**The Impact of the University Context on the Creation of Academic Spin-Offs:**

**Lack of Academic Job Opportunities and Administrative Inadequacy**

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**Abstract**

Spanning from monetary rewards to self-enhancing goals, existing studies on individual motivations to establish academic spin-offs share a positive inclination. Nevertheless, this type of firms are typically not gazelles. With a longitudinal study of 559 spin-offs from 54 Italian universities in the period 1999 to 2013, we investigate the 'dark side' of spin-off motivations. Controlling for several university- and context-level factors, we find that a decrease in academic job opportunities at a regional level results in an increased propensity to spin-offs. Accordingly, we argue that academics sometimes become entrepreneurs as a second-best solution, because of shortcomings in the market for knowledge. Second, while a stronger administrative and TTO support leads academics to create more technology product-oriented spin-offs, there is instead a U-shaped relationship between the number of administrative staff within a university and the establishment of service or non technology spin-off firms. We argue that when the ratio between administrative and academic staff is too low or too high, academic staff reacts by establishing service firms to achieve a better resource management.

**Keywords:** Academic entrepreneurship; Spin-offs; University Context; Technology transfer; Founders' incentives.

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## 1. Introduction

Academic spin-offs have received great attention from researchers and policymakers because of their potential ability to advance scientific knowledge as well as to contribute to regional economic growth (O'Shea et al., 2008). A series of policies have been adopted by national governments with the aim of fostering the technology transfer process and of creating a supportive environment in which to create new science-based firms. As a result, the rate of creation of this type of firms has proliferated in recent years (Mustar et al., 2006) and so has done the literature on the subject. A number of studies emphasize the impact of individual attributes and dispositions on academic entrepreneurship. Given that academic entrepreneurs are actively engaged in knowledge creation and dissemination at universities, one would expect their academic affiliation to positively influence the performance of their business ventures.

However, researchers involved in creating new ventures may not be motivated solely by an entrepreneurial vision. For example, they may be attracted also by the prospect of enhancing their position (Meyer, 2003), or be motivated by a need for achievement (Roberts, 1991) or a desire of independence and challenge (Hessels et al. 2008). Other individual motives include seek of recognition by peers and ambition to develop a technology into a marketable product (O'Gorman et al., 2008; Hayter, 2011). The set of personal motivations proposed by the literature is thus diversified. Spanning from monetary rewards to self-enhancing goals, these are, however, all 'positive' motivations. Nevertheless, the available evidence indicates that academic spin-offs are often not gazelles (Colombo et al., 2011) and in some cases the creation and management of university spin-offs has even been found to be fraudulent, with public funds used for private interests.[1]

It is therefore of interest to investigate the 'dark side' of spin-off motivations. The aim of this paper is precisely to add to the traditional view on the academic founders' incentives to spin-off by considering, (1) at an individual level, the effects of lack of academic job opportunities and, (2) at an organizational level, the impact of administrative inadequacy of universities. With regard to individuals' decisions, we argue that academics might sometimes become entrepreneurs as a "second-best solution", because of shortcomings in the market for knowledge. There are indeed several motivations to spin-off and they may vary within the entrepreneurial team itself. Academic life cycle models suggest that academics launch spin-offs late in their careers, after having developed their human capital (Shane, 2004). The spin-off activity, however, typically involves more persons, with different status and function within the parent university (Pirnay et al., 2003) and often includes young members (Grimaldi et al., 2011). The incentives of young post-doctoral students, for instance, are very different from those of tenured professors. For the formers, launching a spin-off may represent a compensatory solution to difficulties in the academic world. If this happens, we expect that the lack of academic job opportunities positively influences the rate of creation of academic spin-offs.

Though ultimately driven by individual drive, contextual factors may facilitate or inhibit the spin-off activity. Existing studies focused on the role played by the organization and resources of Technology Transfer Offices (TTOs hencefort), research parks, and universities (Link and Scott, 2005; Siegel et al., 2003a, 2003b) as well

[1] See, for instance, the article on Corriere della Sera, the major newspaper in Italy, of October 14, 2014 by A. Camuso "Truffa all'università. Indagati professori per speculazioni sui fondi per la ricerca".

as local-context support mechanisms and regional conditions (Audretsch et al., 2012; Bonaccorsi et al., 2013, 2014; Fini et al., 2011; Meoli et al., 2013). We posit that the inadequacy of administrative and bureaucratic procedures within a university impacts on the propensity to spin-off. When the support from the university to which they belong is scarce or inadequate, entrepreneurial academics, striving for a better management of both cash and human resources, opt for a spin-off solution rather than for alternative technology transfer means (e.g. licensing). We therefore argue that the administrative inadequacy of the parent university positively affect the rate of creation of academic spin-offs.

