German Excellence Initiative enhance the performance of the higher education system?

1.3 The university commitment with the industry and with the society in general

The university commitment with the industry started rather before the introduction of quasi-market in higher education. Education and science started to be reframed according to economic rationales already in eighteenth century (Weber, 1978) when raised the demand for diverse forms of knowledge. Accordingly, university reoriented teaching and research from isolated ivory-towers towards closer and more continuous contact with the state, the economy, and the society in general (e.g. Etzkowitz, 1994). Nonetheless, considering universities as economic actors raised several concerns about the centrality of traditional university missions (teaching and research) as well as the loss of identity of academics as scientists.

The vision of production, valorisation and application of knowledge as a key driver of the economic efficiency, competitiveness, profitability and effectiveness started to be heavily promoted again in the 1990s as crucial element in defending US technological and industrial competitiveness. One aspect of this shift was changes in federal funding for research, enabling universities to keep and licence the intellectual property rights in their discoveries and inventions. The first step in this direction is ascribable to the Bayh-Dole Act, a policy initiative from the Eighties allowing universities to retain profits from intellectual property developed on the campus (Grimaldi, Kenney, Siegel, & Wright, 2011). Similar developments occurred elsewhere, partly coordinated through international agencies such as the Organization of Economic Cooperation and Development (OECD, 1996) partly arising independently in response to the same competitive pressures and as a way of making sense of disruptive technologies and economic crises.

The Bayh-Dole like legislations stimulated the technological entrepreneurship in universities via patenting, licensing, start-up creation, and university–industry partnerships (for reviews of different channels of university technology commercialization see (Lockett, Siegel, Wright, & Ensley, 2005; Phan, Siegel, & Wright, 2005; Siegel, Veugelers, & Wright, 2007). All these activities are part of the so-called “academic entrepreneurship” phenomenon, whose objective is the

commercialization of innovations developed by academic scientists (for a comprehensive review of the literature on academic entrepreneurship, see Rothaermel, Agung, & Jiang, 2007).

Introducing competitive mechanisms in higher education is supposed to have enhanced innovation within universities. By producing well-educated human capital—students—and by attracting and retaining highly skilled 'talent'—scholars, post-doctoral fellows and students—universities are expected to exert a long-term influence on local and regional economies. Simultaneously, they are required to generate new knowledge that can subsequently be mobilised by economic actors in the wider society. Knowledge is at the basis of the economic growth. According to the endogenous growth theory, economic growth is driven by the accumulation of knowledge and technologies, which are viewed as forces that are internal to the economic system, endogenous indeed (Romer, 1986). Such knowledge necessary to grow does not spill over automatically but instead requires a transmission mechanism such as entrepreneurship (Acs, Braunerhjelm, Audretsch, & Carlsson, 2009). Accordingly, several scholars suggested to add entrepreneurship or the propensity to start new firms to models explaining economic growth as the knowledge of individuals is commercialized by the start-up of new ventures (Acs et al., 2009; Audretsch & Keilbach, 2004).

Given the widely acknowledged importance of new venture creation to innovation, employment and economic growth, governmental actions at both the national and sub-national level triggered the emergency of start-up activity. Among the start-ups, academic spinoffs gained a central role in the scholarly debate and in the policy agenda in recent years. In the academic panorama, extant studies focused on both institutional and context determinants of academic entrepreneurship. The first stream of literature mainly investigates the role played by characteristics of parent universities (Colombo, D'Adda, & Piva, 2010; Colombo & Piva, 2012; Link & Scott, 2017; Siegel, Waldman, Atwater, & Link, 2004; Siegel, Westhead, & Wright, 2003). Specific attention was devoted to the technology transfer offices (TTOs) and the way they can create a structural environment that fosters the creation of academic spinoffs (Clarysse, Wright, Lockett, Van de Velde, & Vohora, 2005; Siegel

& Wright, 2015; Wright, Hmieleski, Siegel, & Ensley, 2007). The second stream of literature instead emphases the role of local-context support mechanisms and regional conditions in enhancing entrepreneurial activities (Audretsch, Hülsbeck, & Lehmann, 2012; Fini, Grimaldi, Santoni, & Sobrero, 2011; Meoli, Paleari, & Vismara, 2013). At the same time, governments around the world have attempted to design measures for the support of firm creation as well (Lerner, 2010). Policy makers seek to promote the birth of start-ups mostly by mitigating the obstacles faced by entrepreneurs when starting new firms. However, policy efforts to incentivize innovation may include organizational sponsorship and human capital development of preferred activities (Amezcua, Grimes, Bradley, & Wiklund, 2013) through tax incentives, business incubators (Kolympiris & Klein, 2017), and science parks (Hobbs, Link, & Scott, 2017). Some national policies go further in the sponsorship of capital market institutions, venture capital, and stock markets (Munari & Toschi, 2015).

Unfortunately, the results of such policies have not always been particularly successful. Empirical research focused on the evaluation of specific interventions found mixed evidences (Autio & Rannikko, 2016; Cantner & Kösters, 2012; Jourdan & Kivleniece, 2017). Fostering the creation of start-ups without scrutinizing their quality can be an ineffective public policy (Colombelli, Krafft, & Vivarelli, 2016; Shane, 2009). In fact, most start-ups fail, only few are able to grow and to succeed in generating jobs and commercializing technology. Government policies became more selective by targeting start-ups that are more promising rather than new firms in general. Starting from the U.S. in the year 2011 and quickly followed by several European and Asian countries, governments have pursued and implemented specific national (and super-national) policy actions with the explicit aim of offering support only to promising start-ups in terms of innovativeness (for an overview, see the *2016 Startup Nation Scoreboard*). By implementing national *Startup Acts*, innovative start-ups receive tax reliefs and other benefits (e.g., simplified administrative requirements, flexible contracts to employees, possibility to raise capital through equity crowdfunding, accelerated liquidation procedure) that are supposed to facilitate business and innovation processes. These actions have

contributed to generate and identify a growing number of innovative start-ups in few years. The principal rationale behind is that innovative start-ups outperform other companies.

Whether that is the same for academic spinoffs, it is still motive of investigation. According to extant studies on academic entrepreneurship, firms spun out from universities are expected to have the edge over other comparable firms due to their intrinsic nature. Especially, the relationship with their parent university is decisive by providing financial resources, human capital, knowledge and skills, and competency (Rasmussen, Mosey, & Wright, 2011). Thus, once an academic firm is spun out, its performance can be more fully understood by examining its network (Anand & Khanna, 2000). A great deal of research focuses on the network relations of spin-offs, demonstrating that a developed network of strong relationships may be beneficial (Hoang & Antoncic, 2003). Organizations can gather a variety of resources held by other actors such as market information, ideas, problem solving, social support, venture funding, and financial resources (Hoang & Antoncic, 2003; Johannisson, B. & Monsted, 1998; Nicolaou & Birley, 2003a, 2003b; Shane & Stuart, 2002).

Under the lens of network theory, the third essay of my dissertation aims to investigate whether academic spinoffs outperform innovative start-up counterparts and whether academic spinoffs outperform due to their university affiliation. In particular, the focus is on internationalization because internationally oriented start-ups are important in terms of national economic growth (Oystein, 2002). Internationalized new ventures may contribute to the generation of positive knowledge spillovers, to increased competition and diversity in the economy, and consequently to economic growth. Exporting firms on average tend to be more productive, more capital intensive, and more innovative (Girma, Greenaway, & Kneller, 2004; Kneller & Pisu, 2007). There are two explanations. First, in order to be able to export, firms need some kind of competitive advantage such as unique resources or innovative abilities, because they have to adapt their products or services to foreign markets. Exporting firms either already possess these resources and capabilities before entering a foreign market or they have to develop these since the knowledge and capabilities that the

firm has developed for the local or national market are often not suitable to operations abroad (Lu & Beamish, 2001). Second, export activity has many potential benefits for firms not only in terms of financial gains, as export may also contribute to learning or competence development. By doing business abroad, firms are exposed to new processes and technologie,s which may further contribute to increased productivity and innovativeness. In sum, exporting facilitates both the exploitation of existing knowledge and the acquisition of new knowledge (e.g., market knowledge and technological knowledge).

The main research questions driving the third essay of my dissertation is:

Do academic spinoffs internationalize more than innovative start-up counterparts?

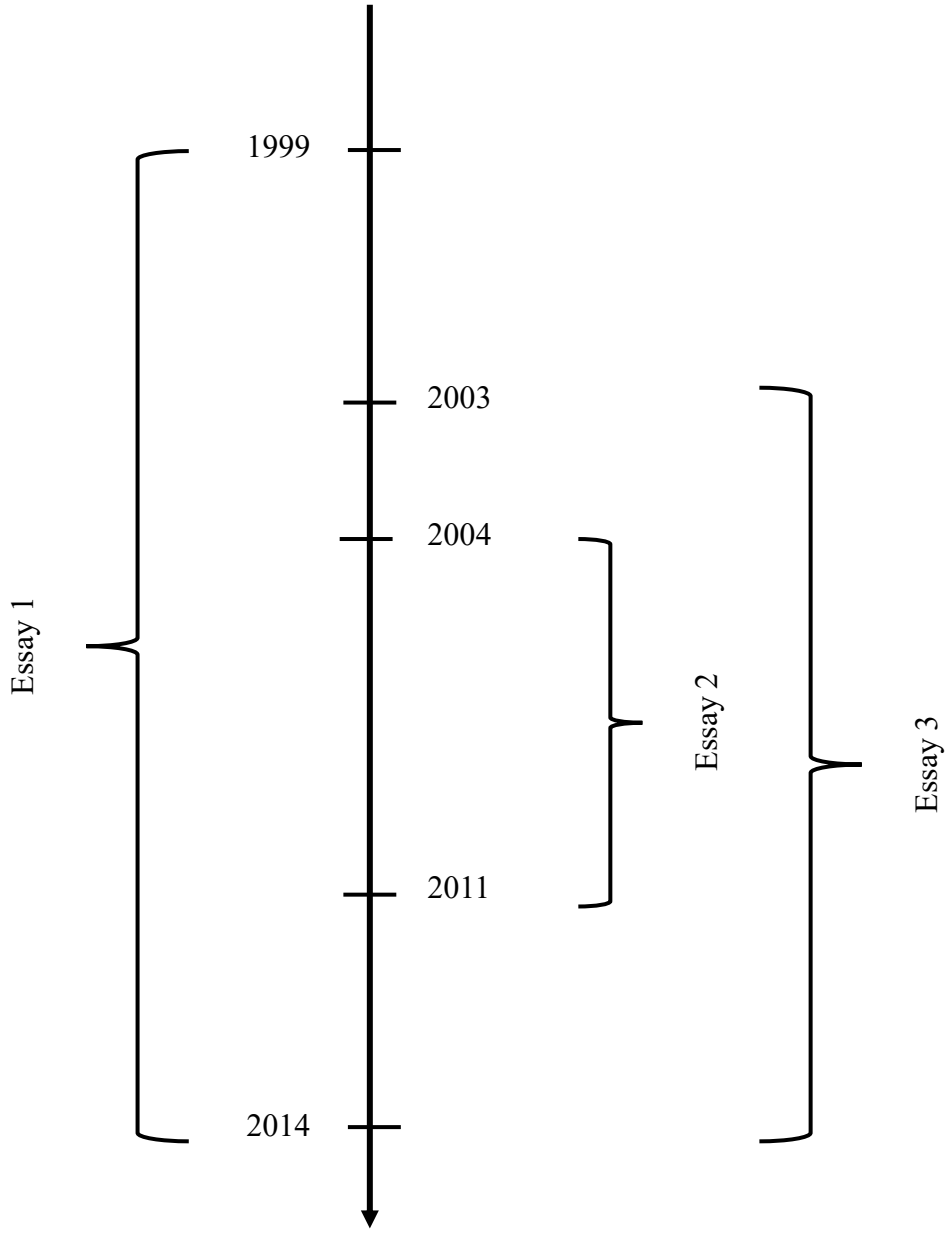
Do academic spinoffs internationalize more due to their affiliation with university?

2. A COMMON TIMEFRAME FOR THE ANALYSIS

Considering the university response to the introduction of market-mechanisms in the higher education system requires a long period of analysis. I adopted a timeframe from 1999 to 2014, as graphically represented in **Figure 1**.

Figure 1. Chronological perspective.

The figure exhibits the timeline with the most significant dates included in my dissertation.



The year 1999 is decisive to analyse the reaction of the universities to the promotion of alternative source of revenues, in particular those coming from the interactions with industry and the raise of academic entrepreneurship. The promotion of university-industry collaboration started to be heavily promoted in the 1990s by, among other agents, the Organization of Economic Cooperation and Development (OECD 1996), as universities with their knowledge production and diffusion became a key driver of the economic efficiency, competitiveness, profitability or effectiveness. This phenomenon led to the diffusion of policies supporting university engagement with the territory. There was the belief among European policy-makers in a so-called "innovation paradox" (European Report on S&T Indicators, 1994; EC Green Paper on Innovation, 1995). The innovation paradox emphasizes that Europe leads in producing publications, but lacks commercial skills. Therefore, during the 1990s, European policy makers convinced that universities should have an active role in the innovation process introduced changes in the legislative framework, by establishing a variety of policy instruments to support academic spin-offs. In particular, the year 1999 was decisive for several European countries, among others Germany, Belgium, France, and Italy (see Clarysse, Wright, Lockett, Mustar, & Knockaert, 2007). In 1999, a significant boost for academic entrepreneurship in Italy came in the form of a new regulatory framework (Law 297/1999, followed by Ministerial Decree 593/2000), allowing public researchers to be involved in technology transfer activities without negative consequences for their jobs or wages. 1999 is the starting point of my analysis in the third essay.

The year 2003 is instead decisive when considering the raise of tuition fees in Italy, as in 2003 there was in important change in the allocation of the government funds for higher education. Since the beginning of the 1990s, the Italian university system has been changing significantly through the implementation of a series of reforms. In 1993, an important reform process began, increasing the autonomy of universities in teaching and in managing financial resources. This process introduced a new competitive environment, in which each university is in competition with others for the

assignment of public funds. Since 1993, the central government transferred to each university a global lump-sum fund (called *Fondo di Finanziamento Ordinario* – FFO), that could be managed by universities autonomously. The assignment of the FFO to universities was based mainly on the amount received in the previous years. Yet, since 1998, a constantly increasing part of the total (FFO) budget began to be distributed according to a formula. The part of the FFO distributed in this way increased sharply from 1.5% in 1998 to 9.5% in 2003. Starting from the following year, a new formula was proposed and adopted by the ministry, including new proxies for teaching and research performance (CNVSU 2004, 2005). The new model operated by determining the 'relative' weight of a university respect to three sets of parameters: (1) number of students, (2) number of graduates and number of formative credits accumulated by students, (3) external grants for research and 'success rate' in obtaining research grants from the ministry.

In December 2014, a new reform of the allocative formula of Italian state universities' core budget was put into effect to increase efficiency. The new funding method detached from the old practice, which was mainly based on historical patterns, so that the 'base component' of annual basic operational grant was allocated on the basis of a new principle, the so-called *standard cost per student*. At the same time, the performance-based component already operative in the previous funding formula, was increased. I do not include this new reform in the analysis, as I am interested to investigate the reaction of universities to the change of government funds allocation by considering only the legislative change in 2003. For coherence reasons, the last year considered in the third essay about academic entrepreneurship activity is the 2014 as well.

The year 2004 is the year when it was announced the Excellence Initiative, whose first phase started in 2006 and second phase in 2007 and lasted until 2011. A third phase was the implemented from 2012 to 2017, but it is not objective of analysis. As I did not want to make the model complicated by the dynamics coming from the re-election of the Excellence universities as well as from the loss of prestige due to the missing re-election, the timeframe of my second essay is between 2004 and

2011. The inclusion of the year 2004 and 2005 is driven by the willingness of including the announcement effect of such policy initiative as the behaviour of universities is expected to change as soon as the initiative was communicated.

2. ESSAY 1: THE EFFECT OF THE FINANCIAL CRISIS ON UNIVERSITY PRICE SETTING STRATEGY

Acknowledgement: This chapter is derived from the working paper 'Cattaneo, M., Civera, A., Meoli, M., Paleari, S., Seeber, M. University price setting in times of crisis: the case of Italy.' This paper was presented at 39th EAIR Forum in September 2017 and at the XXVIII Annual Scientific Meeting Associazione italiana di Ingegneria Gestionale (RSA AiIG 2017) in October 2017. In the current version, sections "Literature review", "Methods and data" and "Results" are fully my contribution; "Introduction" and "Conclusions" are written jointly with the co-authors. Moreover, I am responsible for all the changes in this chapter with respect to published version.

I am immensely grateful to the support received from my co-authors and I want to express my gratitude as well for the insightful comments offered by the participants at the DREAMT PhD Workshop in June 2017, especially to professor Giorgio Rampa, who was my discussant.

2.1 Introduction

"No economic aspect of higher education is of greater importance to the public, policymakers and parents than the setting of tuition" (Winston, 2003, p. 1).

If this is typically true for the Anglo-Saxon countries, studies on tuition setting in the European context barely focus on economic aspects. In Europe, tuition setting is commonly recognized as a policy instrument aimed to shape student enrolment and graduation rate. Policy makers have thereby the hard task to guarantee the conditions to give people the right to education and at the same time maintaining higher education system sustainable.

Along with this tricky balance, states have implemented different funding schemes. Therefore, the amount of tuition fees charged to students varies appreciably within the European panorama. Some countries such as the Netherlands, UK, Switzerland, and Ireland, charge high tuition fees to students yet, by relying on their system of public loans they are able to move forward issues concerning the sustainability of higher educations. By contrast, some European countries such as Germany, Austria, Denmark, Finland, and Norway among the others charge almost free tuitions by virtue of their virtuous system of public funds. In the other countries, the amount of tuition fees charged by institutions strongly depends to the extent to which state funding ensures a large participation of students (Seeber, Meoli, & Cattaneo, 2018).

This already tricky balance became even more complex with the advent of the recent financial crisis. The economic downturn has highly exacerbated the ability of universities to survive and support their activities mainly due to the important cuts occurring at a governmental level and the reduction of willingness to pay for education from students and their families. Universities needed to revise their tuition fees setting yet, their strategic responses can diverge. It is plausible that the degree of competition for students strongly affects university price decisions. Extant literature emphasises the emerging of spatial dynamics among the competitors in detecting the effect of competition in the university price setting (Gu, 2015; McMillen et al., 2007). Nonetheless, whether the substantive economic upheaval caused by financial crisis changed competitive dynamics is still to be investigated (Serna, 2017).

This essay aims to fill this gap by addressing the following research question:

How does financial crisis affect university price setting strategy?

To study the effect of the financial crisis on the university price setting according to the level of competition, I adopted Italy as case of analysis. Italy in interesting for several reasons. First, it is an example of a country strongly affected by the economic recession, where cuts in public funds put heavily universities to the test. For this reason, Italy can be assimilate to other Southern European

countries. Second, in the last ten years it has been characterized by deep changes in the competitive landscape, in terms of competition for students (Cattaneo, Malighetti, et al., 2017). Third, whereas the vast majority of literature on tuition fees concentrates on Anglo-Saxon contexts, investigating Italy can shed light on price setting decision of similar continental European countries.

2.2 Literature review and hypotheses development

Price decisions in every industry may change under abnormal market conditions caused by exogenous shocks such as natural disasters and economic crises. In presence of turbulent times, supplies can become limited and retailer costs can rise in the form of price increases to consumers (Ferguson, 2014). Consumers can react negatively (Homburg, Hoyer, & Koschate, 2005) compounding the poor economic situation facing sellers, since they face difficult personal financial situational factors (e.g., lost wages, less discretionary spending) and consumers' attitudes and behaviour worsen (e.g., less trusting, more price sensitive).

Higher education sector is not an exception. The economic crisis led universities to increase prices to face financial constraints, due to on one hand raising costs of education and on the other cutting government funding for education (Teixeira & Koryakina, 2013). Universities were therefore forced to raise tuitions on average in order to survive.

Hypothesis 1: After the financial crisis universities charged students with higher tuition fees.

At the same time, the demand for higher education decreased as the recession restricts families' income as well as the general economic wellbeing and stability (Long, 2014). Marketing studies provide insights into pricing strategies aimed at justifying in the eye of consumers the implementation of price increases during turbulent times. Among other recommendations, Ferguson (2014) argues that sellers who increase price in turbulent economic times reduce perceptions of price unfairness by using a price-setting practice common to sellers within the same industry.

Thus, in the higher education literature, the presence of competitors is well recognized to affect university pricing behaviour (Hoxby, 1997; Ordine & Rose, 2008). To date, the American context is the most studied from this perspective. McMillen et al. (2007) illustrate that there were price-setting practices among private universities, which responded to the geographic proximity of competitors by rising tuitions. Gu (2015) enriches the study cited above by demonstrating the actual and robust importance of spatial dimension into price model of universities, by relying on the top 100 ranked U.S. universities. Moreover, the author shows that the relationship between prices and geographical distance of universities is not an inverse linear relation as assessed by McMillen et al. (2007) but rather an inverse U-shaped one. In addition, Serna (2017) examined tuition fees setting as a competitive response in the U.S. higher education market according to the Rusk & Leslie (1978), by considering as subject of analysis regions instead of subsamples of institutions and arguing that the same effect can be valid for public universities.

Hypothesis 2a: After the financial crisis, universities increase their price if the competition is high.

Different practices are proposed by other authors in the field of marketing. Ang, Leong, & Kotler (2000) suggest two alternative strategies related to pricing in conditions of crisis: to apply the same prices for higher quality products, or to offer the same quality product at lower prices. The former consists in a strategy of price maintenance, which allows firms to achieve high customer loyalty, to lose poorer customers to competitors and to maintain the brand reputation integer. In turns, customers receive improvements in the product offering in terms of durability and functionality. The firm, however, must be prepared for a smaller market share and lower profitability in the short term. The latter allows firms to hold on to or expand their market share but to the detriment of lower profit margins. In some industries, once market share is lost it is hard to recoup because competitors work intensively to protect their own turf. However, businesses should bear in mind that once a price cut

is implemented, it is very difficult to reverse it when times improve. Therefore, instead of offering a permanent price cut, businesses can offer promotional discounts.

The latter strategy is in accordance with the study of Shama (1978), who explains that an economic crisis forces a significant change in the price decisions of companies, mostly in the direction of reductions for those operating under stiffer competition. The author illustrates the example of the steel industry that in 1975 experienced a period of recession. The steel industry operated under conditions of very weak demand because the major consumers of steel (i.e. the automobile industry and the appliances and housing industries) decreased their demand as they faced demand reduction for their own products, and under conditions of increasing costs of producing sheet and strip raised by 30%. Although the market was very weak, the steel industry increased its list prices 6% in September 1976. However, because of the weak market and strong competition, many companies were willing to sell at the old price.

Even though there are no studies in higher education literature investigating the potential changes on price setting dynamics in competitive environments produced by the global economic recession of 2008, it is possible making a parallelism basing on marketing theories. Universities are forced to raise tuitions on average after the financial crisis, but it is plausible that those operating under competition charge students with lower prices by maintaining their quality with the aim of defending their turf and at the same time attracting new students (or according to Ang's terminology, gaining market share).

Hypothesis 2b: *After the financial crisis, universities reduce their price if the competition is high.*

2.3 Institutional framework

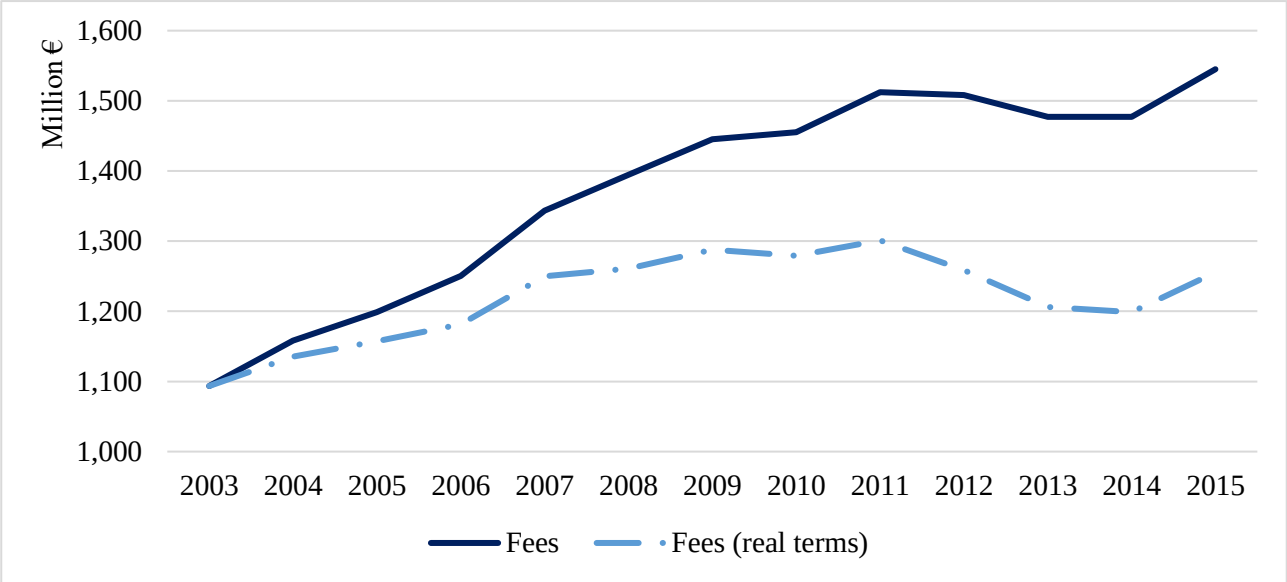
Italian universities have a certain autonomy in setting prices for students. Student contribution can vary by discipline and course of study—bachelor's or master's. Each university is free to determine

the level of tuition that non-regular students (so-called *fuoricorso*), namely those students who take longer than the nominal duration of their degree course to graduate, have to pay. This amount can be up to double that paid by regular students, according to the limits and criteria specified in the annual decree of the Italian Ministry of Education (Law 7 August 2012, no 135). Similar to the case of non-regular students, universities autonomously set the price for non-European students and for Italian students residing abroad (Decree of the President of the Council of Ministers 5 December 2013, no. 159). However, in this regard, it should be pointed out that in Italy tuition fees' setting at public universities is regulated by law and cannot exceed 20% of the single state-allocated fund called *Fondo di Finanziamento Ordinario* (FFO) (Law 7 August 2012, no. 135, conversion into law with modifications of Decree-Law 6 July 2012, n. 95).

The centralization of the price setting mechanism had notable effects on university budgets: in 2014, in public academic institutions, student tuition fees made up only 12% of the total revenue while the residual 88% consisted of the FFO. Nevertheless, the trend characterized these two funding mechanisms could not be more different. Student contribution has thus grown since 2000, going from €1.1 to €1.55 billion (see **Figure 2**). Moreover, whereas in 2000 the majority of Italian public universities set tuition fees lower than the ceiling required by law, in the following years the same institutions significantly raised students' contribution up to the threshold imposed by law (Minelli et al., 2012).

Figure 2. Nominal and real tuition fees over the period 2003-2015.

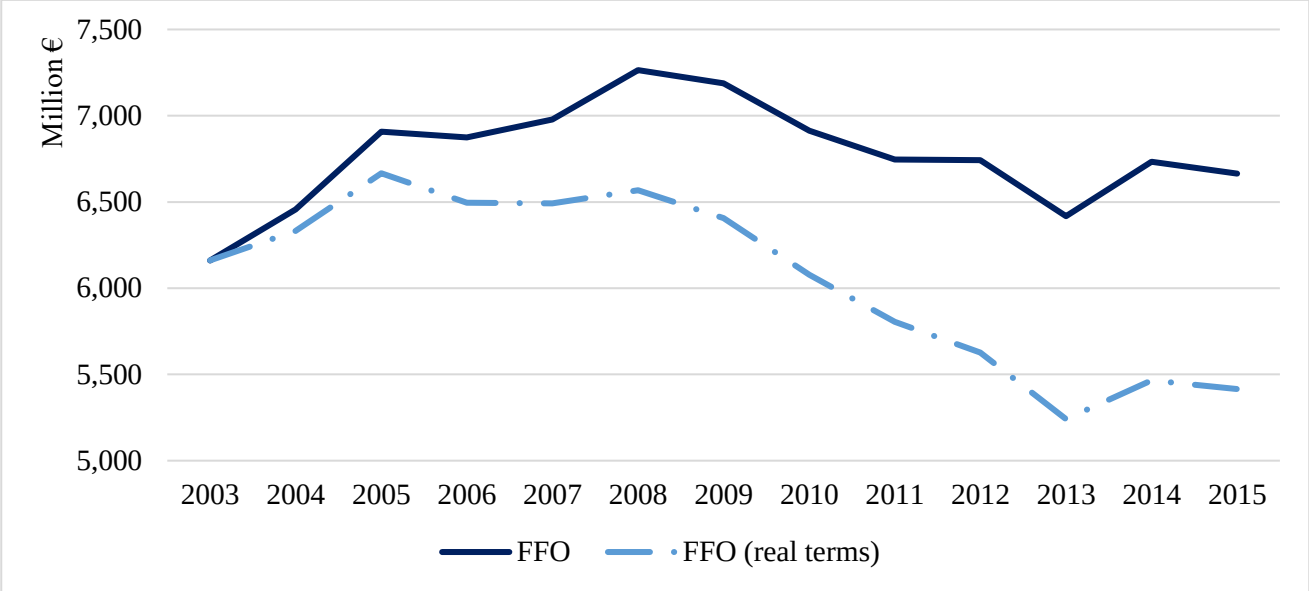
This figure represents the total tuition fees charged in Italian state universities from 2003 to 2015. The amount of tuition is measured in real terms, taking 2003 as base year.



By contrast, Italian public funds were characterised by a period of stagnation up to 2008, as the FFO remained rather steady in real terms from the beginning of the century. However, beginning in 2009, the government started to reduce the public funds intended for the higher education sector even in nominal terms because of both the beginning of the financial crisis, which aggravated the already huge Italian public debt, and the political disinterest toward the university sector (Capano, 2010). Therefore, whereas in 2008 the FFO amounted to around €7.3 billion (+18% in only 4 years), since than it has decreased by 7.3 percentage points and in 2014 it totalled €6.7 billion (see **Figure 3**).

Figure 3. Nominal and real FFO for Italian state universities from 2003 to 2015.

This figure represents the total FFO received by Italian state universities from 2003 to 2015. The amount of FFO is measured in real terms, taking 2003 as base year.



Starting from 2009, the allocation mechanism of the FFO changed considerably. Historically, the central government transferred a global lump-sum fund (the FFO) to each university that could manage it autonomously (Agasisti, 2009). The assignment of the FFO to universities was based mainly on the amount received in the years before 1998, when a constantly increasing proportion of the total FFO budget began to be distributed according to a formula. In spite of this effort, the quota allocated via the formula was very low until 2009 when a growing share of funds was allocated based on teaching and research performance indicators (Donina, Meoli, & Paleari, 2015). During the period 2009–2014, the share based on performance grew between 0.5% and 2.9% annually while the historical component has decreased by about 14 percentage points (Geuna & Piolatto, 2016). However, in 2014, the overall performance share amounted to € 1.21 billion, just 18% of FFO funding, and the transferred financial resources from the government were still proportional to the university expenditure per enrolled student (Agasisti, 2009). These reforms resulted in increased university competition to capture the interest of a smaller but more mobile population of students

who move across the country to choose the most attractive educational offer (Cattaneo, Malighetti, et al., 2017). In practice, universities contend for a market of more geographically dispersed students. Hence, the share of students at Italian universities enrolled in a province different from that of origin increased by nearly 15% during the period 2003–2014. Two are the main reasons. First, since the financial crisis and the recent years of economic recession in Italy as well as in many European countries, students have been making their post-secondary education choices more selectively, even being prone to move more than in the past. Second, the development of transport infrastructure has facilitated the intensifying competition. The entrance into the transport market of low-cost airlines (e.g. Ryanair) and high-speed rail systems (e.g. Freccia Rossa) has encouraged long-distance students to move from southern areas to universities in the north of Italy over the last decade (Cattaneo et al., 2017). These changes have reduced travel prices, diversified services, and raised the frequency of connections.

Therefore, in Italy competition is for attracting students. Nonetheless, in this essay, I aim to understand how competition for students shapes the strategic decision of universities to set their price by considering the prices charged by the neighbour universities. Adopting spatial competition in investigating higher education dynamics is common in literature referring to both student competition (Cattaneo, Malighetti, et al., 2017; Gu, 2012) and price competition (Gu, 2015; McMillen et al., 2007) and it can be a good framework for this analysis.

2.4 Research design

2.4.1 Sample and data source

The aim of the analysis is to study the role played by competition in tuition price setting in the post-crisis period. The sample covers 59 Italian state universities observed from 2003 to 2014[1]. Private

[1] Italian universities are 97 in total; 67 are state universities, 30 non-state universities, 11 of which are long-distances universities. Among 67 Italian state universities, six are doctoral universities (i.e. Institute for Advanced Studies IMT Lucca, Sant'Anna School of Advanced Studies Pisa, Scuola Normale Superiore Pisa, University School for Advanced Studies IUSS Pavia, Italian Institute of Human Sciences SUM Firenze, International School for Advanced Studies SISSA

universities (30 organizations) are characterised by a business model different from the one used by the state counterparts and in order to study a comparable model of price setting, it is not appropriate to include them. Moreover, state universities constitute almost the whole Italian tertiary education market, enrolling the 95% of the entire university student body. Likewise, the sample does not include the six Italian state doctoral universities as well as three universities for foreigners. Both categories of tertiary education organizations are different from traditional public universities, since doctoral universities are specialized in research activities and in postgraduate courses, while universities for foreigners are specialized in teaching and research for the development and diffusion of the language, literature and culture of Italy.

My dataset relies extensively on the online database made available by the Ministero dell'Istruzione, dell'Università e della Ricerca (MIUR)[2] that provides specific institutional information on each university over time: students, professors, technical staff, and educational offerings. I also included in my dataset information provided by the Istituto Nazionale di Statistica (ISTAT) at the regional level, according to NUTS-2 classification.

2.4.2 Econometric model and estimation strategy

The model for the tuition level of university *i* at time period *t* with university-specific effects is specified as equation:

$$y_{it} = \alpha y_{it-1} + \beta x_{it} + \gamma w_i + u_{it} \quad (1)$$

where y_{it} is the average tuition fees per student in period *t*, y_{it-1} is lagged tuition level, x_{it} is the vector of time-varying regressors (including all variables except geographical position), w_i is the vector of time-invariant regressors (i.e. the geographical position) and u_{it} is a time-varying error.

Trieste) and two are universities for foreigners (University of Foreigners of Perugia, and Siena). There is finally a non-state university for foreigners in Reggio Calabria.

[2] http://www.istruzione.it/

According to Arellano & Bond (1991), estimation by ordinary least square (OLS) would not produce consistent results since the lagged dependent variable is correlated with the university effect by model assumption. Thereby, according to the Arellano and Bond's specification, the lagged dependent variable has to be included among the regressors. Arellano & Bond (1991) argue also that, by utilizing the orthogonality conditions that exist between lagged values of the dependent variable and the error term (ui,t), additional instruments can be obtained in dynamic panels. Specifically, these authors state that a valid set of instruments for $\Delta y_{i,t-1} = y_{i,t-1} - y_{i,t-2}$ is ($y_{i1}, y_{i2}, \ldots\ldots, y_{i,T-2}$). Similar sets of instruments are used for elements of the vector of explanatory variables (xi,t) that are considered to be endogenous or at least predetermined (Roodman 2009). I used all lagged regressors as instruments for endogenous variables.

Thus, estimation of Eq. (1) is first-differenced to eliminate time-invariant unobserved effects, and the lagged endogenous outcome variable is instrumented with earlier lags. The amount of FFO per student, the university size and the competition are considered endogenous variables. The endogeneity issue between tuition, appropriations, and enrolment is well known in higher education literature (Doyle, 2012; Paulsen, 1991). Indeed, the amount of state funds and the number of students enrolled can be both cause and effect of tuitions. Universities set tuition fees according to the level of state funds they receive, but it would be incorrect to suggest that a legislator decides on the level of appropriations without considering the impact of his/her decision on tuition. Similarly, universities set tuition fees in order to attract a certain number of students but on the other hand the students' decision to enrol in a given university is driven by the amount of tuition to pay. There can exist also endogeneity between tuition and competition. Price charged by universities are influenced by the number and the proximity of the competitors, but it also plausible that the level of competition is determined by the price charged by each institution (Gu, 2015; McMillen et al., 2007). The other variables in the model are considered exogenous and enter in the model directly as instruments along with their lags. The system GMM estimator adds first-differenced regressors as instruments in the

original equation, such that a system of both the levels and differences equations is estimated, as in Blundell & Bond (1998). Instruments are needed because the difference transformation generates a first-order serial correlation in the errors such that the lagged difference in tuition level is an endogenous regressor.

A concern with dynamic models is serial correlation in errors. The estimator subtracts the time invariant component of the error term, such that autocorrelation in the remaining idiosyncratic error would indicate potentially invalid instruments. I report the first- and second-order test for serial correlation in differences according to Arellano & Bond (1991) and the J test as in Hansen (1982) in order to test the exogeneity assumptions as well as the difference in Hansen tests of exogeneity of each instrument considered in isolation. Another potential issue concerns the number of instruments used in GMM system, since the model may be weakened by using too many instruments (see Roodman, 2009). The difference-in-Sargan test is reported even if, due to the wide sample size, the number of both observations and groups prevail on the number of instruments (Roodman, 2009). Moreover, a test for the GMM instruments for levels and a test for predetermined variables are reported at the bottom of each table (see for example Fini, Jourdan, & Perkmann, 2018).

2.4.3 Variables

In the panel dataset, the dependent variable is the average annual tuition *Fees per student*, defined by considering the total number of bachelor and master students enrolled per year per university[3]. The tuition fees level is then adjusted for inflation with 2003 as the reference year. The average tuition fees charged per student is commonly used as the dependent variable (McMillen et al., 2007; Neill, 2009; Rusk & Leslie, 1978). I do not distinguish between bachelor's and master's students as the majority of Italian state universities do not charge different price according to the course of study. I

[3] To generate the dependent variable, I used the number of total enrolled students rather than the number of paying enrolled students. This is due to the restraint of the percentage of Italian exempts (an average of 1% over the period). The University of L'Aquila, where the whole student body is exempt from paying tuitions, represents the sole notable exception. It is a consequence of the heart quake that in 2009 hit the city of L'Aquila.

do not consider the yearly difference of tuitions because by adopting a dynamic panel model, the difference is taken into account by the inclusion of the lagged dependent variable is in the model as one of the main predictors.

The key explanatory variables are financial crisis and competition. The financial crisis is a complex phenomenon and it is considered in the higher education literature as an exogenous shock. Then measuring it as a dummy variable can be appropriate. *Crisis* is a binary variable assuming value 0 before 2008 and 1 after in order to take into consideration the effect of the crisis from the beginning (Long, 2014). This definition is inspired by the work of Cattaneo, Horta, et al. (2017), who investigated the effect of the financial crisis on student university choice. Competition is instead proxied in three different ways derived from the general spatial competition models. First, the *Number of universities* per region is the application in the higher education sector of the more generally used measure number of organizations in a specific market (see Salop, 1979). Second, the *Inverse of the distance* among universities belonging to the same region is the equivalent of the inverse distance between two organizations as a measure of non-monetary transportation costs (see Brekke, Siciliani, & Straume, 2010, 2011). The distance between the origin province and destination university is a decay-parameter measured by considering the road distance between the legal residence of the university (destination) and the capital of each province (origin) for the percentage of the population of students living in the capital city. By contrast, for the share of the student population living in intra-zonal areas, the university–province distance is calculated based on the formula:

$$d_{\text{intra-regional}} = ((\pi - 1)/\pi)(\sqrt{s_p}/\partial)$$

where s_p is the area (m^2) of province p. In this formula, provinces are assumed to be circular and all areas homogeneously intensively used. The functional form considered is the inverse of distance $d_{i,j}$. The same distance-decay function is considered when computing the competitors' centrality index. Third, the competitors' centrality index (Fotheringham, Nakaya, Yano, Openshaw, & Ishikawa, 2001; Hotelling, 1929) measures the specific student competition pressure of each university in relation to

all other national competitors (destinations), using the sum of the weighted distances from one alternative to all others. The index accounts for the extent to which a university is distant in both physical and operative terms from its competitors. Physical distance has a negative effect, in that each competing university has a smaller impact on the index, the higher is the distance from the university *i*. As far as operating distance is concerned, each university is represented by a weight such that the higher the weight is of each competitor, the higher is the impact on the index value.

$$ComPI_{j,t} = \sum_{\substack{m=1 \\ m \neq j}}^{N} (Univ_{m,t})\ f(d_{j,m}), \qquad (5)$$

This is the formula for the competitors' proximity index for university *j* in year *t*. *N* stands for all other universities; *m* in the higher education system except for university *j*; $Univ_{m,t}$ reflects the characteristics of the students' attraction to the university of destination *m;* and $f(d_{j,m})$ represents a decay function of the Euclidean distance between university *j* and university *m*. In my analysis, the measure of students' attraction ($Univ_j$) is the size of each university, measured by the total number of students. The implementation of a competing destinations model allows one to identify the presence of competitive or agglomeration forces among universities. In terms of expectations, the sign and magnitude of the coefficient estimated for the competition index depends on whether competition or agglomeration forces are prevailing. In general, three scenarios might occur. First, a certain destination might not be significantly affected by the presence of clustered alternatives in the local area, and a non-significant coefficient for the competition index is likely to be observed. Second, a certain destination in a large cluster might be negatively affected, in terms of student attractiveness, by competition because there is a lower probability to be included in the restricted set of students' available choices with respect to isolated alternatives. In practice, ceteris paribus, an increase in either the number of universities or the attractiveness of existing universities will reduce a university's market share forcing the institution to keep the price low. Third, a certain destination might become

more likely to be chosen when it is located in the proximity of competing destinations, if agglomeration forces are at work, because of both direct (university related) and indirect (context related) effects that may lead to prevailing agglomeration forces in a university cluster. On the one hand, a cluster of universities might provide benefits to students enrolling in a specific university located inside the cluster for several reasons. First, universities in the proximity might be seen as a safety net for students dropping out at the end of the first year, in that a student might move to a different institution without relocating. Second, students could choose a second-best option in the destination area, in case they are rejected from their first choice (e.g., failing the admission test in medicine and surgery). Third, in the university cluster there might be several options to enrol in further programmes at the end of a first degree (master degrees, specializations, etc.). On the other hand, at a context level, other aspects could be beneficial for students enrolling in a university belonging to a university cluster. These areas are indeed likely to be characterized by more developed transport infrastructures and the presence of several services related to students' leisure, such as bars, sport centres, shops, cinemas and theatres. In this case, if the competition index proxies these agglomeration forces, universities in a cluster can charge students with high tuitions.

According to previous literature concerning price setting in the higher education context (Rusk & Leslie, 1978), I control for other characteristics considered determinants of tuition price. State appropriation is considered in the literature to be one of the main determinants of tuition level (see Lowry, 2001) and is calculated as the average amount of public funding per student that each university receives from the state per year (FFO). I use the real value adjusted for inflation, taking 2003 as the base year. The size represents the total number of bachelor's and master's students enrolled (see Teixeira et al., 2014). Reputation, indicated by the variable *ARWU,* is proxied by the presence of a university in the ARWU ranking (Academic Ranking Wold Universities), a yearly publication of the Jiao Tong University in Shanghai since 2003[4]. This is measured by a dummy

[4] http://www.shanghairanking.com/

variable, equal to 1 if the institution is ranked, 0 otherwise, for each year during the period 2003–2014. Clotfelter (2014) and Winston (1997) recognize the relevance of reputation for setting tuition price by explaining rising tuition fees as a quality signalling mechanism. The *Right to study* (or *Diritto allo studio*) represents the average amount of money that local authorities provide to finance each region for each year. It is a measure of financial aids that are considered a driver of tuition level (see Kane, 2010). The GDP per capita measures the gross domestic product per inhabitant in a given province according with the NUTS-3 classification and is an indicator of the richness of a determined area (Rusk & Leslie, 1978). For Italy, the effect of GDP per capita is likely to overlap that of the geographical macro regions, which are not included in my analysis.

Detailed variables' description and source information can be found in **Table 1**. Natural logs of all variables, except dummies, are taken to interpret the results in terms of elasticity.

Table 1. Variable definition

Variable name	Variable description	Source
Dependent variable		
Fees per student	Average annual tuition fees per student, per university per year in real terms (year base 2003). Logarithms are used in regression.	MIUR
Independent variables		
Crisis	Categorical variable equal to 0 for years before 2008, 1 for year after 2008 per university.	
Competition		
Universities per region	Number of both private and public universities per region. Logarithms are used in regression.	MIUR
Inverse of distance	Inverse of the distance among both private and public university belonging to the same region. Logarithms are used in regression.	MIUR
Competitors' centrality index	Centrality index per university per year. The sum of distances weighted by the number of students registered at each university per year. Logarithms are used in regression.	MIUR
FFO per student	Amount of public fund per student per university per year in real terms (year base 2003). Logarithms are used in regression.	MIUR
Size	Number of bachelor and master students enrolled per university per year. Logarithms are used in regression.	MIUR
Reputation	Presence in the ARWU ranking per university per year. Dummy equal to 1 if the university is ranked 0 otherwise per year.	ARWU website
Right to study	Amount of financial aid that local authorities provide per region per year. Logarithms are used in regression.	MIUR
GDP per capita	Measurement of income distribution among each region's residents per year. Gross Domestic Product per inhabitant per province (NUTS3 level) per year. Logarithms are used in regression.	ISTAT

Notes: MIUR is the Italian Ministry of Research and Education; ARWU is the Academic Ranking of World Universities published by the Shanghai University in 2003; ISTAT is the Italian National Statistical Institute.

2.4.4 Descriptive statistics

Table 2 shows the descriptive statistics for the sample by distinguishing between pre-crisis and post-crisis. The average annual tuition fees per student in real terms is equal to €946.01, with a range from €269.98[5] for the University of Lecce in 2006, to €6,708 for the IUAV University of Venice in 2013. After the financial crisis the average tuitions increased by 47%, from 761€ per student to 1,119 € per student.

[5] The minimum value in the sample is €18.63 charged by the University of L'Aquila in 2012. This is due to a special measure in response to the earthquake in 2009. Notwithstanding, we perform the analysis by including and excluding the University of L'Aquila from the sample and results do not appreciably change. Therefore, we have decided to include the University of L'Aquila in the analysis but not to report its value in the descriptive statistics.

Concerning competition, if considering the total number of universities per region, Sardinia region is characterised by the lower level of competition. On the contrary, Lazio is the region with the highest level of competition with 13 institutions. If the other two measures of competition are concerned, the inverse of the distance between universities in the same region and the competitors' centrality index, university of Cagliari is subjected to minimum competition while the University L'Orientale' of Naples to the strongest one. Tuition fees per students are higher in competitive environments. By considering universities with a competitors' centrality index greater than the median value, they charge students with on average 20% higher tuition fees compared to less competitive counterpart during the period 2003-2014, and with 36% higher tuition fees in the post-crisis period (see **Figure 4**). However, this figure completely changes by considering extremely fierce competitive environments. In fact, universities under an extremely fierce competition, i.e. with a competitors' centrality index greater than the 80^{th} percentile, exhibit tuition fees per student 24% lower than the amount charged by universities placed in a less competitive environment in the post-crisis period (see **Figure 5**).

Figure 4. Average tuition fees per student over the period 2003-2014 according to the level of competition.

This figure represents the average tuition fees per student charged in Italian state universities from 2003 to 2014. The amount of tuition are measured in real terms, taking 2003 as base year. A university is subjected to high competition if the competitors' centrality index is higher than the mean value. The confidence interval at 95% is included.

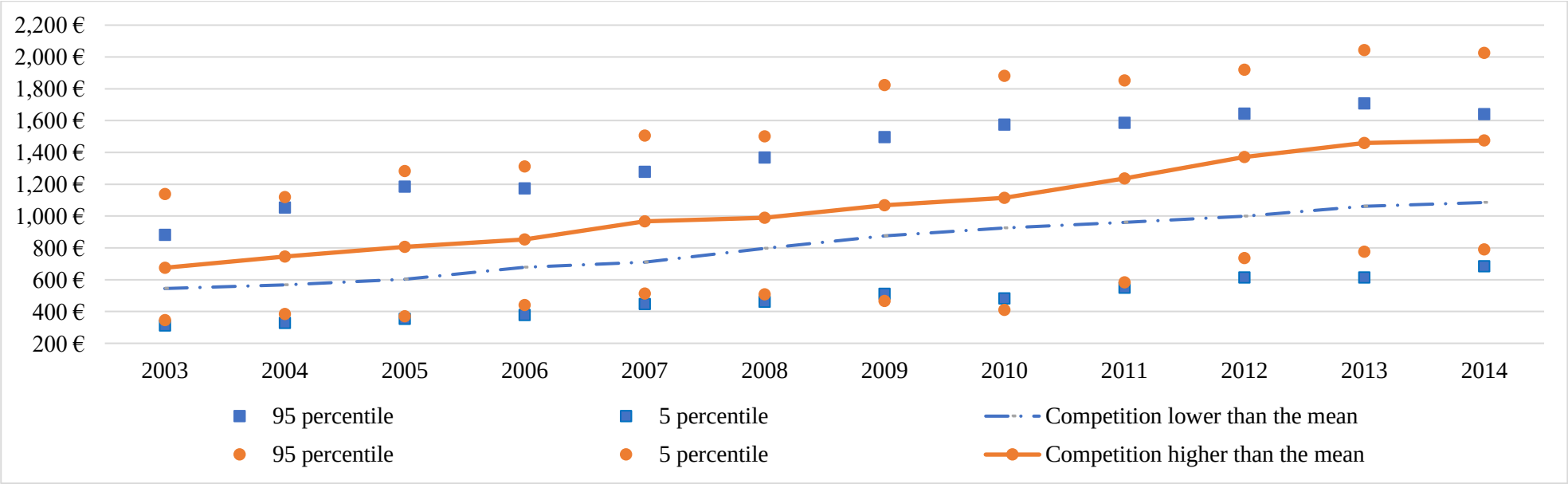
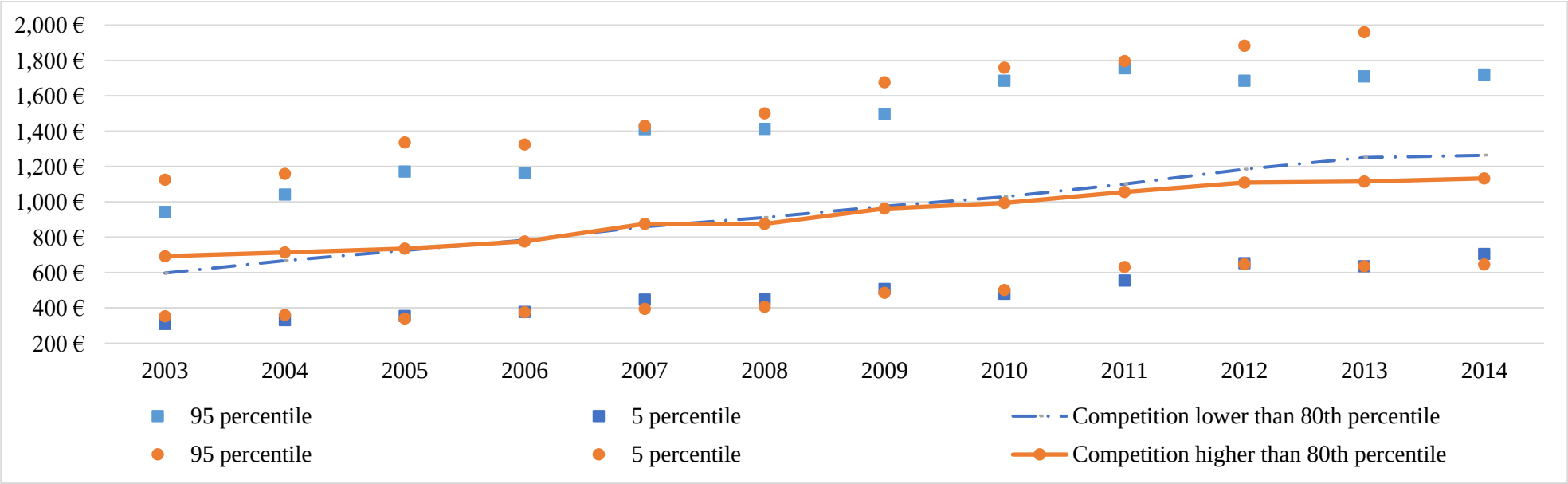


Figure 5. Average tuition fees per student over the period 2003-2014 according to the level of competition.

This figure represents the average tuition fees per student charged in Italian state universities from 2003 to 2014. The amount of tuition are measured in real terms, taking 2003 as base year. A university is subjected to high competition if the competitors' centrality index is higher than the 80th percentile. The confidence interval at 95% is included.



Referring to the other variables considered, the average public funds per student in real terms is about €4,710, with a peak of around €6,708 received by the University IUAV of Venice in 2013 and a dip of around €1,710 for the University Cà Foscari of Venice in 2003[6]. After the financial crisis FFO per student slightly increased by 23%, less than half of the increase in tuition fees. Considering the Right to study, assigned by the regional authorities, Lombardy Emilia Romagna region received more than around 1,800 € per student in 2009 while Molise received in 2003 the minimum amount, of around 60 € per student. Similar to the FFO, also this public source of financing increased after the financial crisis, but its augment is modest as well (+15%)

On average Italian state universities are 283 years old, enrol 28,204 students and only 33% are included in the ARWU ranking. Nearly three quarters of the entire population of universities is concentrated in the North and South of Italy (37% and 39%, respectively), islands included, and the rest are distributed in the Centre (24%). The average provincial GDP per capita (according to the NUTS-3 classification) is €22,318.

Table *2*. Descriptive statistics

This table reports the descriptive statics for the 708 university-year observations employed for the empirical analysis. The sample consists of 59 Italian state universities observed over the period 2003-2014. Table is split between pre-crisis period (2003-2008) and post-crisis period (2009-2014).

[6] The minimum value in the sample is €5,67 received by the University of Urbino in 2007. Since this institution was a private university until 2007, we consider it as an outlier not to report in the descriptive statistics but to consider in the analysis.

	Pre-crisis (2003-2008)					Post-crisis period (2009-2014)				
	Obs.	**Mean**	**SD**	**Min**	**Max**	**Obs.**	**Mean**	**SD**	**Min**	**Max**
Fees per student (€)	354	761.09	392.56	269.98	3449.77	354	1119.41	690.54	18.63	6708.22
Universities per region	354	5.58	3.59	1.00	13.00	354	5.58	3.59	1.00	13.00
Inverse of distance	354	0.84	1.19	0.13	5.27	354	0.84	1.19	0.13	5.27
Competitors' centrality index	354	23,424	42,316	3,224	232,234	354	22,119	39,393	2,830	217,553
FFO per student (€)	354	4,194	1,450	1,710	12,700	354	5,168	1,977	1,770	22,132
Size (students)	354	29,386	25,412	1,318	150,010	354	27,022	22,347	1,601	135,077
Reputation (%)	354	35%	48%			354	31%	46%		
Right to study (M€)	295	22.70	14.70	0.00	54.00	354	26.10	14.50	1.20	55.00
GDP per capita (€)	354	21,883	6,108	11,674	34,234	354	22,754	6,315	13,573	34,509

2.5 Results

Table 3 summarizes the main estimation results of regression Eq. (1). Model 1 includes the competition measured as the number of universities per region; Model 2 includes the competition measured as the inverse of the distance among universities in the same region; Model 3 includes the competition measured through the competitors' centrality index. I clean results from a potential underlying linear trend, accounting for a linear time trend, which results positive and significant but with a small magnitude.

The first hypothesis is verified as after the advent of the financial crisis, the level of tuition fees per student increased by 32.4%, which corresponds in monetary terms to € 306.5 per student (Model 3) inflation adjusted. The economic crisis has thus reduced the financial resources for the higher education sector whose main actors – academic institutions – are led to charge students more. According to my results, the coefficient for the FFO per student is negative and statistically significant, displaying an incipient substitutive phenomenon, in which students' private investments gradually replace public funds. **Figure 2** and **Figure 3** clearly exhibit such compensation mechanism. This is a situation common to several countries where in response to cuts in government funds universities charge to students higher tuitions, which represent an alternative source of revenues to guarantee the sustainability of the higher education system. By contrast, the coefficient for the lagged dependent variable is positive and statistically significant, meaning that the level of tuition charged

by a university on average increases year by year. Such a trend at the university level is in line with the systemic ongoing increasing of university tuitions exhibited in **Figure 2** and is now widespread in several countries (Christopherson, Gertler, & Gray, 2014).

In addition, I find that the price set by universities over time varies according to the degree of competition (hypotheses 2a and 2b). An environment characterised by higher competitive forces leads universities to charge higher tuition fees. An increase in competition – measured as the number of universities per region, the inverse of the distance between universities in the same region and the competitors' centrality index – causes an increase in the average tuition fees per student. However, the dynamic effect of competition on tuition price changed after the financial crisis. Since universities under competition are those charging greater study fees to students, they do not have room for manoeuvre to still increase the price and they are forced to turn to students. The direct consequence is a decreasing of price in order to increase their attractiveness in the eyes of students. The interaction term between crisis and competition indeed suggests that financial crisis negatively moderates the relationship between competition and tuition. This highlights that the universities subjected to very high competition levels post crisis are those who have relatively increased the price less compared to those who have been subjected to competition in the pre-crisis period.

As far as the other variables included in the model are concerned, all those reporting significant coefficients have the predicted signs. Exploiting the reputation accumulated over time, at least at national level, universities ranked in the ARWU charge students with higher tuitions. Likewise, higher education institutions placed in reach areas exhibit higher student tuitions as families with a greater income are willing to pay more for attending universities.

Table 3. System GMM estimates on average tuition fees per student

This table reports the results of dynamic panel regressions on the level of tuition fees per student charged by 59 Italian state universities during the period 2003-2014. Model 1 includes the competition measured as the number of universities per region; Model 2 includes the competition

measured as the inverse of the distance among universities in the same region; Model 3 includes the competition measured through the competitors' centrality index.

	(1) Fees per student (ln)	(2) Fees per student (ln)	(3) Fees per student (ln)
Fees per student t-1 (ln)	0.545***	0.584***	0.549***
	(0.025)	(0.024)	(0.015)
Crisis	0.046***	0.035***	0.324****
	(0.014)	(0.011)	(0.091)
University per region (ln)	0.033***		
	(0.008)		
University per region (ln)*crisis	-0.027***		
	(0.009)		
Inverse of distance (ln)		0.055***	
		(0.020)	
Inverse of distance (ln)*crisis		-0.069***	
		(0.016)	
Competitors' centrality index (ln)			0.030***
			(0.007)
Competitors' centrality index*crisis			-0.035***
			(0.009)
FFO per student (ln)	-0.032***	-0.033***	-0.033***
	(0.001)	(0.004)	(0.001)
Right to study (ln)	0.001	0.003	0.006
	(0.004)	(0.005)	(0.004)
Size (ln)	-0.088*	-0.029	-0.035
	(0.047)	(0.072)	(0.059)
Reputation	0.100**	0.176***	0.125***
	(0.041)	(0.066)	(0.032)
GDP per capita (ln)	0.350***	0.286***	0.256***
	(0.070)	(0.077)	(0.077)
Linear time trend	0.021***	0.019***	0.021***
	(0.001)	(0.001)	(0.001)
Constant	0.634	0.429	0.738
	(0.434)	(0.789)	(0.643)
AR (1)	0.006	0.004	0.005
AR (2)	0.794	0.840	0.856
Sargan test	0.57	0.619	0.931
Hansen test	1.000	1.000	1.000
Diff.-in-Hansen tests of exogeneity of instrument subsets	1.000	0.478	0.421
GMM instruments for levels	1.000	1.000	1.000
Predetermined variables	1.000	1.000	1.000
VIF	1.99	1.96	1.96
Observations	649	649	649
Number of universities	59	59	59

Notes: Standard errors included in parentheses. ***, **, and * indicate significance at less than 1%, 5%, and 10% levels, respectively. Models include controls for lagged tuition fees. Models are estimated by system GMM using all available lags, and instruments are first-differenced regressors (as listed above) and lags of the

outcome variable. AB AR(2) test is the p-value for the Arellano & Bond (1991) autocorrelation test of order 2. Overidentification test is the p-value for the Hansen (1982) J-test. Difference test is the p-value for the difference-in-Sargan test of the exogeneity of instrument subsets.

2.6 Robustness checks

As a robustness check, I rerun the analysis using two alternative measures of competition shown in **Table 4**. I compute the competitor's centrality index weighting the distances by the number of publications provided by Scopus database and the number of articles in national, regional, and local newspapers (Desai, 2008) provided by the Factiva news media database[7] per university per year. In these cases, competition measures attractiveness in the eyes of students by relying on the concept of university reputation and social legitimation (Suchman, 1995).

Moreover, I suppose that 2008 represents a real change of paradigm in university tuition strategy, according to other papers analysing the Italian context during the financial crisis (see Cattaneo, Malighetti, et al. 2017; Cattaneo, Horta, et al. 2017). In fact, it is the year when public funds started to decrease and when socio-economic conditions of the country started worsening. To test it, the stability of the competition indices' coefficients is assessed by adapting the structural break test described in Andrews (1993) to the competing destinations model. A Chow breakpoint test over a range of dates (from 2003 to 2014) is used to calculate the F-statistic. The most likely date for a breakpoint is one that produces the highest F-statistic. The test reveals that a structural break occurred in 2008, leading to the creation of a step dummy variable coded 1 for the years after 2008 (Structural break). Below, I report the coefficients of the interaction between competitors' centrality index and a set of step dummy variable coded 1 respectively for each year from 2005 to 2014. This robustness test is exhibited in ***Table 5***.

[7] The university name is used as search criterion on the database. The number of articles citing the name of each university is then scaled by the maximum value collected, which refers to the Sapienza University of Rome in 2008. Considering that the articles could denigrate a university by illustrating negative episodes, we tested the frequency of such events by selecting a random sample including 10% of the university-year articles, and we found that just 1% of the selected pieces had a discrediting nature.

Table 4. Robustness check using legitimacy competition index

This table reports the results of dynamic panel regressions on the level of tuition fees per student charged by 59 Italian state universities during the period 2003-2014. Competition is measured by two alternative measure basing respectively on the number of publications (Model 1) and on the relative national recognition (Model 2).

	(1) Fees per student (ln)	(2) Fees per student (ln)
Fees per student t-1 (ln)	0.560***	0.539***
	(0.020)	(0.030)
Crisis	0.302***	0.105***
	(0.041)	(0.030)
Competition publications (ln)	0.062***	
	(0.010)	
Competition publications*crisis	-0.054***	
	(0.007)	
Competition legitimacy (ln)		0.020***
		(0.007)
Competition legitimacy*crisis		-0.028***
		(0.006)
FFO per student (ln)	-0.031***	-0.033***
	(0.001)	(0.003)
Right to study (ln)	-0.001	-0.003
	(0.004)	(0.003)
Size (ln)	-0.006	-0.041
	(0.053)	(0.045)
Reputation	0.086**	0.140***
	(0.037)	(0.037)
GDP per capita (ln)	0.227***	0.323***
	(0.084)	(0.046)
Linear time trend	0.020***	0.023***
	(0.001)	(0.002)
Constant	0.691	0.495
	(0.651)	(0.475)
AR (2)	0.005	0.004
AR (2)	0.834	0.790
Sargan test	0.927	0.974
Hansen test	1.000	1.000
Diff.-in-Hansen tests of exogeneity of instrument subsets	1.000	1.000
GMM instruments for levels	1.000	1.000
Predetermined variables	1.000	1.000
VIF	1.97	2.11
Observations	649	649
Number of universities	59	59

Notes: Standard errors included in parentheses. ***, **, and * indicate significance at less than 1%, 5%, and 10% levels, respectively. Models include controls for lagged tuition fees. Models are estimated by system GMM using all available lags, and instruments are first-differenced regressors (as listed above) and lags of the outcome variable. AB AR(2) test is the p-value for the Arellano & Bond (1991) autocorrelation test of order 2. Overidentification test is the p-value for the Hansen (1982) J-test. Difference test is the p-value for the difference-in-Sargan test of the exogeneity of instrument subsets.

Table 5. Robustness check: Chow test

This table reports the coefficients of the interaction between competitors' centrality index and a set of step dummy variable coded 1 respectively for each year from 2005 to 2014. A Chow breakpoint test over a range of dates (from 2003 to 2014) is used to calculate the F-statistic. The most likely date for a breakpoint is one that produces the highest F-statistic.

	(1) Fees per student (ln)	(2) Fees per student (ln)	(3) Fees per student (ln)	(4) Fees per student (ln)	(5) Fees per student (ln)	(6) Fees per student (ln)	(7) Fees per student (ln)	(8) Fees per student (ln)	(9) Fees per student (ln)	(10) Fees per student (ln)
Step dummy 2005	-0.073									
	(0.051)									
Competitors' centrality index*Step dummy 2005	0.008									
	(0.005)									
Step dummy 2006		0.283***								
		(0.074)								
Competitors' centrality index*Step dummy 2006		-0.027***								
		(0.008)								
Step dummy 2007			0.019							
			(0.052)							
Competitors' centrality index*Step dummy 2007			0.001							
			(0.005)							
Step dummy 2008				0.324***						
				(0.091)						
Competitors' centrality index*Step dummy 2008				-0.036***						
				(0.010)						
Step dummy 2009					-0.140***					
					(0.047)					
Competitors' centrality index*Step dummy 2009					0.012**					
					(0.005)					
Step dummy 2010						0.091**				
						(0.045)				
Competitors' centrality index*Step dummy 2010						-0.011**				
						(0.005)				
Step dummy 2011							-0.166***			
							(0.037)			
Competitors' centrality index*Step dummy 2011							0.021***			
							(0.004)			
Step dummy 2012								0.035		
								(0.031)		
Competitors' centrality index*Step dummy 2012								-0.003		
								(0.003)		
Step dummy 2013									-0.028	
									(0.033)	
Competitors' centrality index*Step dummy 2013									0.002	
									(0.004)	
Step dummy 2014										-0.179***
										(0.028)

Competitors' centrality index*Step dummy 2014										0.017***
										(0.003)
AR (2)	0.815	0.826	0.782	0.856	0.772	0.754	0.750	0.803	0.774	0.808
Sargan test	0.939	0.947	0.941	0.920	0.936	0.922	0.910	0.884	0.888	0.879
Hansen test	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Diff.-in-Hansen tests of exogeneity of instrument subsets	0.264	1.000	0.650	0.421	0.150	1.000	0.942	0.532	0.922	1.000
GMM instruments for levels	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Predetermined variables	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
VIF	1.46	1.56	1.72	1.96	2.33	2.14	1.90	1.70	1.56	1.46
Observations	649	649	649	649	649	649	649	649	649	649
Number of universities	59	59	59	59	59	59	59	59	59	59

Notes: Standard errors included in parentheses. ***, **, and * indicate significance at less than 1%, 5%, and 10% levels, respectively. Models include controls for lagged tuition fees. Models are estimated by system GMM using all available lags, and instruments are first-differenced regressors (as listed above) and lags of the outcome variable. AB AR(2) test is the p-value for the Arellano and Bond (1991) autocorrelation test of order 2. Overidentification test is the p-value for the Hansen (1982) J-test. Difference test is the p-value for the difference-in-Sargan test of the exogeneity of instrument subsets.

2.7 Conclusions

This study examined the effect of competition on university price setting in the Italian public higher education system over the period 2003-2014. The economic crisis had important effects on the higher education sector forcing institutions to diversify their source of revenues in order to offset cuts in government funds. Tuition fees raise by 15% since 2008 while the state appropriation decreased by 17%. Universities in competitive areas charged students with higher tuition fees, but in times of crisis institutions operating under fierce competitive forces are those who have kept their prices down, showing that the competition between institutions had a moderating effect on price raise.

The fact that universities in highly competitive environments charge higher tuition fees suggests that a self-differentiation process is in place (Scott & Biag, 2016) even in a strongly centralized country like Italy (Cattaneo, Horta, Malighetti, Meoli, & Paleari, 2018). Universities are forced to adapt to the environment and adopt higher-risk strategies to survive (Barringer, 2016). This sheds light on a debate about diversity within higher education, by providing support to the authors arguing that higher education systems have a tendency to differentiate and to increase their diversity under competitive forces (Aldrich & Pfeffer, 1976 for instance showed that competition encourages institutions to look for market niches).

As universities located in highly competitive areas exhibit lower tuition fees in times of crisis, they show a greater level of sustainability due to their ability to self-regulate. Competitive dynamics limit the freedom of price setting, inducing universities to maintain a lower level of tuition fees, with the aim of protecting themselves from either local or regional competition and attracting students (Foskett, Roberts, & Maringe, 2006). According to the economic theory of price setting in competitive environment, adding a competitor increases the price sensitivity of a brand by augmenting its substitutability in the choice set (Huber, Holbrook, & Kahn, 1986). In this regard, universities could lower prices to attract more students or to fend off the effects of competitors' lower

prices that threaten their existing student body (Winston & Zimmerman, 2000). This finding implies that policy makers should pay more attention to peripheral institutions since they are the ones that mostly depend on public subsidies and that in a period of crisis rely mainly on students (i.e. raising the Right to study resources). This can lead to a potential vicious cycle wherein institutions in marginal areas charge higher prices, exacerbating their low attractiveness in the eyes of students due to their low competitive conditions.

This essay explains the relevance of competition in a quasi-market with decreasing resources, taking Italy as context of analysis. Competition may operate as a mechanism to control the level of student fees, by affecting the behaviour and even the survival of neighboured universities as well as distant institutions (Hoxby, 1997, 2000). Price controlling might prevent universities from becoming mostly privately funded, saving the collective dimension of the education good (Christopherson et al., 2014). Moreover, limiting the level of tuition averts the achievement of an unbearable level of student debt.

The study, however, does not come without limitations. I consider in my analysis the average price level as given and not resulting from an equilibrium between supply and demand. This aspect could be properly investigated by considering economic specification from price setting theory. Moreover, the measure of tuition fees employed in this work does not fully capture the net price faced by students, as I consider the listed tuition fees without isolating the effect of student grants. Furthermore, the economic crisis might be modelled in a more complex way as well as the reputation. These limitations can however leave open potential future research venues.

3. ESSAY 2: THE EFFECT OF THE GERMAN EXCELLENCE INITIATIVE ON THE HIGHER EDUCATION PERFORMANCE

Acknowledgement: This chapter is derived from the working paper 'Civera, A., Lehmann, E.E., Paleari, S., Stockinger S.A.E. Higher Education Policy: Why hoping for Quality when rewarding Quantity?'. In the current version, sections "Methodology", "Results and Robustness" are fully my contribution; "Introduction", "Higher Education Policies in Germany", "Effect of the 'Picking the winner' strategy" and "Conclusions" are written jointly with the co-authors. Moreover, I am responsible for all the changes in this chapter with respect to published version.

For this chapter I am grateful to the Augsburg University where I spent the visiting in which I elaborated the idea at the basis of this research project. In particular, I would like to thank Professor Erik Lehmann, director of the CISAlpino Institute for Comparative Studies in Europe (CCSE), who allowed me to work in his inspiring chair. I am immensely grateful to the support received from all my co-authors. Finally, I want to express my gratitude for the insightful comments offered by the participants at the DREAMT PhD Workshop in March 2018, especially to Professor Federica Origo, who was my discussant.

3.1 Introduction

Concerning funding, higher education policies could be in general divided into three categories. First, performance-based funding where public finance is allocated according to defined performance criteria, most of all university research activities. The second category could be described as a sprinkler approach, where public finance is allocated among the universities ranked by size, like the number of students. And the third category encompasses policy initiatives to subsidize disadvantaged universities. All categories are mainly based on rankings: either performance based rankings, size rankings, or even rankings reflecting the (dis-)advantage of the location. The latter two categories are mainly justified by the historical context, where universities, often since their founding, attract public funding according either to their size or to subsidize disadvantaged locations. These two approaches

also correspond to the principle of egalitarianism, where competition among public universities for public funds is seen rather critical and skeptical. An attitude, which used to be widely spread in continental Europe countries, like Germany and Italy. The first approach however differs from the latter two in that competition for funds is explicitly desired and egalitarianism in the higher education sector favors moral hazard and adverse selection effects at the costs of the tax payers – and the outperforming universities.

The performance-based funding originates from the neoliberal Thatcher era in the UK and the Ronald Reagan's presidency in the US in the 1980s. Since then indeed only academic research could be justified to receive public money, as the whole economy benefits from knowledge spillovers (Friedman, 2017). Consequently, universities were forced to compete for the now smaller pie by their research activities, almost measured by the numbers of articles published in outstanding scientific journals, reflected by journal rankings (Vogel, Hattke, & Petersen, 2017).

Higher education policies of most continental Europe countries still followed their historically grounded policy approach, until the recent past. The appearance, emergence and success of the high-tech industries, best reflected by the 'Silicon Valley Model of Entrepreneurship and Innovation' has shocked the policy makers in Europe and led to a wake-up call. The outstanding success of the high-tech industries has been assumed to be mainly based on outstanding academic research, best reflected by the worldwide rankings of universities and research labs. These rankings, are dominated by Anglo-Saxon universities like Stanford, Princeton or Harvard for the US, Oxford, Cambridge or the Imperial College for the UK, but meanwhile Asian universities are emerging as well. Increasing pressure is exerted on European Universities that need now more than ever a change of paradigm (Audretsch, Lehmann, & Paleari, 2015). Instead of subsidizing disadvantaged universities or locations and allocating public finance just by size, the paradigm change should instead elevate the most promising institutes with a stronger focus in research instead on teaching and education.

To support the role of universities as enhancer of knowledge, innovation and public welfare (Audretsch & Lehmann, 2005; Audretsch, Lehmann, & Warning, 2005; Breznitz & Feldman, 2012; Carree, Della Malva, & Santarelli, 2014; Leyden & AN, 2013), more progressive approaches that are introducing competitive elements are discussed and implemented recently by politicians (Rebora & Turri, 2013b). Since particular outstanding research institutions and star scientists are recognized as the main source of knowledge spillovers (Audretsch & Feldman, 1997; Zucker & Darby, 1997), a higher education policy to select and promote outstanding research universities could be effective by selecting the most promising universities, and efficient by generating spillover effects for the whole economy where public money is re-allocated to the tax payer in the future.

The expectation from the initiative is that an investment in international visibility and reputation of universities, and the respective country, first, allows to participate as top player in the global competition, second, attracts high potential researchers and students, and third, brings out well-trained human capital, basic research and innovations, and thus, contributes to a positive return on investment in terms of economic growth and public welfare.

Not only traditionally more competition-oriented systems like the Anglo-Saxon countries (Dill & Soo, 2005) but also continental European countries like Germany, Italy or Spain thus introduced competitive funding mechanisms (Auranen & Nieminen, 2010; De Filippo, Casani, & Sanz-Casado, 2016; Menter, Lehmann, & Klarl, 2018; Rebora & Turri, 2013b). As one of the strongest market economies in the EU, Germany launched the Excellence Initiative in 2006. The policy intervention aimed to increase international visibility of German universities and spur high-class research by introducing a competitive environment for additional public funds (Menter et al., 2018). Questions have been raised about whether financial incentives really boost the productivity and quality of the higher education system or whether it is worthwhile for policy-makers to mainly emphasize other more traditional strategies (Auranen & Nieminen, 2010). Skeptical voices accompanied the Excellence Initiative (Kehm, 2013; Morgan, 2016), in particular, because it remains

unclear whether such a policy intervention leads to adverse effects where costs outweigh benefits (Geuna & Martin, 2003; Hartmann, 2006, 2010; Pasternack, 2008; Teichler, 2008). Olbertz, former non-affiliated education minister in Saxony-Anhalt stated: "[…] I'm not sure [if] we are a role model in quality. The answer lies in finding a balance between the aim of quality and the aim of social justice and democratic access to the university" (Morgan, 2016). The discussion on how to define and measure performance is crucial at this point and strongly connected to the original aims of Policy Initiatives. The hope of politicians might be to enlarge the locational advantage by international reputation that comes by higher quality. In reply, universities put their effort in improving ranking positions as it is recognized as the main mean to enlarge international reputation. However, raising in the ranks is not necessarily connected to research quality but rather quantity (Olcay & Bulu, 2016). As known from the agency theory indeed, when the principle (i.e. Government) is hoping for 'A' (i.e. increase quality) s/he should not reward the agent (i.e. university) for 'B' (i.e. increase quantity).

The aim of the study is thus to analyze whether the provision of additional public funds leads to the desired increase in research quality by shedding light on the quantitative effects of the Excellence Initiative intervention on university performances. The research question leading the analysis in fact is:

Does the Excellence Initiative enhance the performance of the higher education system?

The study is based on existing studies concerning the Excellence Initiative and performance triggers in the higher education system (Agrawal, McHale, & Oettl, 2017; Auranen & Nieminen, 2010; Bolli & Somogyi, 2011; Bruckmeier, Fischer, & Wigger, 2017; Gawellek & Sunder, 2016; Haeussler & Colyvas, 2011; Menter et al., 2018; Möller, Schmidt, & Hornbostel, 2016; Vogel et al., 2017). These studies put their focus exclusively on the German context and compare Excellence and non-Excellence universities along several dimensions, like efficiency scores (Gawellek & Sunder, 2016), ranking positions (Menter et al., 2018) or the adverse effects when the label of being excellent is withdrawn in the next period (Bruckmeier et al., 2017), and the results are less obvious than expected.

The selected universities did not outperform the treatment group regarding their efficiency (Gawellek & Sunder, 2016), are improving their rankings connected to the award moment at the cost of quality (Menter et al., 2018) and after losing their label, these universities are faced with a significant decline in the enrollment of students, while winning the contest does not lead to a positive enrollment effect (Bruckmeier et al., 2017).

Excellence universities were not picked arbitrary and a comparison of Excellence and non-Excellence universities may be biased by already existing differences in institutional characteristics that lead to the respective status ascription. In order to isolate the pure policy intervention and connected locational advantage effect, I make use of a control group of comparable Excellence and non-Excellence universities from Italy. To understand the mode of action of the employed policy, I rely on three levels of analysis: efficiency of a university (translation of state funds to multiple outputs), research quantity and research quality (Gendron, 2008; ter Bogt & Scapens, 2012).

3.1.1 The Excellence Initiative and what we know so far

In the German system, the Excellence Initiative was introduced to establish world-class institutions. The aim of the Excellence Initiative is enhancing the attractiveness as well as the international competitiveness of Germany by promoting high-class research as well as quality of German universities (Deutsche Forschungsgemeinschaft (DFG), 2013). To achieve such objectives, the Federal and State Governments provided a total of € 1.9 billion to fund the successful projects until the end of 2012. The initiative, organized by the German Research Foundation (Deutsche Forschungsgemeinschaft, DFG) and the German Council of Science and Humanities (Wissenschaftsrat) called for three lines of funding: Graduate Schools to promote young scientists and researchers, Clusters of Excellence to promote top-level research, and Institutional Strategies to develop project-based, top-level university research resulting in being an Excellence university. Universities had to apply for all three funding lines to become an Excellence university. The assessment mainly aimed to evaluate performances ex-ante by submitting future strategies. (Menter

et al., 2018) provide a more comprising description of the Initiative which will be the focus of my analysis.

Existing literature for the Excellence Initiative identifies an announcement effect and that Excellence universities developed worse compared to the non-selected universities after the decision (Menter et al., 2018). Additionally, applying universities lost efficiency compared to non-applying ones. Unsuccessful applications lead to a recuperation while successful ones experienced no positive effect if additional funding is excluded (Gawellek & Sunder, 2016). Coming from Karlsruhe – a university that recently lost the Excellence university status – Bruckmeier et al. (2017) provide evidence to the striking citation of Laband (1907) that "[…] the award of a title does not nearly elevate the awardee to the extent that the loss of the title debases him" (Bruckmeier et al., 2017). They show that the worsening of performance is not due to an actual decline in university quality but to the loss of the excellence status. (Möller et al., 2016) show in a bibliometric analysis that clusters of excellence (another stream of the Initiative) supported exclusively the "winners" of the competition, while the overall German research system did not experience benefits.

3.1.2 Other policy strategies for excellence around the world

The German Excellence Initiative is not the unique example of the government effort to promote excellence within the higher education system. Among others, countries such as France (Benito & Romera, 2011), UK (Rebora & Turri, 2013a), Spain (Seeber, 2017), Nordic European countries (Elken et al., 2016) and Russia (Yudkevich, 2013) as well as Asian countries such as China, South Korea, Japan and Taiwan (Hou et al., 2012).

Several are the aims and the expectations from policymakers when establishing a research excellence strategy. The most commonly cited refers to enhancing the competitiveness of a given system's research landscape in a perspective of international competition with the consequent reforming of the internal governance and restructuring of the higher education and research landscape. This is the case of the French national program Operation Campus for the aggregation and

merger of universities to create from five to ten excellent multidisciplinary “poles” able to compete with the best universities in the world. Similarly, the Russian Project “5-100” launched in 2013 aims to place at least five Russian universities in the “world’s top 100 universities” by 2020. Referring to the Asian pacific area, Chinese government launched 2 major initiatives named Project 211 in 1995 and 985 in 1998. The former selected 100 universities that received special funding to improve their overall performance, while the latter aimed to develop 10 Chinese universities to top global ranking positions in the 21st century. In response to the quest for a world-class university, the Taiwan government instead launched the “Development Plan for World Class Universities and Research Centers of Excellence” in 2006. The goal was that of developing at least one university as one of the world’s top 100 universities in 5 years and at least fifteen key departments or cross-campus research centers as the top in Asia in 10 years.

Other considerations range from enhancing the quality in addition to the reputation of the university, to furthering internationalisation of the higher education institutions, and better integrate universities in their economic environment. To respond to concern over the low quality of Korean higher education, the Brain Korea 21 program was launched in 1999 to produce creative leaders among next generation graduate. In the same vein, the Research Assessment Exercises (RAE) have been held in the UK since 1986. They aimed to allocate funding in a fair but non-egalitarian way according to the policy goal of selectivity to safeguard and stimulate quality research. The new assessment exercise known as REF (Research Excellence Framework) occurred in 2014 and replaced the RAE. Its objectives were to better inform, to provide benchmarking information, and to provide accountability for public investment in research and to produce evidence of the benefits of this investment, with a particular emphasis on the concept of impact.

By contrast, Japan counted on promoting internationalization of higher education to secure a leading position for Japanese higher education in Asia. The Global 30” project launched in 2008 set the aim of recruiting 300,000 international students to study in Japan by 2020. The Spanish case

instead is something different. The International Campus of Excellence in Spain was part of the broader *Estrategia Universidad 2015* and was officially launched in July 2009. It was inspired among others by the principles of modernization and contribution to the external context by fostering strategic alliances between various partners located in the region.

The European Nordic countries chose slightly different paths. Norway focused on development of excellence initiatives at the national level through several forms of schemes to promote larger research groups promising in terms of performance. Finland developed national excellence initiatives as well but focusing more on creating networks between institutions. Excellence initiatives in Denmark relied on financing individuals and smaller research groups, while Sweden opted for a pathway in between, with a mix of the two strategies.

3.2 Literature review and hypotheses development

3.2.1 Universities as not-for- profit organizations

Most of the universities are not-for-profit organizations (Leih & Teece, 2016). The distinction between non-profit and for-profit entities is most important where a degree of public subsidy is involved (Massy, 2006). Extant literature identifies three reasons for favouring non-profit as opposed to for-profit enterprises when considering such subsidies (Hansmann, 1979): (i) their output is important to society; (ii) their output quality is gard to evaluate; and (iii) their output costs so much to produce that it would not be affordable if the enterprises had to recover its full costs.

By virtue of this, most if not all traditional universities receive subsidies, either directly from government or via the tax system. The fact that surpluses must be reinvested within the entity rather than inuring to external private interests makes it more likely that the subsidies will be used as intended. Indeed, similar to for-profit enterprises they benefit from higher prices but they spend their earnings on cross-subsidies that boost mission attainment. In in the university sector, research may be cross-subsidising teaching. Motivation of not-for-profit institutions may thus transcend profit

maximisation and universities receive public subsidies because, as non-profit enterprises, they are expected to further the public good. Adoption of market solutions by governments does not change this expectation. In fact, deregulation delegates to institutions the responsibility for making public-interest decisions that previously were made by oversight bodies.

Pure market mechanisms fail in these contexts because price signals do not adequately reflect the social value of consumption (Besley, 2003). The existence of these concerns leads to solutions for provision of public services that attenuate the use of the profit motive. Accordingly, non-monetary incentives have become most important. Reputation plays a central role for not-for-profit organizations, intended as a stakeholder's overall evaluation of an organization in respect of its past, present, and future handling of stakeholder relationships, which reflects its ability and willingness to meet stakeholder expectations (Helm, 2011). The emphasis on reputation raised from the marketization of the non-profit sector that has been ongoing over the last decades (Arrow & Weisbrod, 2010; Goerke, 2006; Kluver & Eikenberry, 2004), which is characterized by a competition for donors and grants (Weerawardena & Mort, 2008). Consequently, marketing activities to improve not-for-profit organizations' competitive positioning regarding donor appeal and staff retention play a greater role than ever. Accordingly, reputation has emerged as an important concept to explain the attraction of donations (Meijer, 2009; Padanyi & Gainer, 2003), making it one of the most important intangible assets and vital for organizational survival. Universities are mainly focused in reputational benefits as well and governments have been developed incentive policies accordingly.

Developing incentives can be analysed as a principal-agent problem where government is the principal and university management is the agent. A basic assumption in the principal-agent theory, in general as well as applied to the not-for-profit sectors, is the fact that the provision of public services benefits from the effort put in by the agents, and high quality service requires high intensity in the effort. This effort is costly and agents need to be motivated to put this effort. Rewards are not only pecuniary – agents could be motivated to provide high-quality service because they care about

the output they produce. However, the non-pecuniary incentives depend on how the organization is structured. Thus, the mission of the organization can affect the degree to which agents are willing to commit costly effort. Matching is the process by which principals and agents come together. Principals and agents can match with one another on the basis of the perceived mission of the organizations. This is a natural consequence of organizations being mission-oriented. This matching increases efficiency in the operation of public-service organization, since the return from putting in effort are higher when the agents share the same goals as those espoused by principals.

This essays adopts the micro-economic analysis of not-for-profit organizations as theoretical framework to analyse university responsiveness to external incentives, either monetary or non-pecuniary ones, as the Excellence Initiatives provide both.

3.2.2 Different policy approaches to incentivize higher education

Evidence-based higher education policy requires evidence to support it and solid evidence is particularly important where policy decisions involve trade-offs across alternative courses of actions: "choosing action 'A' over 'B'" (Autio & Rannikko, 2016, p. 42). My objective in this essay is to provide an examination of action 'A' – the selection and promotion of few universities ("picking the winners") instead of applying alternative actions (sprinkler policy, subsidizing disadvantaged universities). While this approach could not directly discriminate action 'A' from alternative actions, I will assess the effectiveness of action 'A' with the most common policy strategies in higher education as practiced in Germany, the sprinkler policy and the subsidizing of disadvantaged universities. The three main approaches of higher education policies are summarized in **Figure 6**.

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Figure 6. Approaches of higher education policies.

The figure exhibits the summary of the maon characteristics of the three main policy approach to higher education funding, by distinguishing between costs and benefits. Moreover examples are provided with explicit reference to Germany and Italy that are the countries investigated in the study.

	Characteristics	**Benefits**	**Costs**	**Examples**
Sprinkler Approach	Basic financial resources, evenly distributed	Widespread access and availability of education, research and spillover effects	Freeriding, risk of incentivizing the maximization of inputs; costs caused by asymmetric information	First funding source by central or decentral governments
Subsidizing Disadvantage	Compensation of regional, structural or political disadvantages	Securing a minimum standard of quality; Reduction of inequalities	Focus on disadvantaged → above average might not fully exploit possibilities; Asymmetric information causes difficult definition of subsidize-worthy situations	Unification of DDR & BRD, Subsidies for regionally weak regions (e.g. during financial crisis)
Picking the winner/ lighthouse concept	Competition to trigger and support positive behavior	Supporting high-class research; Enhancing international attractiveness; creating bandwagon effects; Quasi-markets prevent problems of adverse selection and moral hazard	Focus on high performers; Performance linked to the award moment; Damage by loss of title; Might uncouple few from the rest	Excellence Initiative, Rankings

(1) *Sprinkler policy*

The sprinkler policy is based on the principle to spread financial resources across a wide range of units, instead of selecting and favoring a few of them: the central or state government provides basic financial resources evenly to all universities, almost exclusively according to their size (number of students). This policy approach is predominant in Germany ever since the founding of the first University of Heidelberg in 1386 until today. The Times Higher Education in this context stated that "the fact is that egalitarianism has been the watchword of much of German higher education policy […]." (Morgan, 2016) and further "The Ministry of Education and Research was one of the very, very few that had increased in its budget even during the financial crisis […] There are a lot of countries and universities […] that envy their German partners for the very stable source of funding that they have" (Lehmann, Meoli, Paleari, & Stockinger, 2018; Morgan, 2016). This approach is justified in that the government guarantees a basic service and thus, guarantees 'the freedom of research and education' on a decentralized level. However, this approach comes at its cost. In particular, by asymmetric information that leads to freeriding and incentivizing the maximization of inputs instead of performing efficiently (Besley & Coate, 2003).[8] The egalitarian approach also reduces incentives to compete on a global instead of a regional market for scarce resources, like students or academic researchers.

(2) *Subsidizing disadvantaged universities*

Another policy approach is subsidizing disadvantaged units, in particular to reduce regional disparity. In Germany there still is attempts at subsidizing universities in the Eastern part (Kehm, 2004). The institutionalization of this approach is connected to two things: (i) the foundations of states and focus on public welfare including education as well as (ii) the expansion and massification of higher

[8]It is a well known phenomenon that managers in public organizations, and in particular public universities, tend to increase the staff and administration. While they directly benefit from delegating much of the work, they do not have to bear the costs of coordinating and motivating the staff, which is also delegated to middle managers. Otherwise an increased number of staff and administration increases their power, status and thus, their individual utility (Groves & Loeb, 1975; Hughes, 2012, p. 317; Lane, 2006, p. 57 ff).

education especially after World War II. This approach contributes to accommodate inequalities that are too big to be handled by the universities (or regions) as such as well as it ensures a minimum standard of quality and quantity concerning personnel, equipment and facilities (Morgan, 2016). While this approach is limited to disadvantaged institutions that should be elevated to the average it also might prevent those above average to fully exploit their possibilities. Another problem arises by selecting the disadvantaged universities – a measurement problem affected by asymmetric and private information leading to adverse effects and the risk of maximizing input instead of improving efficiency and competitiveness.

(3) Picking the winner

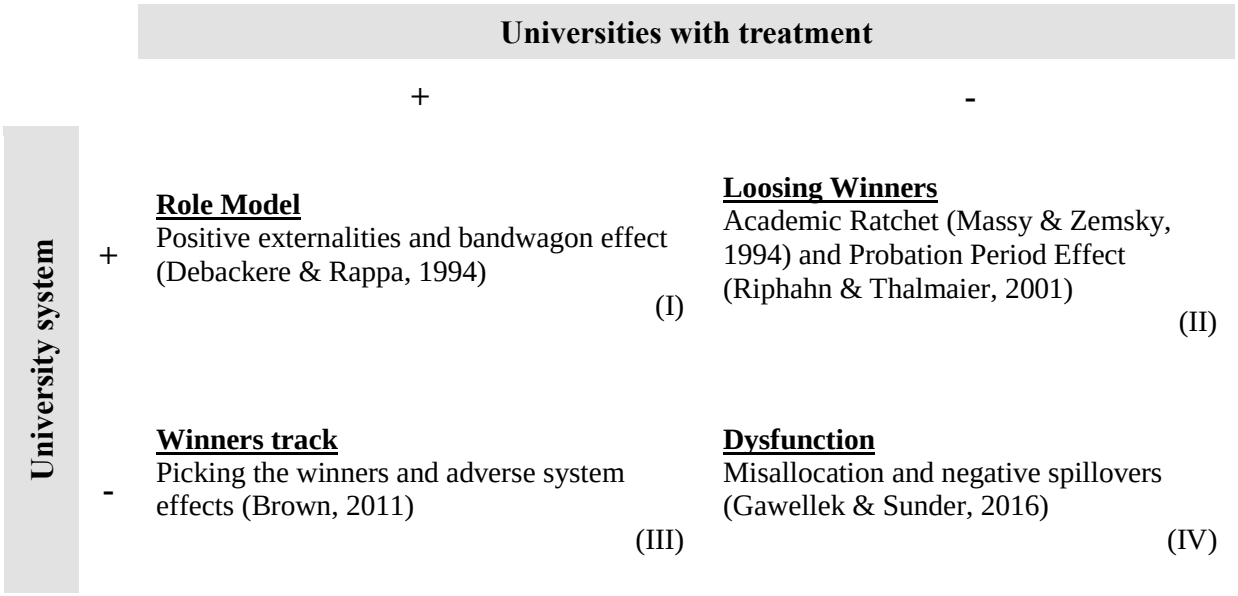
The 'picking the winner' strategy aims to introduce market powers to a traditionally non-market sector like higher education. It was tentatively emerging with third-party funding contests beginning in the second half of the 19th century while it became more prominent in the recent 25 years with Thatcherism and upcoming of the New Public Management (Hicks, 2012; Schimank & Lange, 2009). Quennet-Thielen, state secretary in the Federal German Ministry of Education and Research, explains the need for supporting lighthouses: "If you want to compete in the research world, you have to have some top universities that play in the first league" (Morgan, 2016). Consequently, the system should benefit from quasi-market structures that can prevent problems of adverse selection and moral hazard as well as supporting high performers. This positive effect is supported e.g. by Huber (president of LMU in Munich): "If you consider that in the first round they *[federal and state governments]* spent less than € 2 billion, they really got a bang for their buck. […] The Excellence Initiative has changed the perception of German universities all over the world" (Morgan, 2016). However, the connected incentivizing mechanisms have to be chosen appropriately. Germany introduced the picking the winner mechanism though the Excellence Initiative.

3.2.3 Effects of the 'Picking the winner' approach

Based on the principal agent theory, politicians can be seen as principals that want to achieve the aim of creating and improving locational advantages but experience information asymmetry. Agents – in this context universities – tend to follow their aims to increase input and reputation. By introducing the Excellence Initiative, politicians aimed to trigger international visibility of German universities. However, the desired outcome "international visibility" is not perfectly measurable. This study evaluates the positive effects and/or adverse effects of the Initiative. Namely, those adverse effects are ex-ante adverse selection or ex-post moral hazard behavior. Ex-ante, only those universities might apply for becoming excellent that are big enough and have the resources to prepare three high quality applications – for each funding stream. Thus, adverse selection results in a funding of those universities that tend to already comprise slacks and inefficiencies. Ex-post, universities might shift their efforts after being assigned Excellence university and thus, show moral hazard as outcomes are not perfectly measurable by the principal. In this context, incentives have to be chosen carefully to not hoping for 'A' when rewarding 'B' (Kerr, 1975). **Figure 7** depicts in an explorative way the positive and adverse outcomes.

Figure 7. Exploratory Framework for the "Picking the Winner" approach.

This figure outlines possible outcomes for the treated Universities and the whole University System. Four are the eventual scenarios: role model, loosing winner, winner track, and dysfunction.



(I) *Role Model*

The initiative can incentivize institutions that are treated to increase their efforts to efficiently produce qualitative outcomes (Autio & Rannikko, 2016; Gawellek & Sunder, 2016). The entire system might benefit by focusing towards the winners and thus inducing a bandwagon effect (Agrawal et al., 2017; Aksnes & Rip, 2009; Debackere & Rappa, 1994). In this context, the *Imboden* report that evaluated the Excellence Initiative outlines that the entire higher education system experiences a new "dynamic" and an "impressive qualitative performance of Excellence clusters" is observable, but abstracts from already existent capacities (Imboden et al., 2016).

Previous research confirms a disciplining effect of public competitively acquired funds for the winners (Bolli & Somogyi, 2011), with peer-effects on a departmental level, in that "super stars" increase the productivity of the entire group (Agrawal et al., 2017). Based on the scientists' perception of what generates reputation and is valued "good work", scientists shift resources and efforts to what is valued as important (Haeussler & Colyvas, 2011), like the visibility in ranking positions.

Consequently, both Excellence and non-Excellence universities will invest in international visibility resulting in a higher education policy role model. However, it is important to differentiate what exactly is considered helpful to gain international visibility which will be contrasted by efficiency of the university, research quantity and research quality.

(II) *Loosing Winners*

It is possible to observe moral hazard as a Probation Period effect that is discussed in labor economics (Riphahn & Thalmaie, 2001). The treated universities might run to become the winners and after this "Probation Period" (which is in this context the reward of being an Excellence university) efforts are reduced due to exhaustion, and over-security without further incentives for continuing efforts which leads to less performance (Menter et al., 2018). For the entire university system one could expect the Academic Ratchet effect (Massy & Zemsky, 1994) as the focus of "good behavior" is clearly set with the Excellence Initiative to improve qualitative outcome and international visibility. Thus, the focus of researchers is shifted to this beneficial activities rather than e.g. teaching (Haeussler & Colyvas, 2011).

(III) *Winners Track*

The winners in the competition might benefit from additional reputation and be incentivized to further increase performance and productivity (Autio & Rannikko, 2016; Bolli & Somogyi, 2011; Hegglin & Schäfer, 2015). One could expect this 'halo effect' – due to the reputational gain scholars from those universities might increase the likelihood of publication and citation (Amara, Landry, & Halilem, 2015). An academic Matthew effect– meaning that success breeds success – in centers of excellence was demonstrated for Nordic countries (Langfeldt et al., 2015).

The system experiences adverse effects as the efforts in a competition with superstars are dependent on the perceived differences. The differences induced may not only lower but even reduce the strain of the losers to compete with superstars (Agrawal et al., 2017; Brown, 2011). In this context, many critics feared a decoupling of few universities from the mediocre rest in the country leading to

a focus on those Excellence universities and similarly pointed out in discussions about rankings (Hartmann, 2006; Vogel et al., 2017).

(IV) *Dysfunction*

Selected universities may also reveal a negative performance after being rewarded and spillover effects may negatively affect the entire system (Bruckmeier et al., 2017). Such spillover effects arise by a moral hazard behavior and adverse selection effect displayed by a reinforcement of vicious cycles and path dependent cumulative effects. While the winners might face the probation period effect (Riphahn & Thalmaie, 2001), 'losers' might be decoupled in terms of attractivity, funding and motivation (Brown, 2011; Geuna, 2001). Additionally, sabotage-effect may occur, as (Jauernig, Uhl, & Luetge, 2016) state: "Apparently it is naive to assume that the mode of competitiveness and the wish to outperform others is switched off after the blow of the referee's whistle at the end of the game, since competition seems to increase the overall level of aggression." Finally, focusing solely on competition might increase the efforts for intense competitive behavior and reduce the efforts for an overall benefit for both, treated universities and the entire higher education system.

Accordingly, I therefore formulate four different hypotheses as follows:

Hypothesis 1: the entire Higher Education system benefit from the Excellence Initiative

Hypothesis 2: only non-Excellence universities benefit from the Excellence Initiative

Hypothesis 3: only Excellence universities benefit from the Excellence Initiative

Hypothesis 4: the entire Higher Education system was harmed by the Excellence Initiative

3.3 Research design

3.3.1 Sample and data source

The sample consists of 123 state universities, 72 from Germany and 51 from Italy, observed over the period 2004-2011. This period allows us to study the first two rounds of the Excellence Initiative,

officially launched in 2005 and 2006.A third phase was the implemented from 2012 to 2017 allocating 2.7 billion EUR, but it is not objective of analysis. As I did not want to make the model complicated by the dynamics coming from the re-election of the Excellence universities as well as from the loss of prestige due to the missing re-election. The Excellence Initiative in Germany was exclusively designed for public universities. This leads to the exclusion of private universities, universities of applied sciences or specialized universities for Germany. For Italy I exclude traditional private institutions and distance-learning institutions, public doctoral universities and universities for foreigners, leading to comparable institutions across both countries (Agasisti & Pohl, 2012). The main data sources are the DFG, namely Deutsche Forschungsgemeinschaft, which is the German Research Foundation that organized the Excellence Initiative in collaboration with the German Council of Science and Humanities (Wissenschaftsrat, WR), SCOPUS that is a database by Elsevier, Destatis that is the Federal Statistic Office for Germany, the Italian Ministry for University and Research (MIUR). And the European statistical office Eurostat.

The comparison between Germany and Italy is not new in higher education literature (see for example (Agasisti & Pérez-Esparrells, 2009; Agasisti & Pohl, 2012; Geuna & Nesta, 2006). On the systemic side both countries exhibit important similarities: (i) as supporters of the Bologna reform (Sursock, 2015); (ii) historical roots of academic and cultural exchange (Amt, 2017); (iii) the change from a one-cycle to a two-cycle education system what also affected the attractiveness of academia for young researchers (Froehlich, 2016); (iv) perception of universities as interrelation of teaching and research and subject-specific differences e.g. in Technical Universities ("*Technische Universität"* and *"Politecnico")*; (v) graduation rates and public expenditure per GDP are constantly below the OECD and EU average (Eurostat, 2012; OECD, 2013a, 2013b); (vi) regional gaps (South-North for Italy and East-West for Germany) and historical parallels as late democracies. However, the main difference of both systems is the decentral organization of education in Germany managed by the states while Italy is organized centrally by the Italian Ministry for University and Research. This differentiation is insofar important, as the Excellence Initiative was one way of allowing quasi-direct

funding of universities by the cooperation of the federal and states' governments beyond the traditional framework competencies of the central government.

3.3.2 Econometric model and estimation strategy

The chosen model is a fixed effect panel model as in settings investigating the effect of policy interventions on system performance it is likely that there exists correlation between all the regressors and the error term[9].

To identify the initiative effect, I conduct a *triple* Difference-in-Differences (DDD) analysis as proposed by (Imbens & Wooldridge, 2007), also employed by (Agrawal et al., 2017). It is formulated generally as follow

$$Y_{it} = \alpha + \beta_1^{DDD} TC_j TREATED_i \times Post_t + \beta_2 TC_j \times Post_t + \beta_3 TREATED_i \times Post_t + \tau_t + \mu_i + \theta X_{it} + \varepsilon_{it}$$

where TREATED=German universities winning the Excellence Initiative are treated units; T=treatment period; C=country; Control group: other German firms; Post: years after policy implementation (hence after 2006); Control country: Italy.

The triple difference-in-differences estimator is an advanced version of the more common difference-in-differences estimator. It is well-accepted method to evaluate the effects of the implementation of a policy initiative. Indeed, it allows using natural experiments to evaluate treatment effects in the absence of truly experimental data. Simple comparisons of pre-treatment and post-treatment outcomes for those individuals exposed to a treatment are likely to be contaminated by temporal trends in the outcome variable or by the effect of events, other than the treatment, that occurred between both periods. However, when only a fraction of the population is exposed to the treatment, an untreated comparison group can be used to identify temporal variation in the outcome that is not due to treatment exposure. In this analysis, the difference-in-differences estimator is able

[9] The results from Hausman test support the fixed -effect model approach. Furthermore, the results from the Breusch-Pagan Lagrange multiplier test support this choice compared to an OLS model approach.

to measure the effect of the Excellence Initiative on the performance of Excellence universities by taking non-Excellence universities as control group.

The triple difference-in-differences is thereby considered a more convincing method to evaluate the effects of a single policy change. The extant literature investigating the efficacy/inefficacy of Excellence Initiative argues that a simple difference-in-differences approach does not disentangle whether the difference in performance between German excellence and non-Excellence universities is due to intrinsic characteristics allowing Excellence universities to outperform the others regardless of the policy intervention (Bruckmeier et al., 2017; Gawellek & Sunder, 2016; Menter et al., 2018). I address this issue by introducing a second control group, the Italian universities, thereby implementing a triple difference-in-differences approach. By doing so, a new issue raised, as I need to identify Italian universities that are the most similar to the German Excellence universities. As in Italy the Excellence Initiative did not take place, I need to implement a statistical procedure to match the two groups. I rely on the CEM (Coarsened Exact Matching) method for the estimation of causal effects of institutional peculiarities on the probability of being evaluated as Excellence universities. The CEM algorithm consists of three steps: (1) desired variables of all universities are coarsened temporarily; (2) all universities of the initial cohort are sorted into strata on the basis of their coarsened variables; and (3) only universities with strata containing at least one Italian university and one German Excellence university are kept and others are discarded (Blackwell, Iacus, King, & Porro, 2012; Iacus, King, & Porro, 2011; Iacus et al., 2012). Universities are matched on pre-treatment variables (values in 2004 and 2005) to avoid announcement or direct effect biases by the introduced Initiative (Menter et al., 2018). The selected variables for the matching are the efficiency scores, the number of publications, and the citations-to-publications ratio. Efficiency scores and citations-to-publications ratio are the outcome variables for the following

regression while the number of publications is a transformation of the outcome variable publications per professors[10].

3.3.3 Variables

As the introduction of the Excellence Initiative aims to enhance the performance of the German higher education system, I consider three main dependent variables: (1) an efficiency score retrieved by Data Envelopment Analysis (DEA), (2) the publications to professor ratio, and (3) the citations to publications ratio.

To define the efficiency of universities I use the nonparametric DEA introduced by Charnes, Cooper, & Rhodes (1979) and Banker, Charnes, & Cooper (1984) that allows multiple outputs like teaching, research and the third mission (Wang & Huang, 2007; Wolszczak-derlacz, 2017). I calculate output-oriented, variable returns to scales (instead of constant returns to scale) and apply the bootstrapping approach to make the (non-parametrical) bias-corrected scores suitable for a parametrical analysis (Simar & Wilson, 1998, 2000; Sueyoshi & Goto, 2013).[11] Different financial measures are used as input variables, as they reflect the efforts made by the government (Agasisti & Pohl, 2012; Athanassopoulos & Shale, 1997). As output variables, I use graduates, citations and patents as measures for the three missions of a university: teaching, research and contribution to society (Acs, Anselin, & Varga, 2002; Agasisti, Catalano, Landoni, & Verganti, 2012; Etzkowitz & Leydesdorff, 2000).

The quantity of academic research is measured by the publications-to-professor ratio, a number which is directly affected by an individual researcher (Menter et al., 2018). It is the ratio between the number of publications recorded in Scopus and the number of professors. For Italy I considered only tenured staff (i.e. full professors, associate professors and tenure assistant professors)

[10]We do not adopt the number of publications per professor because in the two countries the number of professors is hardly comparable.
[11]Robustness checks for the uncorrected DEA scores are available on request.

while for Germany I considered full professors and assistant professors, which are relatively new life-long positions that are becoming even more common in the German higher education system. This variable represents the concept of research quantity.

The quality of academic research is proxied by the citations-to-publications ratio, which is (rather) unaffected by the individual researcher and expresses in general the novelty and originality, and thus the quality, of a single publication. It is the ratio between It is the ratio between the number of citations recorded in Scopus and the number of publications recorded in Scopus. It is measured at university level.[12] It is a proxy for research quality as it represents how the peers evaluate the work of an individual researcher. This measure is assumed to be independent from size effects (Katerattanakul, Han, & Hong, 2003; Katz, 2000). I control for the parallel trend assumption that has to be fulfilled for DDD by plotting my endogenous variables over time and additionally perform the parallel trend assumption test suggested by (Autor, 2003).

The main independent variables are:

1. Country. It is a dummy variable equal to 1 for Germany (the treated contry) and equal to 0 for Italy (the control country)
2. Excellence Initiative. It is measured with a dummy variable equal to 1 for the years after 2006 when the Excellence Initiative was launched, 0 for years before 2006 (namely 2004 and 2005). This is my treatment event.
3. Excellence universities. German Excellence universities are proxied by a dummy variable equal to 1 for the universities that won the extra funds from the Excellence Initiative, 0 for the universities that either did not win the extra funds or did not participate to the competition. 9 are Excellence universities and 63 are non-Excellence universities. Italian excellence and non-Excellence universities are derived by the coarsened exact matching (CEM). Universities are matched on pre-treatment variables (values in 2004) to avoid announcement or direct effect

[12] Data collection dates back to summer 2017.

biases by the introduced Initiative (Menter et al., 2018). The variable considered in the matching are the efficiency scores, the number of publications and the number of citations – which are the three dependent variables used in the main analysis. The matching procedure dropped 9 Italian universities. Out of the remaining 51, 6 are the Italian universities with similar characteristics to the 9 German Excellence universities while the other 45 result to be non-Excellence universities. **Table 8** and **Table 9** exhibit the T test on the equality of the mean of the average treatment effect on the treated by considering the three dependent variables of the analysis. P values are greater than 0.1, meaning that the control group matched (i.e. Italian excellent and non-excellent universities) is not statistically different from the treated group (i.e. German excellent and non-excellent universities).

Controls are in line with studies on performances of higher education systems in a comparative perspective (Agasisti et al., 2012; Agasisti & Pérez-Esparrells, 2009; Agasisti & Pohl, 2012). In particular:

1. Tuition fees. It is the average level of tuition charged to bachelor's and master's student per year. This variable captures one of the main difference between the two higher education systems analyzed. Indeed, in Germany university is almost free as the tuition has been eliminated in all *Länders* since 2007. Universities charging fees are characterized by small amounts, around 500 euros. In Italy, tuitions are allowed by law and are higher than in Germany. Nonetheless, the maximum amount that universities can charge to students is around 20% of the total government funding received by the state.
2. Hospital. It is a dummy variable equal to 1 if the university has an affiliation with an hospital, 0 otherwise. It represents a potential different cost structure of medical universities. Indeed, the field of medicine is more expensive than other studies.
3. Percentage of graduates by disciplines. It represents the percentage of graduates in the main subfields according to the Ministry of Education of both countries. In particular 7 macro-areas

are considered: Human Sciences; Sports, Business and Social Sciences; Medicine; Agricultural Sciences; Engineering; and the remaining other Sciences.

4. Unemployment rate. It is the percentage of unemployed population between 15 and 64 years-old at NUTS-2 level. This proxy aims to detect potential influence of the economic development of a Region on the universities' performance.
5. Population density. It is measured by the number of inhabitants at NUTS-2 level. It represents the regional development and attractiveness, as areas with greater concentration of inhabitants (e.g., cities and metropolis) are always dynamic and lively.

These variables have been chosen to describe both the institutional and the context factors affecting the performances of university systems. Further details are shown in **Table 6**.

Table 6. Variable definition

Every variable is measured by university per year. DEA VRS bootstrapping has been calculated using state funding as input and graduates, citations and patents as output. The German Excellence universities are selected through detailed proposals submitted to the DFG, Italian Excellence universities are selected though a statistical matching approach. 2006 is considered in the analysis the year when the Excellence Initiative officially started. DFG, namely Deutsche Forschungsgemeinschaft, is the German Research Foundation that organized the Excellence Initiative in collaboration with the German Council of Science and Humanities (Wissenschaftsrat, WR). SCOPUS is a database by Elsevier. Destatis is the Federal Statistic Office for Germany, while MIUR is the Italian Ministry for University and Research. Eurostat is the EU statistical office.

Variables	Description	Sources
Panel A: dependent variables		
DEA VRS bootstrapping	Efficiency bias-corrected score retrieved by Data Envelopment Analysis (DEA)	Own calculation (MaxDEA)
Citations/publications	Citations-recorded by publications listed in Scopus per university per year	SCOPUS
Publications/professors	Number of publications listed in Scopus per professor per university per year	SCOPUS; Destatis; MIUR
Panel B: triple DID variables		
Excellence university	Dummy variable equal to 1 if a university is considered an Excellence university, 0 otherwise.	DFG
Excellence Initiative	Dummy variable, equal to 1 after 2006, 0 otherwise.	DFG
Country	Dummy variable equal to 1 for Germany, 0 for Italy.	
Panel C: control variables at institutional level		
Fees per students (000€)	Fees payed by students for their studies	Destatis; MIUR
Hospital (%)	Dummy variable equal to 1 if a university has an affiliated hospital, 0 otherwise	Destatis; MIUR
Graduates in Human Sciences (%)	Share of graduates in Human Sciences including Language and Cultural studies, Arts Sciences per university per year.	Destatis; MIUR
Graduates in Sports (%)	Share of graduates in Sports per university per year.	Destatis; MIUR
Graduates in Business and Social Sciences (%)	Share of graduates in business and social sciences including law and psychology per university per year.	Destatis; MIUR
Graduates in Medicine (%)	Share of graduates in Human Medicine and Health Sciences including Veterinary and Pharmacy per university per year.	Destatis; MIUR
Graduates in agricultural (%)	Share of graduates in Agricultural Studies including Forrest and Nutrition Sciences per university per year.	Destatis; MIUR
Graduates in Engineering (%)	Share of graduates in Engineering including Architecture per university per year.	Destatis; MIUR
Graduates in Natural Sciences (%)	Share of graduates in Natural Sciences including Mathematics, Physics, Chemistry and Biology per university per year.	Destatis; MIUR
Graduates in Other Studies (%)	Share of graduates in other fields of studies per university per year.	Destatis; MIUR
Panel D: control variables at regional level		
Unemployment rate (%)	Number of people unemployed as a percentage of the labour force per year by NUTS 2 level.	Eurostat
Population density (million)	Absolute number of inhabitants per year by NUTS 2 level.	Eurostat

3.3.4 Descriptive Statistics

Table 7 reports descriptive statistics for the entire sample, for Excellence and non-Excellence universities as well as for pre- and post-treatment period. Not surprising – the statistics differ across Italy and Germany. Universities in Germany are less efficient than Italian universities (Lehmann et al., 2018), even if the former have improved after the excellence initiative, but seem to be more productive, i. e. get more articles published per researcher. Also research quality, as measured by the citations-to-publications ratio, is higher in Germany. While the growth rate of the citations per publication is higher in Italy (26.8%) than in Germany (19.85%) since the treatment period, the growth rate of publications per professor is the same (29.5%).

Table 8 and ***Table 9*** report the main descriptive statistics and the statistical difference between Italy and Germany for Excellence and non-Excellence universities respectively. The Tables demonstrate that the matched German and Italian Excellence universities are not statistically different before the Excellence Initiative but become statistically different afterwards. The same reasoning does not hold for German and Italian non-Excellence universities, as I did not want to lose any German universities, By comparing Excellence and non-Excellence universities, the former perform better in relation to efficiency, quantity and quality both in Italy and in Germany. However, it is interesting to underline that in Germany whereas treated and non-treated units increase their efficiency and their research quantity by similar amounts after the Excellence Initiative, the treated units increased their research quality by 6.2%, the non-treated counterpart improved by 22.4%. Finally, **Table 10** depicts the correlation matrix.

Table 7. Descriptive statistics per country

This table exhibits the descriptive statistics split by country (left side of the table). In the central section of the table, statistics before and after the Excellence Initiative that is my treatment period are included. On the right side of the table, I split the sample between Excellence and non-Excellence universities.

	Total		Before Excellence Initiative		After Excellence Initiative		Excellence universities		Non-Excellence universities	
	DE	IT	DE	IT	DE	IT	DE	IT	DE	IT
DEA VRS bootstrapping	0.54	0.91	0.51	0.87	0.55	0.92	0.83	0.96	0.50	0.91
Publications/professors	3.04	0.71	2.49	0.58	3.22	0.76	5.36	0.90	2.70	0.69
Citations/publications	22.51	19.03	19.59	15.84	23.48	20.09	25.61	27.16	22.07	17.94
Fees per students (000€)	0.35	1.27	0.00	1.13	0.46	1.32	0.47	1.36	0.33	1.26
Hospital (%)	45.83	56.86	45.83	56.86	45.83	56.86	88.89	100.00	39.68	51.11
Graduates in Human Sciences (%)	28.00	15.15	27.40	14.94	28.20	15.23	20.43	11.85	29.08	15.59
Graduates in Sports (%)	1.64	3.30	1.60	3.07	1.65	3.38	1.65	1.92	1.63	3.49
Graduates in Business and Social Sciences (%)	25.06	40.27	25.16	41.01	25.02	40.02	22.49	42.02	25.42	40.04
Graduates in Medicine (%)	8.82	8.77	10.31	8.98	8.33	8.71	10.46	11.31	8.59	8.44
Graduates in Agricultural Studies (%)	1.74	2.11	1.78	2.27	1.73	2.06	3.24	1.69	1.53	2.17
Graduates in Engineering (%)	13.50	20.53	14.35	20.58	13.22	20.51	15.90	15.96	13.15	21.14
Graduates in Natural Sciences (%)	21.16	9.73	19.41	9.14	21.75	9.92	25.83	15.17	20.50	9.00
Graduates in Other Studies (%)	0.08	0.13	0.00	0.01	0.11	0.18	0.00	0.08	0.09	0.14
Unemployment rate (%)	9.01	7.91	11.46	8.27	8.19	7.79	8.09	5.86	9.14	8.19
Population (million)	8.40	12.40	8.40	12.20	8.41	12.40	10.90	11.10	8.04	12.60
Observations per year	72	51	72	51	72	51	9	6	63	45
Observations	576	408	144	102	438	360	72	48	504	360

Table 8. Difference between Excellence universities pre-post period

The table exhibits the descriptive statistics for the matched sample of German and Italian Excellence universities. Difference is the difference between the means and P-values refer to T-tests on the equality of the mean assuming equal variance between the two groups. Variables included are those used in the matching.

	Before excellence initiative				After excellence initiative			
	DE	**IT**	**Difference**	**P-value**	**DE**	**IT**	**Difference**	**P-value**
DEA VRS bootstrapping	0.78	0.90	-0.12	0.21	0.84	0.98	-0.15	0.01
Publications	1762.18	1687.17	75.01	0.65	2433.35	907.92	1525.43	0.000
Citations/publications	24.47	22.45	-2.02	0.24	25.99	28.73	-2.71	0.01
Observations per year	9	6			9	6		
Observations	18	12			72	48		

Table 9. Difference between non-Excellence universities pre-post period

The table exhibits the descriptive statistics for the matched sample of German and Italian non-Excellence universities. Difference is the difference between the means and P-values refer to T-tests on the equality of the mean assuming equal variance between the two groups. Variables included are those used in the matching.

	Before excellence initiative				After excellence initiative			
	DE	**IT**	**Difference**	**P-value**	**DE**	**IT**	**Difference**	**P-value**
DEA VRS bootstrapping	0.47	0.87	-0.40	0.00	0.51	0.92	-0.41	0.00
Publications	649.27	558.82	90.45	0.41	870.07	776.58	93.49	0.11
Citations/publications	18.90	14.95	3.95	0.00	23.13	18.94	4.19	0.00
Observations per year	63	45			64	54		
Observations	126	90			512	432		

Table 10. Correlation matrix

This table reports the correlation coefficients among the dependent and independent variables employed in the regressions. Significant correlations of less than 5% are in bold.

	1	2	3	4	5	6	7	8	9	10
1. VRS bootstrap	1.000									
2. Publications/professors	-0.020	1.000								
3. Citations/publications	0.098	0.530	1.000							
4. Excellence universities	0.206	0.302	0.233	1.000						
5. Country	-0.541	0.617	0.208	0.011	1.000					
6. Excellence initiative	0.057	0.117	0.212	0.000	0.000	1.000				
7. Fees per student	0.395	-0.330	-0.004	0.049	-0.602	0.199	1.000			
8. Hospital	0.333	0.344	0.481	0.320	-0.109	0.000	0.037	1.000		
9. Graduates in Human Sciences (%)	-0.042	-0.064	-0.194	-0.117	0.352	0.014	-0.216	-0.196	1.000	
10. Graduates in Sports (%)	0.104	-0.051	-0.122	-0.023	-0.091	0.008	0.103	-0.086	-0.099	1.000
11. Graduates in Business and Social Sciences (%)	0.122	-0.390	-0.137	-0.022	-0.418	-0.012	0.161	0.028	-0.158	-0.129
12. Graduates in Medicine (%)	0.179	0.326	0.387	0.064	0.002	-0.047	-0.072	0.639	-0.251	-0.068
13. Graduates in Agricultural and Nutrition (%)	0.030	0.025	0.091	0.076	-0.051	-0.015	-0.059	0.142	-0.100	-0.039
14. Graduates in Engineering (%)	-0.110	-0.086	-0.112	-0.008	-0.156	-0.013	0.204	-0.279	-0.474	-0.120
15. Graduates in Other Sciences (%)	-0.002	-0.0475*	-0.021	-0.034	-0.032	0.073	0.063	-0.075	-0.059	-0.028
16. Unemployment rate (%)	-0.332	-0.113	-0.269	-0.123	0.131	-0.223	-0.371	-0.028	0.014	0.005
17. Population (million)	0.387	-0.077	0.100	0.070	-0.397	0.008	0.402	0.052	-0.128	0.018

	11	12	13	14	15	16	17
11. Graduates in Business and Social Sciences (%)	1.000						
12. Graduates in Medicine (%)	-0.107	1.000					
13. Graduates in Agricultural and Nutrition (%)	-0.041	0.017	1.000				
14. Graduates in Engineering (%)	-0.420	-0.259	-0.059	1.000			
15. Graduates in Other Sciences (%)	-0.042	-0.061	0.001	0.124	1.000		
16. Unemployment rate (%)	-0.018	-0.101	0.089	0.023	-0.041	1.000	
17. Population (million)	0.190	-0.020	-0.106	0.045	-0.072	-0.360	1.000

3.4 Results

The findings of the fixed effects model are presented in **Table 11**.[13] Since 2006, both the countries have improved their performance in terms of efficiency, research quantity and research quality. The first column depicts the results with the efficiency scores as the dependent variable and explain that there is no statistically significant effects on the efficiency of the German Excellence universities. Referring to the research quantity (**Table 11**, column 2), the Excellence Initiative generated a positive and significant effect on the German Excellence universities. Indeed, since the treatment period, the German treated units on average increased their publications per professors by 12.5%. The effect of the Excellence Initiative on the research quality (**Table 11**, column 3) instead is strongly negative for Excellence universities as the citations to publication ratio on average decreased by 21% compared to the pre-treatment value.

The Excellence Initiative affects the entire system as well. The non-Excellence universities increased their research productivity (i.e. publications per professor) by 10% but decreased their research quality by 8% on average. Implementing the Excellence Initiative can be regarded role model as it has a positive impact on research quantity. However, I detect a dysfunction as the Initiative it has a negative effect on research quality. Such negative effect on the entire system can be interpreted in two different ways, either Excellence universities exhausted all the resources available in the system with the consequent lowering of the entire system or all universities get triggered by a bandwagon effect, a phenomenon in which the probability of individual adoption is increasing with respect to the proportion who have already done so (Colman, 2008). These results can be interpreted in the light of the bandwagon phenomenon, as both the Excellence and non-Excellence universities indeed improved their performance after 2006, according to the descriptives in **Table 7**. The loss of research quality consequent to the appointment as Excellence universities might be explained by the

[13]Multicollinearity tests dismissed the potential for problems since none of the mean variance inflation factors exceeded 3.27 which is below the cut-off of 10 (see Kutner, Nachtsheim, and Neter 2004).

classical Principal Agent interaction: Politicians want to increase international visibility and – based on information asymmetry – believe to achieve this mainly by an increase in research quality. They hope for locational advantages by both new research innovations and connected international reputation. However, universities understand that the most important instruments to measure international visibility are e.g. rankings. Thus, they invest in a strengthening of their positions by increasing research productivity and potentially by tactics like salami-slicing or similar (Carree et al., 2014; Olcay & Bulu, 2016). (Menter et al., 2018) show the positive development for Excellence universities in rankings. However, despite politicians might have thought to increase international visibility by research quality, the international visibility rose due to the agents' efforts and they "got a bang for their buck" (Morgan, 2016).

The results related to controls are in line with previous literature. Universities charging more tuitions exhibit greater levels of efficiency and quality. Universities with medicine faculty underperform in terms of research productivity and quality due to the cost-intensive equipment and differing financial and personnel structure (Agasisti & Pohl, 2012; Kempkes & Pohl, 2010). The same holds for the field of Business and Social Sciences. Universities operating in regions with a lower unemployment rate exhibit higher efficiency, quantity, and quality than their counterparts in a favorable regional labor market, eventually due to substituting effects between expenditures on education and expenditures on unemployment (Shin, 2010). Furthermore, universities operating in more populated areas outperform in terms of efficiency, research quantity and quality since it is more likely that in such attractive areas a high number of experts and skilled human capital exists, which can contribute to improve all the performance dimensions in analysis.

Table 11. The effect of Excellence Initiative on university performance

This table reports the results of the fixed effects panel model. The sample consists of 72 German universities and 51 Italian universities observed during 2004-2011. Models 1-3 shows the baseline models, which test for policy intervention only. Model 4-6 include all the control variables. The dependent variables are respectively the efficiency non-biased scores retrieved by a DEA analysis; the publications-to-professor ratio and the citations-to-publications ratio. Natural Sciences is the reference case for the field of study. Robust standard errors are reported in parentheses. ***, **, and * indicate significance at less than 1%, 5%, and 10% levels, respectively.

	(1) VRS bootstrapping	(2) Publications/ professors	(3) Citations/ publications	(4) VRS bootstrapping	(5) Publications/ professors	(6) Citations/ publications
Excellence initiative	0.046***	0.165***	3.985***	0.036***	0.089**	3.322***
	(0.012)	(0.036)	(0.388)	(0.012)	(0.036)	(0.395)
Excellence universities * Excellence Initiative	0.034	0.061	2.290**	0.052	0.087	2.253**
	(0.034)	(0.106)	(1.132)	(0.034)	(0.100)	(1.101)
Country * Excellence initiative	-0.008	0.481***	0.245	-0.014	0.319***	-1.067**
	(0.016)	(0.048)	(0.508)	(0.017)	(0.049)	(0.542)
Excellence universities * Excellence Initiative * Country	-0.009	0.629***	-4.998***	-0.012	0.547***	-5.515***
	(0.045)	(0.137)	(1.464)	(0.044)	(0.130)	(1.430)
Fees per student				0.021**	0.034	0.619**
				(0.009)	(0.028)	(0.305)
Graduates in Human Sciences (%)				0.367**	-0.158	-8.601*
				(0.147)	(0.437)	(4.819)
Graduates in Sports (%)				1.248***	-1.521	3.350
				(0.415)	(1.234)	(13.61)
Graduates in Business and Social Sciences (%)				0.448***	-1.414***	-16.31***
				(0.126)	(0.374)	(4.131)
Graduates in Medicine (%)				0.957***	-1.675***	-23.99***
				(0.142)	(0.421)	(4.643)
Graduates in Agricultural Sciences (%)				-0.526	-5.773***	1.778
				(0.402)	(1.193)	(13.17)
Graduates in Engineering (%)				0.095	-0.814	-11.20**
				(0.168)	(0.499)	(5.507)
Graduates in Other Sciences (%)				0.042	-2.309	-21.60
				(0.554)	(1.645)	(18.15)
Unemployment rate				-0.007***	-0.057***	-0.372***
				(0.002)	(0.007)	(0.073)
Population (million)				0.012	0.086**	0.974**
				(0.013)	(0.038)	(0.415)
Constant	0.871***	0.565***	14.95***	0.242	2.332***	23.00***
	(0.040)	(0.189)	(1.096)	(0.163)	(0.483)	(5.326)
Observations	984	984	984	984	984	984
R-squared	0.383	0.536	0.132	0.123	0.540	0.326
Number of universities	123	123	123	123	123	123

3.5 Robustness checks

Table 12 and **Table 13** present findings distinguishing between Germany and Italy. The coefficients for Germany are consistent and slightly different from those of the main regression. This result demonstrates that it is the policy itself to determine a difference in the performance between excellence and non-Excellence universities. Either by introducing a control group (Italian universities) or not, Excellence Initiative represents a turnaround point affecting the performance of the university system. It contributes to the previous studies investigating the Excellence Initiative, which were not able to disentangle whether the difference in performance between German excellence and non-Excellence universities is due to intrinsic characteristics allowing Excellence universities to outperform the others regardless of the policy intervention (Bruckmeier, Fischer, and Wigger 2017; Gawellek and Sunder 2016; Menter, Lehmann, and Klarl 2018).

Table 12. The effect of Excellence Initiative on German university performance

This table reports the results of the fixed effects panel model. The sample consists of 72 German universities observed during 2004-2011. Models 1-3 shows the baseline models, which test for policy intervention only. Model 4-6 include all the control variables. The dependent variables are respectively the efficiency non-biased scores retrieved by a DEA analysis; the publications-to-professor ratio and the citations-to-publications ratio. Natural Sciences is the reference case for the field of study. Robust standard errors are reported in parentheses. ***, **, and * indicate significance at less than 1%, 5%, and 10% levels, respectively.

	(1) VRS bootstrapping	(2) Publications/ professors	(3) Citations/ publications	(4) VRS bootstrapping	(5) Publications/ professors	(6) Citations/ publications
Excellence initiative	0.038***	0.647***	4.230***	0.011	0.350***	1.057***
	(0.011)	(0.039)	(0.319)	(0.015)	(0.050)	(0.385)
Excellence universities * Excellence Initiative	0.025	0.690***	-2.707***	0.054*	0.648***	-2.698***
	(0.032)	(0.110)	(0.903)	(0.031)	(0.102)	(0.790)
Fees per student				0.009	0.007	0.254
				(0.011)	(0.036)	(0.281)
Graduates in Human Sciences (%)				0.455**	0.194	-0.940
				(0.180)	(0.594)	(4.621)
Graduates in Sports (%)				0.786	-3.017	-17.32
				(0.572)	(1.886)	(14.67)
Graduates in Business and Social Sciences (%)				0.489***	-1.203**	-6.124
				(0.166)	(0.549)	(4.267)
Graduates in Medicine (%)				1.212***	-1.813***	-22.68***
				(0.181)	(0.598)	(4.646)
Graduates in Agricultural Sciences (%)				-0.004	-7.263***	17.15
				(0.529)	(1.745)	(13.57)
Graduates in Engineering (%)				0.132	-0.903	-6.681
				(0.202)	(0.665)	(5.172)
Graduates in Other Sciences (%)				0.326	-1.556	-3.916
				(0.657)	(2.168)	(16.86)
Unemployment rate				-0.013***	-0.076***	-0.784***
				(0.003)	(0.009)	(0.070)
Population (million)				0.012	-0.107	-1.40***
				(0.021)	(0.069)	(0.536)
Constant	0.508***	2.487***	19.59***	0.148	5.006***	45.41***
	(0.009)	(0.032)	(0.259)	(0.212)	(0.699)	(5.434)
Observations	576	576	576	576	576	576
R-squared	0.032	0.469	0.263	0.145	0.582	0.477
Number of universities	72	72	72	72	72	72

Table 13. The effect of Excellence Initiative on Italian university performance

This table reports the results of the fixed effects panel model. The sample consists of 51 Italian universities observed during 2004-2011. Models 1-3 shows the baseline models, which test for policy intervention only. Model 4-6 include all the control variables. The dependent variables are respectively the efficiency non-biased scores retrieved by a DEA analysis; the publications-to-professor ratio and the citations-to-publications ratio. Natural Sciences is the reference case for the field of study. Robust standard errors are reported in parentheses. ***, **, and * indicate significance at less than 1%, 5%, and 10% levels, respectively.

	(1) VRS bootstrapping	(2) Publications/ professors	(3) Citations/ publications	(4) VRS bootstrapping	(5) Publications/ professors	(6) Citations/ publications
Excellence initiative	0.046***	0.165***	3.985***	0.043***	0.136***	4.165***
	(0.009)	(0.014)	(0.403)	(0.011)	(0.014)	(0.430)
Excellence universities * Excellence Initiative	0.034	0.061	2.290*	0.035	0.040	0.743
	(0.028)	(0.040)	(1.174)	(0.027)	(0.032)	(1.017)
Fees per student				0.073***	0.164***	1.618*
				(0.022)	(0.026)	(0.824)
Graduates in Human Sciences (%)				-0.603*	-0.787**	-38.19***
				(0.313)	(0.374)	(11.88)
Graduates in Sports (%)				1.403**	0.687	16.47
				(0.572)	(0.683)	(21.71)
Graduates in Business and Social Sciences (%)				-0.052	-0.596**	-34.95***
				(0.236)	(0.282)	(8.963)
Graduates in Medicine (%)				0.274	-0.144	-28.30***
				(0.274)	(0.327)	(10.39)
Graduates in Agricultural Sciences (%)				-1.683***	-1.319*	-35.84
				(0.620)	(0.740)	(23.53)
Graduates in Engineering (%)				-0.418	-0.096	-31.64**
				(0.367)	(0.438)	(13.93)
Graduates in Other Sciences (%)				-1.871	-3.160**	-36.16
				(1.193)	(1.423)	(45.28)
Unemployment rate				0.016***	0.036***	1.437***
				(0.004)	(0.005)	(0.163)
Population (million)				-0.03**	0.076***	-0.093
				(0.015)	(0.017)	(0.553)
Constant	0.874***	0.584***	15.84***	1.191***	-0.420	32.66***
	(0.008)	(0.011)	(0.328)	(0.296)	(0.353)	(11.23)
Observations	408	408	408	408	408	408
R-squared	0.084	0.337	0.269	0.235	0.619	0.503
Number of universities	51	51	51	51	51	51

A cluster-robust OLS as alternative model is reported in **Table 14**. Not controlling for fixed effects, the variable *Excellence universities*Excellence initiative*Country* is statistically different from zero and positive in Model 2 and negative in Model 3.

Table 14. Robustness check. Clustered linear regression model

This table reports the results of the random effects panel model. The sample consists of 51 Italian universities observed during 2004-2011. Models 1-3 shows the baseline models, which test for policy intervention only. Model 4-6 include all the control variables. The dependent variables are respectively the efficiency non-biased scores retrieved by a DEA analysis; the publications-to-professor ratio and the citations-to-publications ratio. Natural Sciences is the reference case for the field of study. Robust standard errors are reported in parentheses. ***, **, and * indicate significance at less than 1%, 5%, and 10% levels, respectively.

	(1) VRS bootstrapping	(2) Publications/ professors	(3) Citations/ publications	(4) VRS bootstrapping	(5) Publications/ professors	(6) Citations/ publications
Excellence universities	0.032	0.161*	7.496***	-0.064	-0.539**	2.773*
	(0.070)	(0.091)	(1.194)	(0.048)	(0.220)	(1.564)
Excellence initiative	0.079***	0.498***	8.228***	0.050**	0.435***	7.570***
	(0.018)	(0.038)	(0.533)	(0.022)	(0.058)	(0.567)
Excellence universities * Excellence Initiative	0.034	0.061***	2.290*	0.033	-0.046	2.235*
	(0.029)	(0.023)	(1.248)	(0.031)	(0.072)	(1.280)
Country	-0.402***	1.654***	3.942***	-0.426***	1.558***	6.514***
	(0.061)	(0.176)	(1.362)	(0.102)	(0.287)	(1.651)
Excellence universities * Country	0.278**	1.980***	-1.926	0.293***	1.652***	-3.484
	(0.129)	(0.568)	(2.255)	(0.111)	(0.554)	(2.557)
Country * Excellence initiative	-0.008	0.481***	0.245	-0.054*	0.350***	-1.017
	(0.030)	(0.054)	(0.518)	(0.031)	(0.089)	(0.630)
Excellence universities * Excellence Initiative * Country	-0.009	0.629***	-4.998***	-0.009	0.813***	-4.641***
	(0.045)	(0.195)	(1.498)	(0.052)	(0.243)	(1.511)
Fees per student				-0.010	-0.197*	0.539
				(0.021)	(0.102)	(0.765)
Hospital				0.146**	0.844***	5.624***
				(0.071)	(0.246)	(1.289)
Graduates in Human Sciences (%)				0.245	-5.652***	-25.85***
				(0.291)	(1.007)	(5.221)
Graduates in Sports (%)				0.109	-3.308***	-22.62***
				(0.246)	(0.967)	(5.004)
Graduates in Business and Social Sciences (%)				-0.393*	-4.940***	-18.56***
				(0.234)	(1.037)	(5.614)
Graduates in Medicine (%)				-0.048	-2.378**	-11.25*
				(0.290)	(1.098)	(6.539)
Graduates in Agricultural Sciences (%)				-0.309	-4.854*	0.682
				(0.455)	(2.457)	(14.27)
Graduates in Engineering (%)				-0.274	-3.770***	-17.98***
				(0.242)	(0.989)	(5.315)
Graduates in Other Sciences (%)				0.919	-2.473	10.85

				(1.465)	(3.215)	(18.07)
Unemployment rate				-0.018***	-0.057***	-0.348***
				(0.004)	(0.021)	(0.122)
Population (million)				0.006	0.041**	0.266**
				(0.007)	-0.019	(0.11)
Constant	0.855***	0.514***	13.89***	1.052***	4.373***	27.09***
	(0.045)	(0.041)	(0.988)	(0.296)	(1.059)	(5.091)
Year dummies	YES	YES	YES	YES	YES	YES
Observations	984	984	984	984	984	984
R-squared	0.361	0.539	0.215	0.543	0.776	0.582

Moreover, in **Table 15**, I changed the control group of the Italian Excellence universities, according with the classification provided by ANVUR (2013) from 2011.[14] The coefficient showing the effect of German Excellence Initiative on the research quality is not different from zero. This can delineate a sensitivity of the results to the definition of this indicator or to the definition of the control group. The other results however are very similar to those of the base model.

Finally, **Table 16** and **Table 17** repeat the main analysis distinguishing between two geographical clusters; the first one includes the economically stronger North of Italy and the South of Germany while the second one the remaining areas (Abramo, D'Angelo, & Rosati, 2016). Results are consistent just for the economically strong areas of the two countries indicating that it is this area to shape the general trend. The coefficient of Unemployment is positive and significantly different from zero. This result is counterintuitive. However, the results for the other regressors are only slightly different from those for the base model.

Table 15. Robustness check. Italian Excellence universities based on ANVUR ranking

This table reports the results of the fixed effects panel model. The Italian Excellence universities are defined according to the ANVUR The sample consists of 51 Italian universities observed during 2004-2011. Models 1-3 shows the baseline models, which test for policy intervention only. Model 4-6 include all the control variables. The dependent variables are respectively the efficiency non-biased scores retrieved by a DEA analysis; the publications-to-professor ratio and the citations-to-publications ratio. Natural Sciences is the reference case for the field of study. Robust standard errors are reported in parentheses. ***, **, and * indicate significance at less than 1%, 5%, and 10% levels, respectively.

[14] The results of 2006 are unfortunately not public.

	(1) VRS bootstrapping	(2) Publications/ professors	(3) Citations/ publications	(4) VRS bootstrapping	(5) Publications/ professors	(6) Citations/ publications
Excellence initiative	0.050***	0.155***	4.251***	0.038***	0.069*	2.832***
	(0.012)	(0.037)	(0.398)	(0.014)	(0.038)	(0.426)
Excellence universities * Excellence Initiative	-0.012	0.491***	-0.021	-0.018	0.093	-1.704*
	(0.016)	(0.048)	(0.516)	(0.029)	(0.082)	(0.918)
Country * Excellence initiative	-0.001	0.111	0.022	-0.017	0.360***	-0.679
	(0.031)	(0.094)	(1.005)	(0.017)	(0.049)	(0.543)
Excellence universities * Excellence Initiative * Country	0.026	0.579***	-2.730**	0.055	0.546***	-1.433
	(0.042)	(0.128)	(1.370)	(0.041)	(0.114)	(1.271)
Fees per student				0.022**	0.034	0.603**
				(0.010)	(0.027)	(0.299)
Graduates in Human Sciences (%)				0.467***	-0.480	-9.767**
				(0.145)	(0.406)	(4.519)
Graduates in Sports (%)				1.160***	-1.167	3.060
				(0.370)	(1.036)	(11.54)
Graduates in Business and Social Sciences (%)				0.372***	-1.487***	-19.08***
				(0.126)	(0.354)	(3.940)
Graduates in Medicine (%)				0.932***	-1.651***	-23.08***
				(0.142)	(0.398)	(4.437)
Graduates in Agricultural Sciences (%)				-0.440	-5.551***	-0.079
				(0.396)	(1.109)	(12.36)
Graduates in Engineering (%)				0.095	-0.862*	-11.57**
				(0.173)	(0.485)	(5.403)
Graduates in Other Sciences (%)				-0.014	-2.621	-26.39
				(0.573)	(1.604)	(17.87)
Unemployment rate				-0.007***	-0.056***	-0.493***
				(0.003)	(0.007)	(0.079)
Population (million)				0.053	0.147	5.78***
				(0.034)	(0.096)	(1.07)
Constant	0.660***	1.698***	18.04***	-0.157	1.728*	-23.70**
	(0.006)	(0.019)	(0.204)	(0.349)	(0.978)	(10.89)
Observations	984	984	984	1,064	1,064	1,064
R-squared	0.045	0.463	0.262	0.119	0.532	0.342
Number of universities	123	123	123	133	133	133

Table 16. Robustness check. Geographical cluster: North Italy and South Germany

This table reports the results of the fixed effects panel model. I pooled together North Italy and South Germany. It is due to the assumption that German and Italian universities belonging to this macro-region present similarities. The sample consists of 51 Italian universities observed during 2004-2011. Models 1-3 shows the baseline models, which test for policy intervention only. Model 4-6 include all the control variables. The dependent variables are respectively the efficiency non-biased scores retrieved by a DEA analysis; the publications-to-professor ratio and the citations-to-publications ratio. Natural Sciences is the reference case for the field of study. Robust standard errors are reported in parentheses. ***, **, and * indicate significance at less than 1%, 5%, and 10% levels, respectively.

	(1) VRS bootstrapping	(2) Publications/ professors	(3) Citations/ publications	(4) VRS bootstrapping	(5) Publications/ professors	(6) Citations/ publications
Excellence initiative	0.013	0.224***	3.222***	-0.012	0.177***	2.631***
	(0.014)	(0.047)	(0.717)	(0.014)	(0.048)	(0.731)
Excellence universities * Excellence Initiative	0.090***	0.015	4.240***	0.086***	0.001	2.944*
	(0.031)	(0.102)	(1.563)	(0.029)	(0.100)	(1.507)
Country * Excellence initiative	0.036	0.283***	0.247	0.066**	0.192**	2.155
	(0.025)	(0.083)	(1.272)	(0.028)	(0.097)	(1.480)
Excellence universities * Excellence Initiative * Country	-0.090*	1.057***	-8.426***	-0.124**	0.835***	-8.607***
	(0.053)	(0.178)	(2.721)	(0.053)	(0.181)	(2.766)
Fees per student				0.008	0.005	0.759*
				(0.008)	(0.027)	(0.414)
Graduates in Human Sciences (%)				0.241	-1.364*	-34.22***
				(0.224)	(0.770)	(11.77)
Graduates in Sports (%)				3.944***	1.922	55.84
				(0.898)	(3.088)	(47.23)
Graduates in Business and Social Sciences (%)				-0.141	-0.904	-36.44***
				(0.184)	(0.633)	(9.688)
Graduates in Medicine (%)				-0.278	-2.321**	-37.44***
				(0.264)	(0.908)	(13.89)
Graduates in Agricultural Sciences (%)				-0.683	-7.073***	-15.05
				(0.530)	(1.824)	(27.90)
Graduates in Engineering (%)				-0.237	-0.165	-28.81
				(0.352)	(1.210)	(18.51)
Graduates in Other Sciences (%)				-5.365*	-14.69	-233.6
				(2.836)	(9.754)	(149.2)
Unemployment rate				0.0180***	-0.018	1.123***
				(0.004)	(0.015)	(0.234)
Population (million)				0.018	0.173***	0.024
				(0.011)	(0.039)	(0.598)
Constant	0.845***	1.413***	20.18***	0.582**	0.274	42.21***
	(0.009)	(0.030)	(0.455)	(0.228)	(0.783)	(11.97)
Observations	224	224	224	224	224	224
R-squared	0.105	0.550	0.238	0.348	0.655	0.413
Number of universities	28	28	28	28	28	28

Table 17. Robustness check. Geographical cluster: South Italy and North Germany

This table reports the results of the fixed effects panel model. I pooled together South Italy and North Germany. It is due to the assumption that German and Italian universities belonging to this macro-region present similarities. The sample consists of 51 Italian universities observed during 2004-2011. Models 1-3 shows the baseline models, which test for policy intervention only. Model 4-6 include all the control variables. The dependent variables are respectively the efficiency non-biased scores retrieved by a DEA analysis; the publications-to-professor ratio and the citations-to-publications ratio. Natural Sciences is the reference case for the field of study. Robust standard errors are reported in parentheses. ***, **, and * indicate significance at less than 1%, 5%, and 10% levels, respectively.

	(1) VRS bootstrapping	(2) Publications/ professors	(3) Citations/ publications	(4) VRS bootstrapping	(5) Publications/ professors	(6) Citations/ publications
Excellence initiative	0.063***	0.136***	4.366***	0.051***	0.046	3.283***
	(0.016)	(0.047)	(0.465)	(0.016)	(0.046)	(0.463)
Excellence universities * Excellence Initiative	-0.029	0.067	-0.466	-0.037	0.107	0.093
	(0.062)	(0.189)	(1.859)	(0.059)	(0.175)	(1.749)
Country * Excellence initiative	-0.026	0.528***	-0.0414	-0.041**	0.345***	-1.380**
	(0.019)	(0.059)	(0.576)	(0.020)	(0.059)	(0.586)
Excellence universities * Excellence Initiative * Country	0.059	0.537**	-1.697	0.088	0.400**	-3.047
	(0.071)	(0.216)	(2.121)	(0.068)	(0.201)	(2.011)
Fees per student				0.038**	0.120***	0.857*
				(0.016)	(0.046)	(0.462)
Graduates in Human Sciences (%)				0.421**	0.114	-0.872
				(0.175)	(0.516)	(5.170)
Graduates in Sports (%)				1.087**	-1.880	0.948
				(0.462)	(1.359)	(13.61)
Graduates in Business and Social Sciences (%)				0.556***	-1.562***	-9.159**
				(0.151)	(0.443)	(4.439)
Graduates in Medicine (%)				1.145***	-1.572***	-20.29***
				(0.160)	(0.472)	(4.726)
Graduates in Agricultural Sciences (%)				-0.433	-4.690***	6.343
				(0.494)	(1.452)	(14.55)
Graduates in Engineering (%)				0.147	-0.843	-6.555
				(0.189)	(0.556)	(5.567)
Graduates in Other Sciences (%)				0.116	-2.441	-11.90
				(0.594)	(1.748)	(17.51)
Unemployment rate				-0.009***	-0.060***	-0.549***
				(0.003)	(0.007)	(0.074)
Population (million)				0.003	-0.024	2.13***
				(0.020)	(0.059)	(0.591)
Constant	0.605***	1.782***	17.40***	0.249	3.535***	9.636
	(0.007)	(0.023)	(0.226)	(0.223)	(0.657)	(6.584)
Observations	760	760	760	760	760	760
R-squared	0.045	0.452	0.282	0.151	0.544	0.379
Number of universities	95	95	95	95	95	95

3.6 Conclusions

The aim of this study was to show the effects of the picking the winner policy initiative in Germany. In particular, I address two questions:

- Is the Policy approach of the Excellence Initiative in Germany suitable to stimulate the higher education system and in particular, the winners of the competition?
- Even if it turns out to be a suitable approach, how can the results of the Initiative in terms of performance be measured? More precisely: Why hoping for Quality when rewarding Quantity?

In short, I find that the Initiative stimulated not only the higher education system as such but also the winners. However, the judgment and evaluation of the outcome is dependent on how to measure it. Germany compared to Italy is below the performance in terms of efficiency, however, above the performance in terms of research output and research impact. Further, I find bandwagon effects for the entire German university system in terms of research quantity that is significantly increasing and quality that is significantly decreasing compared to the Italian university system. The effects are even stronger to both sides – positive and negative – for German universities that were chosen to be Excellence. While I see the in general positive effect of research output, I detect an adverse effect for research impact. I trace this effect back: not to an increase of publications (that is around 30% between pre- and post-treatment) but rather to a considerably slower increase in citations – meaning the actual impact rather than a pure raise in quantity. German Excellence universities rose their citations by 37% compared to German non-Excellence universities by 55% and to Italian Excellence universities by 60%.

I implicate by my results that researchers are considering output maximization instead of impact maximization. The question of who should actually get rewards of such a competition – the one that "sells the most" or the one that "sells the most valuable" – should be questioned and consequently answered (Kerr, 1975). Inverting such a trend one has to consider possible policy rationales: If the target of policies is to increase ranking visibility, one should continue to incentivize

the maximization of output, as this is a pervasive way to increase e.g. ranking visibility (Vogel et al., 2017). However, if the target is to increase research impact one should incentivize not "salami-publishing" (Geuna & Martin, 2003; Martin, 2012) but rather to publish e.g. in high Impact Factor Journals. However, this takes time and is not displayed by the Excellence Initiative in two essential points: first, the time dimension of the funding is too small to experience a sustainable quality improvement and second, the "*Graduiertenkolleg*", graduate schools funded by the Initiative for fast track (mostly cumulative) promotions, are considered as a signal incentivizing the exact opposite, videlicet fast and many publications (Baader & Korff, 2015). This is just in line with Kerr (1975): "Whether dealing with monkeys, rats, or human beings, it is hardly controversial to state that most organisms seek information concerning what activities are rewarded, and then seek to do (or at least pretend to do) those things, often to the virtual exclusion of activities not rewarded."

These results show that the incentives and installed evaluation mechanism by the Excellence Initiative supported a role model in terms of quantitative output compared to a dysfunction in terms of qualitative output. Two steps could be considered in the future: (1) The winners of the Initiative could be tracked and consecutive payouts based on milestone strategies might monitor the progress of the submitted drafts even in a longer time span and (2) Transparency seems to incentivize more than pure financial measures of which the utilization remains unclear after allocation.

This study comes at some limitations: as citations are no immediate measure and Scopus as a database is constantly updated I am aware of several lag effects (see e.g. also resilience and different results at Morgan, 2016). However, this problem could only be solved in a bigger timeframe that consequently includes the third round of the Excellence Initiative. For this purpose, comprehensive and balanced data is not yet accessible and the effect of the first Initiative might be blurred. The choice of Italian Excellence universities is a matter of discussion, although I use both a quantitative and more qualitative approach. Likewise, considering a comparison with more than one country may be interesting. Additionally, I face a general concern according to omitted variables.

4. ESSAY 3: THE EFFECT OF UNIVERSITY INTERNATIONALIZATION ON THE INTERNATIONAL ORIENTATION OF ACADEMIC SPINOFFS

Acknowledgement: This chapter is derived from the published paper 'Civera, A., Meoli, M., & Vismara, S. (2018). Do academic spinoffs internationalize?. *The Journal of Technology Transfer*, 1-23.' In the published version, sections "Literature review and Hypotheses development", "Research Design", "Results", and "Robustness tests" are fully my contribution; "Introduction" and "Conclusions" are written jointly with the co-authors. Moreover, I am responsible for all the changes in this chapter with respect to published version.

I am immensely grateful to the support received from my co-authors. I am responsible for all the changes in this chapter with respect to the published version. I would also like to editors of and three anonymous reviewers for their helpful comments on earlier versions of this manuscript. Finally, I want to express my gratitude for the insightful comments offered by the participants at the XXVII Annual Scientific Meeting Associazione italiana di Ingegneria Gestionale (RSA AiIG 2016) in October 2016, at the Technology Transfer Society (T2S) in October 2015.

4.1 Introduction

Academic spinoffs are companies created by academic personnel (Colombo et al., 2010) to exploit technological knowledge that originated within universities (Fini et al., 2011) and have received great attention from scientists and policy makers (Perkmann et al., 2013). The European Commission, for instance, recommends that research institutions "communicate clear incentives for researchers who take part in knowledge transfer activities."[15] Many member states have coherently implemented laws to foster the establishment of academic spinoffs, among other technology transfer mechanisms (Clarysse et al., 2007). The rationale is that these firms are expected to act as engines of development, resulting in economic and social spillovers in excess of the private returns (Griliches, 2013). Indeed,

[15] http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52007SC0449.

although they are unlikely to generate major short-term shifts in macroeconomic performance on their own, their indirect effects on technology-using sectors are significant (Ljungberg & McKelvey, 2012).

Academic spinoffs are an economic phenomenon framed at the intersection of several research streams such as economics, policy studies, and innovation and entrepreneurship (for a review of the literature, see Civera, Meoli, & Vismara, 2017). Regardless of the perspective from which one might look at academic spinoffs, there is significant interest on the motivations to create them. The determinants can be found in both individual motivations (Horta, Meoli, & Vismara, 2016) and institutional and context-specific characteristics (Meoli, Pierucci, & Vismara, 2018). At the individual level, studies have revealed that researchers involved in creating new ventures may not be motivated solely by an entrepreneurial vision but wish to enhance their position or have aspirations for independence or recognition (Link, Siegel, & Bozeman, 2007). The creation of academic spinoffs is therefore motivated by a broad set of goals (Meoli, Paleari, & Vismara, 2017). Such pursuit of noneconomic motivations might prelude the risk of performance disappointment. The empirical evidence shows indeed that most academic spinoffs do not outperform peer companies and few are remarkably successful.

Despite their unsatisfactory performance, academic spinoffs often seek to internationalize their activities at an early stage (Bjørnåli & Aspelund, 2012). Some recent studies have investigated the internationalization of academic spinoffs by focusing on their top management teams (Franco-Leal, Soetanto, & Camelo-Ordaz, 2016; Pettersen & Tobiassen, 2012). Others have assumed a more macro-level perspective by focusing on the environmental support offered by universities, incubators, and science parks (e.g., Smith, Romeo, & Bagchi-Sen, 2008; Styles & Genua, 2008). However, the topic is far from fully explored. A gap in the literature remains concerning the post-entry internationalization of academic spinoffs. Neither academic entrepreneurship studies nor the international entrepreneurship literature has quantitatively addressed whether academic spinoffs are

more or less inclined to internationalize than comparable firms. This gap must be filled, given the potential to generate new theoretical insights by examining this unique context.

The main research questions driving my analysis are:

Do academic spinoffs internationalize more than innovative start-up counterparts?

Do academic spinoffs internationalize more due to their affiliation with university?

Empirically, I rely on a sample of 508 academic spinoffs from 59 Italian universities established between 1999 and 2014. A conditional difference-in-differences (DID) approach is used to assess whether creation by a university has a significant impact on the propensity to internationalize. The sample of academic spinoffs is matched with a population of 1,060 innovative start-ups included in the Italian Registry of Innovative Firms (*Registro delle imprese innovative*).

4.2 Literature Review and Hypotheses Development

4.2.1 Academic spinoffs in the entrepreneurial ecosystems

Entrepreneurship plays an important role in economic development (see Acs, Desai, & Klapper, 2008; Audretsch, Keilbach, & Lehmann, 2006; Audretsch & Lehmann, 2005) but it cannot be decoupled from the local context in which entrepreneurs operate (Acs, Autio, & Szerb, 2014). Peculiarities of the place (M. P. Feldman, 2014) where entrepreneurs work and live determine their attitudes, aspirations, and opportunities, as well as the typology and performance of their businesses.

Starting from the knowledge spillover theory of entrepreneurship (Audretsch et al., 2012; Audretsch & Lehmann, 2005; Belitski & Desai, 2016), a multi-level approach has been adopted to study the entrepreneurial activity (Acs et al., 2008; Levie & Autio, 2008; Reynolds et al., 2005; Stuetzer, Obschonka, Brixy, Sternberg, & Cantner, 2013) and its positive and negative externalities (Stenholm, Acs, & Wuebker, 2013; Sternberg, 2009) at the regional level. Recently, both theoretical and empirical research on entrepreneurial ecosystems has grown (Hayter, Nelson, Zayed, &

O'Connor, 2018). The common belief beyond the concept of the entrepreneurial ecosystem is that certain attributes exist outside the boundaries of a firm but within a region that contributes to the competitiveness of a new venture. (Audretsch & Belitski, 2017) in their study described the entrepreneurial ecosystem as a set of interdependent actors and system-level institutional, informational, and socioeconomic contexts. Universities are key agents (Hayter, 2016) because their knowledge creation and diffusion results in positive spillovers to the local environment (Audretsch, Lehmann, Paleari, & Vismara, 2016; Lehmann & Menter, 2016). Universities can help support entrepreneurial cultures and networks by removing institutional barriers, training skilled workers and entrepreneurs, and funding support programs such as networking events and incubation facilities (Bischoff, Volkmann, & Audretsch, 2018; Wright, Siegel, & Mustar, 2017). Universities, to some extent, are institutions that feed entrepreneurial ecosystems, in part through the establishment of academic spinoffs. Spinoffs provide new ideas and technologies for other economic agents within the entrepreneurial ecosystem. Because they advance scientific knowledge and contribute to social and economic growth, university spinoffs are a key component of a vibrant entrepreneurial ecosystem (Schillo, 2018).

4.2.2 Internationalization of academic spinoffs

Academic spinoffs typically possess advanced technologies that are attractive in international niche markets and are therefore natural candidates for internationalization (Kiederich & Kraus, 2009). Then, academic spinoffs often target new, emerging, and frequently international markets (Oviatt & McDougall, 1994), selling their products/services abroad soon after inception (Crick & Jones, 2000).

The internationalization of academic spinoffs can be explained using the network approach theory, a theoretical framework widely adopted in the literature on firms' internationalization. The network approach assumes that a firm's survival depends on resources controlled by other institutions, which play a key role in the learning and knowledge development of firms. Networks are particularly relevant to firms established through the commercialization of academic research, as learning and

knowledge development are fundamental tasks for these firms (Styles & Genua, 2008). Indeed, networks of the academics involved in university spinoffs help them identify and exploit initial opportunities to internationalize. Academic spinoffs have the significant advantage of the resources and networks, brand name, and reputation of parent institutions (Zahra, 2005). Moreover, parent institutions provide their spinoffs with specific information, identification of opportunities, and access to markets (Gulati, Nohria, & Zaheer, 2000).

Pettersen & Tobiassen (2012) adopt this theory in investigating the internationalization of academic spinoffs, performing a multiple case study analysis and interviews to disentangle the effect of several network types that provide financial resources, knowledge innovation and technology, marketing, and reputational transference. Bjørnåli & Aspelund (2012) applied network theory to the internationalization of academic spinoffs and demonstrated the importance of strategic international alliances cultivated by the entrepreneurial team. Securing international alliances is an important step in the internationalization of academic spinoffs, as alliances provide concrete critical resources, such as specific skills and financial resources, as well as intangible resources like legitimacy and market power. Similarly, the study of Franco-Leal et al. (2016) investigated the impact of non-academics in founding teams and networks on the performance of academic spinoffs in targeting international markets. They argue that academic spinoffs need complementary knowledge, skills, and resources from non-academics in starting a new venture, particularly in targeting international markets. Finally, Teixeira & Coimbra (2014) explicitly adopted the network theory to address the role of university support in internationalization of academic spinoffs. They showed that university spinoffs obtaining support from a Technology Transfer Office (TTO) or other Science and Technology (S&T) infrastructures tend to internationalize earlier. TTOs and other S&T infrastructures (e.g., science parks and incubators) provide distinct support mechanisms, including access to resources (most notably, a skilled labor force), network and business advice, financial and capital advice/support, and intellectual property rights support.

The reverse-internalization theory can also help explain the value of university affiliation in the international context. Globalization is leading firms to fragment their activities geographically into several production processes, increasing the international division of labor. The privileged scientific and technological resources of firms affiliated with universities arguably make them more inclined and equipped to internationalize. Recent literature has shown that university affiliation is positively recognized by external investors, who are willing to pay more for an equity position in affiliated firms (Bonardo, Paleari, & Vismara, 2010, 2011; Meoli et al., 2013), especially in cross-border deals (Cattaneo, Meoli, & Vismara, 2015).

It is therefore reasonable to expect academic spinoffs to be equipped to internationalize and have a competitive advantage over non-academic counterparts due to their university affiliations and resources. Thus, I formulate the first hypothesis:

Hypothesis 1: University spinoffs internationalize more than similar firms.

If affiliation with a university is advantageous for the internationalization of a firm, affiliation with an internationalized university is even more so. An internationalized university is expected to increase the value-added benefits of "ordinary" affiliation in both capabilities and network opportunities (Wang & Shapira, 2012). Because innovation occurs within a network of firms and research institutions—with their many opportunities to acquire new information (Tsai, 2001)—international networks offer wider access to knowledge and resources. Styles & Genua (2008) recognize that the fundamental networks of academic technology developers and the secondary networks of professional managers are not only involved in but also crucial for the exploitation of initial opportunities to internationalize.

Aside from contributing resources, an international environment increases the likelihood that people will possess original ideas, different viewpoints, and creativity (Fleming, Mingo, & Chen, 2007), as such academics have more exposure to different cultures, business practices, and

institutional frameworks. Intense contact with heterogeneous collaborators from external and international contexts fosters technical and cultural know-how. A researcher's mobility via international opportunities granted by international universities is beneficial for affiliated firms, which receive valuable expertise, knowledge, and cognitive integration from mobile scientists. Edler et al. (2011), contributing to the stream of literature on the benefits of brain circulation, show that a precondition for international knowledge and technology transfer is scientists' mobility.

Finally, firms affiliated with international universities attract more dynamic and opened-minded employees. The integration of international and local students enables them to work in teams more effectively and encounter fewer difficulties in interacting with foreign cultures. Enrollment in an internationalized university encourages students toward international orientation (Luijten-Lub, 2007), enhances their international professional opportunities, and trains them to interface with an increasingly globalized society and labor market (Denson & Zhang, 2010). Thus, I propose the second hypothesis:

Hypothesis 2: University spinoffs are more likely to internationalize if established by an internationalized university.

4.3 Research Design

4.3.1 Sample and data sources

My analysis uses a dataset of 508 spinoffs from 59 Italian universities established over 1999–2014. In 1999, a significant boost for academic entrepreneurship in Italy came in the form of a new regulatory framework (Law 297/1999, followed by Ministerial Decree 593/2000), allowing public researchers to be involved in technology transfer activities without negative consequences for their jobs or wages. To evaluate the early internationalization, I study Italian spinoffs in the first two years after establishment; thereby the last year of observation is 2016 and the analysis includes companies

created by 2014. Data are taken from the Spinoff Italia database[16] of the Italian Ministry of Education, Universities and Research (MIUR), which provides the name, year of establishment, sector, geographical location, and parent university of each spinoff. I augment this dataset with accounting data taken from AIDA (*Analisi informatizzata delle aziende* by Bureau van Dijk). I retrieve information on internationalization from MintItaly, a new database from Bureau van Dijk that includes data on the foreign sales of approximately 75,000 Italian companies drawn from telephone interviews.

A control sample is necessary to investigate whether academic affiliation leads to a greater propensity to internationalize. Therefore, a matching sample is created from the Italian Registry of Innovative Firms (*Registro delle imprese innovative*).[17] Companies included in this register benefit from (among other regulatory features) the flexible employment contracts of start-ups and receive fiscal incentives to employ highly qualified personnel. Using the Italian Registry of Innovative Firms' website (http://start-up.registroimprese.it), I obtained a dataset of 2,486 Italian innovative start-ups established by 2014.

To build the sample, I start with 1,325 university spinoffs—the number of academic spinoffs created from 1999 to 2014 at Italian universities. Information on foreign sales is available for 508 of these companies. For the matching sample, I derive 1,060 firms from the initial 2,486 innovative start-ups for which information on foreign sales is available. The sample therefore comprises 1,568 firms. Italian academic spinoffs are a subcategory of innovative start-ups; therefore, in selecting the control

[16] http://www.spinoffricerca.it/

[17] At the end of 2012, Decree Law 179/12 was approved to foster the establishment of "innovative start-ups." This law recognizes that start-ups are important for the promotion of sustainable growth, technological development, and employment—in particular, youth employment. The law aims to develop an environment that fosters the creation of entrepreneurial opportunities, innovation, and social mobility, strengthen the links between universities and businesses, and attract foreign investment and talented people to Italy. To be covered by the law, companies must be independent, based in Italy, and comply with the following criteria: companies other than academic spinoffs (which are automatically included) must be less than five years old, have a turnover of less than 5 million euros, be at least 51% directly owned by physical subjects, aim to develop innovative products or services, and have a high degree of technological content. Moreover, the firm must meet (at least) one of the following additional requirements: R&D expenses/return ratio must be greater than 15%; at least one-third of the total workforce must possess a PhD or have worked for at least three years at a research institute; and the firm must be the holder or licensee of at least one patent.

sample, I consider only companies outside of the academic spinoffs already selected. Companies within the two sample sets are similar in terms of location, average number of employees, and industrial composition (for further details, see (Ministero dello Sviluppo Economico, 2016; Unioncamere–InfoCamere, 2016).

4.3.2 Econometric model and estimation strategy

The empirical analysis first assesses whether university spinoffs are internationalized more than non-academic innovative start-ups. Second, I analyze whether the internationalization of academic spinoffs is affected by the internationalization of the parent universities.

I test the first hypothesis using a cross-sectional regression in which the dependent variable is the probability of internationalization within two years of foundation, depending on the conditions at the time of establishment, for both academic and non-academic spinoffs. Because internationalization can be correlated to unobserved firm characteristics beyond affiliation or non-affiliation with academic institutions, a conditional difference-in-differences (DID) methodology is used, allowing us to address potential endogeneity issues. The combination of a simple DID approach with propensity score matching (PSM) provides more reliable results because the conditional DID based on non-parametric matching controls the selection of both the observable and unobservable characteristics of the sample (e.g., (Heckman, Ichimura, Smith, & Todd, 1998; J. A. Smith & Todd, 2005). In the conditional DID, nearest-neighbor matching with a single neighbor and replacement is used in the PSM. Through a probit regression, I estimate the probability of being a university spinoff (the "treatment" in my analysis) to obtain propensity scores. Each treated observation is paired with the non-treated one with the closest propensity score from the pool of potential control observations. The matching is performed with replacements to avoid biasing the estimates through the sort order and sample size of the observations (Dehejia & Wahba, 1999). I implement a common support as a necessary condition for the validity of the matching estimator, but do not exclude any treated observations if common support is found. To improve accuracy, I require exact matching for the

following stratification criteria: the firm's characteristics, regional features, geographical position, and sectoral nature. After matching the sample of treated academic spinoffs with non-treated innovative start-ups, I analyze how being an academic spinoff affects internationalization probability through a probit model. Consistent with the conditional DID approach, this regression includes the variables used in the matching procedure and a dummy variable identifying academic spinoffs (the treatment).

Concerning my second hypothesis, I assess how establishment by an internationalized university affects the internationalization of academic spinoffs. Because not all academic spinoffs internationalize, studying only those exhibiting international sales within two years from foundation may introduce a bias that could influence the results. Including an exclusion restriction as a control ensures the identification assumption (see Heckman, 1977). Following Heckman (1979), the exclusion restriction aims to correct any sample selection biases that can result from using non-randomly selected samples (for further technical details, see Puhani, 2000).

Following prior studies, I employ the two-step Heckman selection model. First, I use Bureau van Dijk's AIDA database and the Italian Registry of Innovative Firms to collect a sample of 1,060 Italian innovative start-ups, which are similar to the academic spinoffs in the sample according to nearest-neighbor propensity scores based on firm size and leverage, as well as on regional patents, GDP growth, and STEM[18] graduates. These firms are likely to internationalize during the period of study. I use a probit regression to predict whether a firm is an academic spinoff by including regional population, which is the exclusion restriction included among the baseline regressors in the regression models. The second specification of the Heckman procedure is then enriched by several university-level variables: internationalization, size, patents, and TTO size. In the second stage, I include the inverse Mills ratio extrapolated from the first stage as a regressor to account for the potential selection

[18] The acronym stands for Science, Technology, Engineering, and Mathematics.

bias, as the propensity to internationalize via the influence of the international orientation of a parent university is observable only for academic spinoffs with a proclivity for internationalization.

4.3.3 Variables

The dependent variable is firm internationalization. Oviatt & McDougall (1994) introduced the term "international new ventures" (e.g., McDougall & Oviatt, 2000; Oviatt & McDougall, 1994) to indicate organizations that seek to derive significant competitive advantage from the use of resources and the sale of outputs in multiple countries. Such characterizations of internationalization (e.g., subsidiaries established in other countries, ownership of foreign assets, or foreign direct investments) do not fully apply to start-ups (Oviatt & McDougall, 2005). In line with most studies on international entrepreneurship (e.g., (Leiblein & Reuer, 2004), I consider new ventures "that from or near foundation, obtain a portion of total revenue from sales in international markets" (Knight & Cavusgil, 2005, p. 15) internationalized. Operationally, the dependent variable is a dummy equal to 1 if the firm exports (i.e., sells abroad) within two years of foundation and 0 otherwise.

The explanatory variable *Academic spinoff* is a dichotomous variable equal to 1 if the firm is an academic spinoff and 0 otherwise; it is used to test the first hypothesis. According to the network approach, academic spinoffs take significant advantage of resources and networks, brand names, reputation (Zahra, 2005), market information, opportunity identification, and access to markets from parent institutions. The second hypothesis is investigated using a measure of *University internationalization*, built through a principal component analysis of three internationalization measures. Principal component analysis is often used to group highly correlated variables into principal components to simplify the analysis. The decision about which principal components to retain depends on the percentage of the variance accounted for the variable, the absolute variance accounted for each principal component, and whether the component can be meaningfully interpreted (Leech, Barrett, & Morgan, 2014). Varimax orthogonal rotation is used to transform the components into more clearly interpretable factors (Kaiser, 1958). Such a composite international indicator

captures the benefits of having emerged from an international university. In particular, it includes advantages in resources, information, and knowledge (Styles & Genua, 2008), as well as individual open-mindedness, creativity, and expertise (Edler et al., 2011; Fleming et al., 2007). Operationally, I construct my measure of university internationalization using three variables. First, I measure the percentage of international students from the total number of bachelor's, master's, and PhD students[19] enrolled in the university in which each spinoff is established. I use this measure because the increase in the number of international students constitutes a substantial part of higher education institutions' internationalization efforts (Knight & de Wit, 1995). A university's commitment to internationalize requires involvement and communication with foreign students. Data on the total number of students enrolled and number of foreign students are available from the MIUR website. Second, I measure the ratio of international co-authored publications to total publications recorded by the parent universities. International co-authored publications are considered those that are co-authored by at least two scholars from different countries in the SciVal database.[20] Co-authoring is a means of transferring scientific output by offering scientists the opportunity to communicate and collaborate with other academics. Co-authored publications are thus recognized as a valid proxy of collaborative R&D (e.g., Wang & Shapira, 2012). Third, I measure the percentage of foreign staff to total faculty hired by the parent universities. An international academic staff is correlated with the internationalization of doctorates—the student strata that produce scientific output and maintain the research capability of the university. I identify international faculty using the MIUR website.

In line with similar studies on academic entrepreneurship, university-level explanatory variables beyond university internationalization are used in the analysis (e.g., (Fini et al., 2011; Meoli & Vismara, 2016). A university's scientific knowledge, technologies, and social and professional

[19] Unlike other international settings, in the Italian system, PhDs are students and not university employees.

[20] SciVal is Elsevier's database of peer-reviewed literature, which provides extensive research output for most scientific disciplines.

networks are indeed enabling factors of both entrepreneurship and internationalization (see, for example, Pettersen & Tobiassen (2012). University size (number of students, including bachelor's, master's, PhD, and specialization courses) is included as a general proxy of available organizational assets; university patenting activity (number of patents) accounts for the output of research activity that might fuel spinoff creation and internationalization; and TTO size (number of full-time employees) measures the direct support of the administrative staff for spinoff creation. The main data sources include the MIUR website for information on academic staff; the SCOPUS database for university publications and patenting data; and the Conference of Rectors of Italian Universities (CRIU) for TTO size. Data are collected only for universities that have established at least one spinoff involved in the sample.

I then identify two categories of control variables for regional and firm-specific characteristics. According to entrepreneurial ecosystem studies (see, for example, Audretsch & Belitski, 2017; Audretsch & Lehmann, 2005), entrepreneurship is enhanced by the interrelatedness of several actors in a certain region. Contextual factor control variables include regional GDP growth (in percentage), which accounts for the higher probability of international-oriented business establishment in a region experiencing a favorable economic cycle; regional patenting activity (number of patents at the regional level), as locally available competencies shape the patterns of technological diversification; ratio of graduates in STEM disciplines to the total number of graduates, indicating a higher likelihood of finding human capital; and regional population as an identifying variable for the Heckman selection model. Data for this category are collected from the Italian National Institute of Statistics (ISTAT) for the year of firm foundation. Regional variables have the same values for each firm, both academic and non-academic ventures, established in the same region in the same year.

The second set of control variables comprises size, measured as the amount in euros of total assets, as a general proxy of the organizational assets available, and the ability to repay debt (debt-

to-equity ratio). Firm-level data are provided by AIDA and the Italian Registry of Innovative Firms. Information is collected only for the year of establishment of each academic and non-academic firm. In addition to these controls, I include a set of dummy variables related to the Italian macro regions according to the NUTS-2 classification to account for all unobservable differences between these areas. I also include a set of dummy variables related to industries, as defined in AIDA. **Table 18** lists the variables used in the study and their definitions.

Table 18. Variable definition

All the variables refer to the year of firm foundation, except for the dependent variable (firm internationalization), which is defined two years after the establishment.

Variable	Definition
PANEL A: Firm-level dependent variable	
Internationalization	Dummy variable equal to 1 if a firm exports (i.e., sells abroad) within two years from foundation, 0 otherwise. In the robustness tests, this is a dummy equal to 1 if firm's sales abroad are at least 8%, 0 otherwise.
PANEL B: University-level explanatory variables	
University internationalization	Standardized variable factor obtained from a principal component analysis performed on three different measures of university internationalization: international students, international co-authored publications, and foreign staff. International students are measured as the percentage of international students to the total number of Bachelor, Master's, and PhD students enrolled per university. International co-authored publications are measured as the ratio of international co-authored publications to total publications recorded per university. Foreign staff is measured as the percentage of foreign staff to the total faculty hired per university.
University size	Total number of students, including Bachelor, Master's, PhD. and specialization courses
University patents	Number of patents granted per university
TTO size	Number of employees in TTOs per university
PANEL C: Firm-level control variables	
Size	Total assets (000€)
Leverage	Debt-to-equity ratio calculated by dividing company's total liabilities by its stockholders' equity
PANEL D: Region-level control variables (NUTS-2)	
Regional patents	Number of patents granted by the European Patent Office
Regional GDP growth	Growth rate of regional gross domestic product
Regional STEMs	Number of graduates in science, technology, engineering and mathematics between 20 and 29 years old over regional population (per thousand people)
Regional population	Number of regional inhabitants (000s). Identification variable for Heckman selection model

4.3.4 Descriptive statistics

Table 19 shows the summary statistics for academic and non-academic firms, and **Table 20** the correlation matrix. The degree of internationalization is higher for non-academic firms (13.4% vs. 9.4%). The same holds for firm size (172,230 vs. 229,450 euros) and several regional factors: GDP growth (0.62% vs. 2.92%), regional STEMs (12.32 vs. 13.95 students per 1,000 people), and regional

population (4.07 vs. 5.21 million people). The only exception is regional patents: 91.26 for university spinoffs and 70.68 for non-academic firms. Concerning geographical distribution (not reported in **Table 19***)*, northern Italy hosts more than 50% of academic and non-academic spinoffs and about 20% occur in the south; 54.92% of academic spinoffs and 56.84% of non-academic start-ups are located in the northwest and northeast, 25.79% of university spinoffs and 17.37% of innovative start-ups emerge in the central region, and the residual 19.29% of academic spinoffs and 25.79% of non-academic start-ups emerge in the south and the isles.

Table 19. Summary statistics for the population of 1,568 firms

The descriptive statistics are split into two groups of firms, 508 with an academic affiliation and 1,060 without an academic affiliation. Difference refers to the difference of means test assuming equal variance between the two groups of firms with and without academic affiliation. ***, **, and * represent statistical significance at the 1%, 5%, and 10% levels, respectively

	Academic affiliation	Non-academic affiliation	Difference
PANEL A: Firm-level dependent variables			
Internationalization (%)	9.40	13.40	-4.0
PANEL B: University-level explanatory variables			
International students (%)	2.75		
International co-authored publications (%)	30.38		
Foreign staff (%)	0.75		
University size (000s)	29.0		
University patents	8.37		
TTO size	3.73		
PANEL C: Firm-level control variables			
Size (000€)	172.23	229.45	-57.22***
Leverage	4.59	5.80	-1.21
PANEL D: Region-level control variables (NUTS-2)			
Regional patents	91.2	70.6	20.6***
Regional GDP growth (%)	0.62	2.92	-2.30**
Regional STEMs (per thousand people)	12.32	13.95	-1.63***
Regional population (m)	4.07	5.21	-1.14***
Observations	508	1,060	

.

Table 20. Correlation matrix

Statistically significant values ($p<0.05$) are reported in bold.

Variable	1	2	3	4	5	6	7	8	9	10	11	12
1. Internationalization	1											
2. University internationalization	**0.098**	1										
3. University size	0.032	0.018	1									
4. University patents	-0.063	**0.179**	**0.359**	1								
5. TTO size	0.056	**0.337**	**0.202**	**0.199**	1							
6. Age	**0.165**	**-0.298**	-0.058	**-0.324**	**-0.135**	1						
7. Size	-0.030	-0.049	0.067	**0.187**	0.065	**-0.229**	1					
8. Leverage	-0.028	0.0051	-0.003	-0.031	-0.020	-0.006	-0.019	1				
9. Regional patents	0.025	**0.317**	**0.101**	**0.250**	0.010	**0.261**	**-0.083**	**0.082**	1			
10. Regional GDP growth	-0.040	**-0.233**	-0.007	**0.161**	**-0.196**	-0.029	0.045	0.049	0.047	1		
11. Regional STEMs	**-0.083**	**0.412**	0.045	**0.386**	**0.264**	**-0.383**	**0.140**	0.072	**0.359**	**0.112**	1	
12. Regional population	-0.037	**0.105**	**0.217**	**0.448**	**0.274**	**-0.176**	**0.083**	0.003	**0.298**	0.011	**0.193**	1

The university-level variables are of interest only for academic spinoffs. Institutions spinning out such firms enroll an average of 29,032 students, grant 8.37 patents, and have 3.73 full-time employees dedicated to technology transfer activities. University internationalization is measured by a principal component analysis of three factors: the percentages of international students (on average, international students comprise 2.75% of Italian university enrollment), international publications (on average, of the publications produced in Italian universities, 30% are internationally co-authored), and international staff (on average, international faculty comprise 0.75% of Italian university employees). In the analysis, I use the standardized form of university internationalization, with a mean of 0 and standard deviation of 1.

4.4 Results

The econometric analysis starts with an estimation of the probability of being an academic spinoff through a binary probit model. **Table 21** displays estimation results. Academic spinoffs are likely to be smaller than other innovative companies. The results also imply that the probability of a firm being an academic spinoff is positively correlated with GDP growth and number of regional patents but negatively associated with the percentage of regional STEMs and number of inhabitants living in a determined region.

The choice of matching variables stems from the nature of the academic spinoffs. Academic spinoff activity is a resource-driven phenomenon (Feldman & Klofsten, 2000). The establishment and development of academic spinoffs depend on the resources available. According to Fini et al. (2011), the environment that both universities and academic spinoffs operate within have competencies and resources, both tangible and intangible, critical for the development of these ventures. In addition to regional variables, a firm's characteristics, such as size and leverage, are considered determinants of financial resources available for the academic spinoffs.

Table 21. Marginal effects estimated from a probit regression for the likelihood of being an academic spinoff

This table reports the results of a probit regression on the probability that a firm is an academic spinoff. The dependent variable is a dummy, equal to 1 if the firm is an academic spinoff, 0 otherwise. ***, **, and * represent statistical significance at the 1%, 5%, and 10% levels, respectively. Robust standard errors are in parentheses. Geographic and industry controls are included.

	Academic spinoff
Size	-0.001***
	(0.003)
Leverage	-0.002
	(0.002)
Regional patents	0.010***
	(0.001)
Regional GDP growth	2.172**
	(1.008)
Regional STEMs	-0.087***
	(0.016)
Regional population	-0.001***
	(0.000)
Constant	1.788***
	(0.212)
No. obs	1,568
Pseudo R-squared	0.172

I perform matching based on the propensity scores shown in **Table 21**. Starting from a population of 1,568 firms, of which 508 are academic spinoffs and 1,060 are innovative start-ups, the PSM analysis produces a matched sample of 908 firms, of which 508 are university spinoffs and 400 are non-academic companies.

Table 22 presents the means and p-values of the t-test on the mean differences for all regressors and propensity scores after matching to test the quality of the matching procedure. The two groups are not characterized by systematic differences in the descriptive statistics reported in **Table 22**.

The (proportional) t-tests[21] support the validity of the matching procedure, as the p-values are all well above the significance thresholds.

Table 22. Matching covariates for the sample of 908 firms resulting from the matching

This table reports the descriptive statistics for the matched sample of academic and non-academic firms. P-values refer to T-tests on the equality of the mean assuming equal variance between the two groups.

	Academic spinoffs	Non-academic start-ups	P-value
Propensity score	0.264	0.262	0.942
Size (000€)	172.23	172.76	0.618
Leverage	4.59	5.05	0.656
Regional patents	91.2	91.7	0.627
Regional GDP growth (%)	0.62	1.79	0.273
Regional STEMs (per thousand people)	12.32	12.34	0.984
Regional population (000s)	4.07	4.81	0.480
No. obs	508	400	

Based on the matched sample, the analysis first assesses whether university spinoffs are internationalized more than innovative start-ups. The results in **Table 23** show that being a university spinoff company increases the likelihood of internationalizing by 5% compared with non-academic counterparts (marginal effect corresponding to the coefficient 0.435). Among the control variables, the percentage of regional STEMs is a determinant of internationalization: a 10% increase in regional STEMs raises the likelihood of internationalizing by 7% (marginal effect for the coefficient 0.056).

[21] It is common to validate the PSM procedure by comparing variable means between the treatment and control groups through standard t-tests (e.g., Colombo and Piva 2012; Yang et al. 2012).

Table 23. Effect of being an academic spinoff on internationalization

This table reports the results of a probit regression on the probability that a firm is internationalized. Dependent variable is a dummy variable equal to 1 if the firm is an exporter (i.e., sells abroad), 0 otherwise. ***, **, and * represent statistical significance at the 1%, 5%, and 10% levels, respectively. Robust standard errors are in parentheses. Geographic and industry controls are included.

	Internationalization
Academic affiliation	0.435**
	(0.206)
Size	0.001
	(0.000)
Leverage	-0.003
	(0.009)
Regional patents	-0.001
	(0.002)
Regional GDP growth	-0.559
	(2.088)
Regional STEMs	0.056**
	(0.027)
Constant	-2.645***
	(0.426)
No. obs	908
Pseudo R-squared	0.141

Table 24 shows the impact of affiliation with an internationalized university on the international propensity of academic spinoffs, which concerns my second hypothesis. Model 1 in **Table 24** represents the first step of the Heckman selection model. The findings confirm that firm- and region-level controls are important predictors of whether a company is likely to be a university spinoff, as the estimation of marginal effects indicates. The signs and level of significance produced by estimating the marginal effects are confirmed. Regional population is included as the identification condition; it is statistically significant and negatively correlated to the dependent variable, indicating that the probability of being an academic spinoff is lower in more populated areas by 2.6 percentage points (marginal effect corresponding to the coefficient -0.001).

Model 2 in **Table 24** represents the second step of the Heckman selection model. The university internationalization variable derives from a principal component analysis of the three internationalization variables defined for the three university functions. The resulting variable has a positive and significant effect on internationalization, meaning that the international level of academic institutions increases the internationalization propensity of spinoff firms: a change by one standard deviation in the university internationalization variable increases internationalization by 0.08 standard deviations (the marginal effect corresponding to the coefficient 0.550). Internationalized universities are more likely to establish internationalized spinoffs due to the combination of international students they train (Luijten-Lub, 2007), staff they hire, and publications their scientists produce. Internationalized universities possess value-added capabilities and network opportunities (Wang & Shapira, 2012), as well as dynamic and expert human capital (Edler et al., 2011; Fleming et al., 2007). The variable used to measure the international orientation of universities may not adequately describe such a multifaceted process.

Concerning the control variables, university and TTO sizes are not statistically significant, whereas university patents have a negative effect. An increase in the number of patents of 1 unit (from an average value of 8.37 to 9.37) corresponds to a reduction in spinoff internationalization of 0.5% (marginal effect for the coefficient -0.034). Regional GDP growth is a predictor of internationalization as well. Ventures located in areas with low GDP growth rates have a greater likelihood of internationalizing because the domestic market may not adequately address their needs. The marginal effect estimation for the regional GDP growth variable produces a negative coefficient equal to -7.559 significance at a 5% level, meaning if GDP grows by a percentage unit, the probability of firms in the region being internationalized drops by 19%. The empirical evidence thus suggests that a growing domestic market encourages firm managers to focus on domestic operations (Elango, 1998), whereas small domestic markets induce firms to internationalize for their own survival (Sapienza, Autio, George, & Zahra, 2006).

Table 24. The effect of university internationalization on internationalization of academic spinoffs

This table reports the results of a two-step Heckman selection procedure on the probability of internationalizing of academic spinoffs. Model 1 reports the results of the first step of the Heckman selection model, where the dependent variable is a dummy variable equal to 1 if the firm is an academic spinoff. Model 2 reports the results of the second step of the Heckman selection model, where the dependent variable is a dummy variable equal to 1 if the academic spinoff is an exporter, 0 otherwise. ***, **, and * represent statistical significance at the 1%, 5%, and 10% levels, respectively. Robust standard errors are in parentheses. Geographic and industry controls are included.

	(1)	(2)
	Academic spinoff	Internationalization
University internationalization		0.550***
		(0.206)
University size		0.146
		(0.099)
University patents		-0.034**
		(0.016)
TTO size		0.174
		(0.141)
Size	-0.003***	-0.005
	(0.001)	(0.000)
Leverage	-0.002	-0.007
	(0.002)	(0.005)
Regional patents	0.010***	0.002
	(0.001)	(0.002)
Regional GDP growth	2.167**	-7.599***
	(1.024)	(2.558)
Regional STEMs	-0.084***	-0.049
	(0.016)	(0.032)
Regional population	-0.001***	
	(0.000)	
Inverse Mills ratio		-0.300
		(0.539)
Constant	1.848***	-2.069**
	(0.215)	(1.046)
No. obs	1,568	508
Pseudo R-squared	0.195	0.143

4.5 Robustness checks

In this section, I conduct additional analyses to verify the robustness of the results on the internationalization of academic spinoffs and university internationalization. First, I test the robustness of the results on an alternatively defined dependent variable that assumes a value of 1 if academic spinoffs have more than 8% sales abroad and 0 otherwise. This test is more restrictive than that used in the initial analysis. In the probit regression, the results are shown to be robust with university internationalization statistically significant at the 5% level (see **Table 25**, column 1). Second, I separately test the effect of the three factors adopted to determine the variable for university internationalization: the percentages of international students (see **Table 25**, column 2), international staff (see **Table 25**, column 3), and international publications (see **Table 25**, column 4). The percentage of international publications and international staff are positive and statistically significant at the 5% level, whereas international students are not statistically significant. This underlines how important the international research dimension of internationalized universities is for their spinoff firms.

Table 25. Robustness check. Alternative measures of internationalization

This table reports the results of the second step of a two-step Heckman selection procedure on the probability of internationalizing of academic spinoffs. The first step specification is the same as reported in **Table 24**; I do not report it for the sake of brevity. The dependent variable in column 1 is a dummy variable equal to 1 the academic spinoffs perform more than 8% of sales abroad, 0 otherwise. The dependent variable in Models 2 to 4 is a dummy variable equal to 1 if the academic spinoff is an exporter, 0 otherwise. ***, **, and * represent statistical significance at the 1%, 5%, and 10% levels, respectively. Robust standard errors are in parentheses. Geographic and industry controls are included.

	(1) High-intensity Internationalization	(2) Internationalization	(3) Internationalization	(4) Internationalization
University internationalization	0.387**			
	(0.173)			
International students		0.368		
		(0.247)		
International publications			4.593***	
			(1.540)	
International staff				92.21***
				(29.00)
University size	0.207**	0.051	0.203**	0.691***
	(0.104)	(0.121)	(0.101)	(0.208)
University patents	-0.039**	-0.025	-0.038**	-0.053***
	(0.017)	(0.016)	(0.017)	(0.018)
TTO size	0.157	0.062	0.255	0.024
	(0.148)	(0.150)	(0.156)	(0.149)
Size	-0.003***	-0.003***	-0.003***	-0.003***
	(0.001)	(0.001)	(0.001)	(0.001)
Leverage	-0.001	-0.001	-0.001	-0.001
	(0.004)	(0.003)	(0.004)	(0.004)
Regional patents	0.003	0.001	0.004	0.006
	(0.004)	(0.004)	(0.004)	(0.004)
Regional GDP growth	-7.548***	-6.915***	-6.941**	-7.159***
	(2.597)	(2.666)	(2.711)	(2.725)
Regional STEMs	-0.052	-0.008	-0.010	-0.004
	(0.036)	(0.038)	(0.039)	(0.038)
Mill's ratio	0.181	0.163	-0.062	0.064
	(0.556)	(0.565)	(0.572)	(0.576)
Constant	-2.619**	-2.003	-4.837***	-8.683***
	(1.064)	(1.238)	(1.357)	(2.294)
No. obs	508	508	508	508
Pseudo R-squared	0.140	0.134	0.158	0.158

4.6 Conclusions

Policymakers are increasingly supporting academic spinoffs because they recognize the importance of this kind of firm in fostering economic and social development (Rasmussen, Moen, & Gulbrandsen, 2006). My study investigates whether internationalization is a strategy pursued by

academic spinoffs. Two key results emerge: first, academic spinoffs have a greater propensity to internationalize than their non-academic counterparts, and this happens to a greater extent when the parent university is more internationalized.

This study advances tunderstanding of the entrepreneurial process, contributing to both the academic entrepreneurship and internationalization literature. Although some recent works have focused on international spinoffs, this line of research is still in the early stages (Bjørnåli & Aspelund, 2012; Pettersen & Tobiassen, 2012; Teixeira & Coimbra, 2014). This essay responds to the call for research on the internationalization of academic spinoffs (Cumming, Sapienza, Siegel, & Wright, 2009; Pettersen & Tobiassen, 2012) by investigating the role of academic affiliation. Analyzing the internationalization of academic spinoffs is important because they have inherent characteristics that differ from those of other firms (Colombo & Piva, 2012; Rasmussen & Wright, 2015).

Moreover, I contribute to the emerging stream of research on entrepreneurial ecosystems (Audretsch & Lehmann, 2005; Bischoff et al., 2018; Hayter et al., 2018) by highlighting the role of universities' international orientation as well as their network embedding important actors within the society. Universities are feeders of entrepreneurial ecosystems; through academic spinoffs, they provide trained entrepreneurs with access to their knowledge and technologies.

Nonetheless, both universities and their academic spinoffs positively shape regional economic wealth and competitiveness. Universities generate positive spillover effects in their regions, which reciprocate with grants, donations, and close research collaborations (Lehmann & Menter, 2016). The economic, societal, and technological impact of academic spinoffs is arguably indirect, especially if I consider their internationalization (Link, 2017). In this context, internationalized universities might act as intermediaries of internationalization.

Despite the novelty of this study, it is not without limitations. First, the analysis is limited to a single country—Italy; thus, caution should be used in generalizing the findings because they may

not be valid for different boundary conditions. Amoroso, Audretsch, & Link (2018), for instance, find that the impact of knowledge sources differs across Europe. Second, I investigate the internationalization of academic spinoff companies exclusively through a dichotomous variable. It would be worthwhile to use different points of view and other measures. One promising avenue for further research is investigating the differences between factors such as international entry mode (e.g., imports, exports, partnerships, FDI), extent (e.g., size of exports or FDI investments), scope (e.g., geographical coverage), and speed, as internationalization is a multifaceted phenomenon. It would also be interesting to consider other positive externalities that universities may generate beyond spinoff companies. Internationalized universities may create knowledge spillovers that influence the entrepreneurial process in both scientific output and human capital, suggesting that their role is continually evolving.

In addition, there are aspects about internationalization of academic spinoffs that have not been addressed by this essay and could be covered by further research. Future studies can address the role of entrepreneurial teams in the internationalization of ventures originating from universities and research institutes. It is common practice for international entrepreneurs to seek strategic alliances to overcome potential resource scarcity (Bjørnåli & Aspelund, 2012; Keupp & Gassmann, 2009). Such strategic alliances are achieved only through commitment from the entrepreneurial team and board of directors (Coviello & Jones, 2004; Wright, Westhead, & Ucbasaran, 2007). In the case of academic entrepreneurship, this can hold even truer and the degree of internationalization of academic spinoffs can be a consequence of the presence of a highly international team due to the international propensity of the parent university. Such a causality relationship needs to be disentangled within the university internationalization variable and may represent a new avenue for future research.

5. DISCUSSION

Introducing market mechanisms in higher education sector has different implications. In this dissertation, I consider three of them: (i) the cost sharing of higher education and the shift toward student tuition; (ii) the performance-based funding mechanisms to promote research excellence; and (iii) the promotion of interaction with industry and the raise of academic entrepreneurship. European governments have promoted market-like mechanisms and introduced them within the Higher Education systems through changes in the extant legislatures, financial and/or reputational incentives as well as ad-hoc policies. Universities reactions to state initiatives are multiple. There is always resistance from the institutions to the changes promoted by the governments as the criticism of scholars demonstrate.

In particular, concerning the raise of tuition, researchers are worried about the shift of Higher Education nature from a public to a private one. Referring to the performance-based research funding mechanisms they are distressed by the increasing attention devoted to the rankings that risks to threaten the equity and diversity at the basis of Higher Education. In relation to the promotion of university-industry collaborations, they are concerned about the potential loss of identity of the scholars who are incentivized to become entrepreneurs at the expense of their traditional role. The first essay of my dissertation allows shedding light on the university reactions at both Italian and more general European level.

In Italy, the marketization of higher education in terms of increasing competition for students had multiple effects. First, agglomeration forces prevailed on competitive ones. When agglomeration forces are in act, a certain university becomes more likely to be chosen when it is located in the proximity of competitors, as they constitute together a university cluster. Enrolling in a university within a cluster has several benefits for students. First, students can move to a different institution without relocating in case of drop out at the end of the first year. Second, students can choose a neighbour university in the cluster in case they fail to be admitted in a university. Third, after

accomplishment of the first degree, in a cluster it is easier to find more variety for the consecutive studies. Universities by virtue of the beneficial effect of the agglomeration forces strategically decide to charge students with higher prices. However, after the advent of financial crises, competitive forces do prevail on agglomeration ones. Indeed, in times of crisis all Italian universities had been forced to increase prices in order to offset cuts in government support. Yet, universities located close to others, increased their price less than universities isolated. This turnaround testifies the ability of the Italian higher education policy to self-regulate by adopting the competition as a price control mechanism. Nonetheless, a reflection about the level of optimal competition is necessary. Indeed, it is convenient to promote competition for students up to a certain threshold, beyond which the tuition starts to increase overcoming any potential benefit.

At European level, it is worthy to underline the importance of the contingent factors. Indeed, without addressing contingent factors, one cannot extrapolate a supranational policy by observing the different national policies. Nonetheless, contingencies may relate to both the supply side and the demand side of higher education market. European governments aiming at increasing university sustainability needs to implement complementary policies, For example, a "supply-driven" intervention, through direct financial support of higher education institutions, needs to address the issue of institutions' moral hazard, by creating incentives to supply higher education services in efficient conditions. By contrast, a "demand-driven" policy, providing student aids, needs to tackle the students' moral hazard, by creating an incentive to responsible behaviour.

I may conclude that in response to the injection of market mechanisms in higher education, the role of tuition fee level is controversial as well as the reaction from universities is ambiguous.

The second essay of my dissertation deals with performance-based research funding mechanisms. They are led by the idea of increasing the performance of higher education systems. This is not the case for the Excellence Initiative in Germany. The main issue encountered was the misalignment between the choice of the performance to incentivize and the government expectations.

Indeed, whether the ultimate goal is enhancing the quality of the system this cannot be reached by promoting international visibility through the climb of the ranking. There is indeed lots of scepticism around the international rankings. Rankings are sponsored by private companies (Lim, 2018) and after the advent of the new public management by governments as well as government bodies (OECD, 2011). In addition, what led to the creation of the most famous international rankings was the development of *scientometrics* and *bibliometrics*. It started long time ago when US librarians sorting scientific journals in order to identify the best ones and select which ones to buy (Pontille & Torny, 2015). A few decades later, such a process was extended by Eugene Garfield to create the Journal impact factor and the Science citation index, thereby fostering the well-known *citation culture* (Wouters, 1998). The commercialisation of information about paper citations started and remained a quasi-monopolistic activity (Pontille & Torny, 2015) until 2004 with the creation of Scopus.

Although the obsession for ranking is not steered by academics but rather by governmental policies, scientists play a role in this game as the instruments developed by public actors directly rely on and are organized by academic peer-review. This has yielded a growing divide in the academic profession between who participate in defining the norms of today's science and the terms of the competition, and who subject to them. A gap has also formed between 'who successfully pass the selections and evaluations, and who fail. The Excellence Initiative is an example of performance-based funding mechanisms based on peer-review evaluation aimed at increasing international visibility of universities by boosting participation in international ranking. As a result, institutions strategically act in order to reach the better position within these classifications, without taking into consideration the effective quality of their outcomes.

The long-term sustainability of performance-based research funding will depend on how well they meet governments' objectives. For example, they are not suitable for enhancing university's contribution to the economy and society (Hicks, 2012). Moreover, promoting excellence is in tension with equity and diversity, which are basic university values since ever. Novelty, innovation and

intellectual diversity may risk to be suppressed because elites tend to judge academic quality according to the paradigms they have established on their own. In addition, the contribution of universities to national and cultural identity may lessen because these are devalued in systems where the contribution to international level required publications exclusively in English (Whitley 2008). A potential development for performance-based research funding is adopting independent rankings as the *US News & World Report* annual departmental rankings and National Academy decadal departmental rankings are.

However, universities can only compete effectively for prestige if they have institutional autonomy and discretionary resources. Thereby, as suggested by Massy (2006) in formulating performance-based funding, policy-makers should rely in the persuasive approach instead of strictly formulaic approach, according to the Hoenack's (1983) formulation of the principal-agent problem. The idea is allocating a small amount of funding based on the subjective evaluation of key elements of performance – and make the evaluations public. Experience shows that a few percentage points of annual appropriation can refocus universities on important public goals (Massy, 2006), without undermining their responsiveness to markets. Among institutional goals, productivity improvement, adherence to mission, and most importantly provision of information about education quality should be included. The key aspects of performance-based funding are as follows. First, the amount of money at stake should be large enough to get institutional leaders' attention, yet small enough to allow them to engage in constructive dialogue without fighting the scheme at every opportunity. Second, the objectives should be few in number, understandable and compelling in terms of the public interest. Third, institutional leaders should be allowed to present qualitative as well as quantitative evidence but the standards of evidence should be high. Unsupported rhetoric and assertion should be penalised so that institutions have an incentive to get effective action. Firth, the exercise should be transparent. At the same time, the evaluators should not be required to prove that their judgments are correct. Performance-based steering presumes that, as non-profit enterprises that enjoy substantial

government subsidies and tax advantages, universities want to further the public interest. It also recognises that competing forces, including the pressures associated with growing marketplace competition, may cloud or confound their thinking.

A third implication of introducing market mechanisms in higher education sector is the commercialization of university knowledge and the raise of academic entrepreneurship, that I face in the third essay of my dissertation. The Higher Education sector was increasingly judged from the 1990s onwards in terms of its economic efficiency and contributions to national systems of innovation, economic competitiveness and growth at pertinent scales (Etzkowitz, 1994; Godin, 2006; Olssen & Peters, 2005). Universities actively participate to national economic growth by virtue of the knowledge they generate, according to the endogenous growth theory (Jessop, 2017). Government policies focused on national and sub-national economic and social development cannot ignore it. The time is ripe for research that also looks at the higher-level institutions related knowledge dissemination and commercialization, universities included (Acs, Åstebro, Audretsch, & Robinson, 2016; Autio & Rannikko, 2016). Indeed, universities with specific characteristics may contribute to the social and economic wellbeing more than other universities. The third essay of my dissertation investigates if this is the case of internationalized universities. Findings show that internationalized universities generate more internationalized spinoffs, which are in turn more internationalized than comparable innovative start-ups due to their affiliation with universities. Promoting internationalization of companies is important for the economic growth of a system, thereby policy makers should promote the internationalization of universities.

Internationalization of universities is a widespread phenomenon and it is not only driven by the rationale of generating more internationalized companies. Internationalization is beneficial for universities from different perspectives, among others marketing and international student recruitment, and the global reputation. Universities expect to benefit from a more internationally oriented staff and student body. However, (Knight, 2015) invites to interpret internationalization with

caution, as there are several myths to dispel. In particular, she warns that more foreign students on campus do not necessarily produce more internationalized institutional culture and curriculum. Unless specific programs are developed by the university, international students tend to band together, without having any deep engagement with the host country culture. Moreover, the author suggests not to believe that the more international a university is—in terms of students, faculty, curriculum, research, agreements, and network memberships—the better its reputation. This is tied to the false notion that a strong international reputation is a proxy for quality. The situation is made even more complicated by international rankings, which are often mentioned in the context of being a marketing tool for the university. However, they do not allow measuring accurately the degree of internationalization of a university and the extent to which the international dimension is a robust indicator of quality. In the same vein, whereas the key drivers for internationalization are revenue generation, as international students are charged more by universities, and brain gain, the main risks that can derive are brain drain, the loss of cultural or national identity, the jeopardy of the quality of higher education, and the homogenization of curriculum. Nevertheless, in a country like Italy, internationalization of higher education is still at the inception and the benefits deriving from it would be greater than the drawbacks.

5.1 Limitations and research agenda

Marketization of Higher Education is a multifaceted phenomenon and focusing only on three implications may not be enough to give a comprehensive and exhaustive framework of analysis. This can be indeed enriched with other levels of investigation.

Referring to the issue of funding, a systematic analysis at European level could be useful. Tuition-subsidy systems differ across developed countries but what shapes the pattern is not clear yet. Likewise, no reason has been found yet regarding why countries' higher education finance systems differ so considerably. This question is particularly puzzling, because in the immediate post-World War II period, all these countries' tuition-subsidy systems did not differ that much as systematic

public subsidies were non-existent and tuition was comparably low (Eicher, 1998a; Nakata & Mosk, 1987). Enrolment levels were also very low, as barely 5% of each age cohort enrolled in higher education (Trow, 1972; Windolf, 1997). These ongoing complex (re)distributive dynamics make policies for the promotion of higher education an extremely interesting and relevant field of study for economists, sociologists and political scientists. In these respects, an important prosecution of this line of research may provide guidelines for the implementation of policies addressing either the demand or the supply side of higher education markets. Thus, depending on the composition of an existing education system, higher education can either mitigate or reinforce prevailing social, economic, and educational inequalities.

Referring to the issue of promoting research excellence and international visibility, it should be taken into consideration that they always carry with themselves classification. In the case of the German Excellence Initiative, universities are rated according to their performance. Yet, in this case ratings can also lead to more implicit classifications (Musselin, 2018). After the first round in 2006, German universities were no longer equal as they were supposed to be before (Jürgen Enders & Teichler, 1995), and could therefore organize into new groups. Some could be labelled *Zukunftskonzept* and identified as Excellence universities. A less explicit group—with no label—consisted of universities that went through the process and were positively evaluated, but did not make the final cut for the *Zukunftkonzept* group. They generally performed quite well in terms of running excellent scientific clusters and excellent graduate schools—two other competitive processes launched alongside the *Zukunftskonzept* competition. Most of them received additional support from their Land ministry and began implementing part of their project even if they did not win the 'jackpot'. At the other extreme, some universities did not compete at all[22] and in a way excluded themselves from the start. Thus, four implicit groups emerged from the *Exzellenzinitiative* competition: the

[22] In 2005, in the very first round of the German Exzellenzinitiative, 27 universities (around one-fourth of German institutions) sent draft proposals. In the second round, 22 universities sent a draft, but the competition also included the 9 universities that became Zukunftskonzepte in 2006.

winners; the ‘almost winners’ that received support from local authorities; the applicants that clearly failed; and the numerous institutions that did not even try. This aspect is neglected in all the study about the Excellence Initiative and the one in the thesis is not an exception. Moreover, competition involves the interaction of different levels, namely the individuals, the institutions and the national dimension. Nonetheless, the interplay between all these actors is still neglected by the extant studies with some exceptions (Lazega et al., 2016, Wang et al., 2016). Studying the location of research units in competitive versus less competitive universities, and the national and international networks in which these universities are located could quite significantly renew the study of higher education and research systems.

Referring to the entrepreneurial university and the academic entrepreneurship activity, the importance of network has been extensively studied in literature. In particular, networks have been identified as having implications on the type of spinoffs, particularly to what extent technology and human resources are transferred into the newly created firms (Grandi & Grimaldi, 2003; Nicolaou & Birley, 2003a, 2003b) as well as the spinoffs’ performance (Grandi & Grimaldi, 2003; Gübeli & Doloreux, 2005; Shane & Stuart, 2002). Nonetheless, prior research, has not addressed what particular advantages a spinoff firm would gain from one type of spin-out versus alternative forms (e.g., “technology only” versus “personnel only” versus “technology and personnel”), given the parent institution’s network. Moreover, social ties, either formal or informal, linking different resources to generate distinctive advantages may constitute another area for organizational and strategy research. Whit a particular emphasis on the international dimension, there has been limited analysis of internationalization and academic entrepreneurship although there has been some research comparing academic entrepreneurship between countries (e.g. Clarysse et al., 2005, 2007). While entrepreneurial opportunities generated by innovative science may potentially have global markets, is the lack of commercial expertise among academic entrepreneurs particularly telling in international markets? Alternatively, are academics with worldwide research reputations better able to attract

interest from global venture capital firms and multi-nationals? From the firm's perspective, this has important implications for whether there are different challenges faced by spin-offs from universities that seek to internationalize compared to regular commercial start-ups. By the same token, exploring the tension between a lack of international commercial expertise and an international research reputation opens up possibilities for improving understanding of the drivers of internationalizing new ventures or newly-created global ventures.

5.2 Theoretical and practical implications

Concerning university funding, findings in this thesis should be interpreted more as the "context" or conditions where prices are set than literally as a delineation of the causes of tuition levels or tuition increases. What is shown is that tuition prices in major state public universities are correlated highly with a series of economic and contextual variables, such as economic recession, competitive forces and government funds. Tuition prices tend clearly to be higher where the state effort is insufficient to the financial obligations of the institutions as well as when institutions are subjected to a moderate competition. State policymakers should be aware of this fact not only for the value to achieving desired outcomes, but also for the knowledge that appropriations shortfalls will raise tuition prices just as surely as if the prices had been raised by the legislators themselves. Simultaneously, policymakers should be aware that the system is able to self-regulate even in a strongly centralized systems. There are indications that higher education tuition levels have become increasingly vulnerable to economic forces. Those seeking income redistribution and greater equality of opportunity have identified pricing as a major policy tool. Higher tuitions accompanied by need-based student aid programs shift resources from middle- and upper-income families to the poor.

The context is of primary importance also for the assessment of research excellence. Rankings of entire university organizations both at a national level and a global scale are of paramount importance for the self-perception as a competitive actor (Ellen Hazelkorn, 2015). Competition among universities depends upon and is even created by the development of rankings, evaluations,

and statistics of all kinds. It follows numerous implications. Universities have transformed themselves from general institutions into specific autonomous entities able to define its own mission and compete with other universities that display a not very different profile. Accordingly, the decision-making structures within universities are becoming increasingly hierarchical, at both the departmental and the overall level of the organization. There is increasing concern for leadership in academia, and traditional collegial bodies of decision-making like the academic senate are losing importance. The rational that universities are in need for strong leadership comes with the requirement to position the entire organization and its organizational subunits within competitive fields. Moreover, organizational accountability is becoming more important; with tighter accounting, budget-related issues and expertise are becoming more important to the university. The external expertise is gaining importance as well and universities have become increasingly open to management consultancy (Serrano-Velarde, 2010). It follows a trend toward professionalized management of universities and the emergence of a management profession. New position have been created during the last decade many new positions have been created in fields like planning, student services, quality control, and public relations, by contributing to the establishment of a more formal organizational structure for universities.

Regarding academic entrepreneurship, a related policy question concerns whether countries might usefully adopt Bayh–Dole type legislation. Comparisons with U.S. experience could be misleading and should not be used to predict the evolving features of institutional innovation ownership in Europe (Mowery & Sampat, 2004; Verspagen, 2006). This is even more true for developing nations (So et al., 2008). Following Geuna & Rossi (2011), there is still significant differentiation in the general regulation of universities across Europe. Further case-by-case analysis thus is necessary in order to understand how these systems are evolving. Most European countries have been interested by legislative changes that, even when not in line with the Bayh–Dole Act, had the similar objective to spur the commercialization of public research results. These government

regulations in several countries worldwide have defined the general boundaries of national research systems, accounting for various actors and factors at different level of analysis, including system-level specificities (governmental actions, institutional lows, local context characteristics, etc.), university level internal support mechanisms and individual scientist level factors. All of these factors play a role in the process through which universities develop capabilities/competencies to transfer knowledge and technology.

Much recent policy attention has been devoted to the university level. Academic entrepreneurship has important economic and policy implications, since licensing agreements and university-based start-ups (spin-offs) can result in additional revenue for the university, employment opportunities for university-based researchers (especially, post-docs) and graduate students, and local economic and technological spillovers through the stimulation of additional R&D investment and job creation. At university level, there are several policy implications, in terms of the generation of spin-off companies. Start-up creation can be stimulated through the development of certain resources and capabilities that help fill the knowledge gap. First, universities need to develop an appropriate culture and infrastructure to support academic entrepreneurship and technology commercialization (O'Shea et al. 2011). Second, universities need to establish an active partnership with industry and government funding agencies and generate financial support from these institutions. Third, universities need to recruit, retain, and develop valuable scientists. The role of universities in creating and exploiting knowledge seems only likely to grow. In an environment where the commitment of enterprises to their current locations is increasingly dubious, universities are particularly interesting institutions because thus far they appear to be spatially fixed and unlikely to abandon their current location for lower-cost destinations. University research could become only more important in maintaining the innovatory leadership necessary to maintain high incomes. In this larger context, academic entrepreneurship is certain a part of the debate about the best ways to ensure the diffusion of university knowledge to the larger society. Nonetheless, research commercialization is considerably broader

than spinoffs and licensing. In order to assess the effects of Bayh–Dole like legislation on academic entrepreneurship, more systematic data on all dimensions of technology commercialization efforts at universities and national laboratories are necessary.

6. CONCLUSION

This dissertation has studied how universities react to the introduction of market-like mechanisms into Higher Education. By focusing on the three main challenges that higher education institutions have to address- namely financial sustainability, international research excellence and development of an entrepreneurial culture, my dissertation provide some insights about the mechanisms adopted by universities to address the current situation. In the first essay, I underlined how competition within institutions may be beneficial for controlling tuition price growth in times of crisis. In the second essay, I explained why allocating funds to advance international visibility and competitiveness, even if set with the best of intentions, could be detrimental for university systems. In the third essay, I emphasised how the international dimension of a university may make it more entrepreneurial by enhancing the international performance of its affiliated companies.

These results contribute to literature streams on sustainability of higher education, on research excellence and international competitiveness, and on academic entrepreneurship, leading to a better understanding on how university may face marketization of Higher Education on the basis of which a research agenda and practical implications can be formulated.

7. REFERENCES

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