The Italian system of higher education has been characterized, over the past fifteen years, by different levels of career opportunities and administrative staff support (Donina et al. 2014), and is therefore suitable for testing our hypotheses. With a longitudinal study of 559 spin-offs launched from 54 universities in the period 1999 to 2013, we test whether the rate of formation of spin-offs (number of spin-offs per year per university) is affected by the lack of academic job opportunities and by the administrative inadequacy of parent universities. Controlling for several university- and context-level factors, we find that scarce possibilities of initial appointment in academic positions result in an increased propensity to undertake an entrepreneurial career through spin-offs. Second, an inadequate number of technical and administrative staff in a university leads academics to establish more spin-offs. However, this happens only for technology product-oriented spin-offs. There is instead a U-shaped relationship between the number of administrative staff within the universities and the number of service or non technology spin-off firms. We therefore argue that when the ratio between administrative and academic staff is too low ("lack of human resources") or too high ("excess of bureaucracy"), the academic staff tends to react by creating service firms to achieve a better resource management.

The remainder of the article is organized as follows. Section 2 develops the hypotheses of the paper. Section 3 consists of a narrative description of two case studies that is interspersed with quotations from key informants. Section 4 describes the research design. Section 5 presents the results, and Section 7 concludes the paper.

## 2. Hypotheses development

The "Survey of Doctorate Recipients" shows that the number of students willing to become faculty members is larger than the number of those who will actually find employment in that sector, suggesting imbalances in the scientific labor market (Roach and Sauermann, 2010). Moreover, while the number of Ph.D. students is increasing, in many countries public support to universities is decreasing and it is evolving towards the improvement of the efficiency of research organization rather than increasing research expenditures (Mangematin, 2000). Under these conditions, an entrepreneurial career, through the foundation of an academic spin-off, can allow a doctorate holder a satisfactory exploitation of their advanced knowledge in a certain field of expertise. The spin-off may therefore in some cases not be the first-best solution, but rather a compensatory, self-employment opportunity, in which young researchers engage in the absence of academic

job opportunities. If this is the case, we expect that, at a regional level, when the academic job opportunities decrease, compared to the number of fresh graduates, the propensity to spin-off increases.
Based on these arguments, we add to existing literature on factors leading individuals to found academic spin-offs (see, e.g., Shane, 2004, Fini et al, 2011) by formulating the following hypothesis:
*Hypothesis 1: A decrease in initial academic job opportunities compared to the number of Ph.D graduates positively affects the rate of creation of academic spin-offs.*

The organization and policy of a university clearly have an impact on its technology transfer capacities (Di Gregorio and Shane, 2003). Accordingly, the inadequacy of administrative and bureaucratic procedures in a university is expected to drive a higher number of academics to pursue entrepreneurial opportunities. We argue that this inadequacy is larger when the administrative staff is undersized. In these circumstances, the technology transfer activity, as a third, non-core, mission of the university is often sacrificed. Smaller universities might not even have a formal TTO, or have only recently settled one. If we consider that the age of the TTO are the main measurable TTO-related factors that positively affect the number of spin-offs (Powers and McDougall, 2005), we can hypothesize that universities with a small administrative and technical staff will find it hard to foster and support spin-offs. TTOs composed of a handful of members (in our sample, TTOs employ in median 4 persons) will find it difficult to provide a customized support to spin-offs and will be probably lack specific expertise, such as industry knowledge or legal skills, and 'networked' boundary spanning individuals that would make them more effective.[2] Undersized administrative staff will therefore results in low or no support for technology transfer activities. This is tested with the following hypothesis:
*Hypothesis 2a: An increase in the amount of administrative support in a university positively affects the rate of creation of academic spin-offs.*

The nature of university spin-offs is heterogeneous and several papers distinguish technology spin-offs from others (Carayannis et al., 1998; Druilhe and Garnsey, 2004; Mustar et al., 2006). This focus on technology is coherent with the policy aim of fostering the commercialization of academic research in particular in science and engineering, where the positive externality on the economy at large are expected to be larger (Bozeman, 2000). Moreover, the support of the parent university is particularly important for the establishment of spin-offs in high-tech sectors, such as ITC, machinery, and biotech. Increased administrative support in a university is therefore expected to be even more for technology spin-offs. Hypothesis 2a is refocused as follows:

[2] In our econometric analysis, we proxy the university administrative support with the ratio between the number of technical and administrative staff members over the number of academics. This allows us to have a longitudinal perspective, with a dependent variable varies across individual (i.e. universities) and years. The size of the TTOs, though perhaps a better proxy, does not vary significantly in time. For this reason, we resort to the administrative to academic ratio as main dependent variable and, as a robusteness check, we re-run the regressions by splitting the sample between universities with large vs small TTOs (i.e. above or below the median). Results are reported in Table 8 and discussed in Section 5.

*Hypothesis 2b: An increase in the amount of administrative support in a university positively affects the rate of creation of academic spin-offs in high-tech sectors.*

The ultimate policy goal of spin-offs, and the rationale for its public support, is fostering the transmission of knowledge from universities to industry. When knowledge is codified, it can be easily transferred but also imitated by others. Codified knowledge is therefore typically protected using legal means, such as patents. Tacit knowledge is instead embodied in individuals and implies non-tradability. To be both created and transferred, it requires co-operation and interactive learning. The taxonomy proposed by Pirnay et al. (2003) classifies academic spin-offs along this criteria. Spin-offs devoted to the exploitation of tacit knowledge in a logic of expertise providers (service spin-offs) are distinguished from those with a core business rooted in codified knowledge exploited for industrial purposes (product-oriented spin-offs).

To establish service spin-offs requires less support from the parent university (Pirnay et al., 2003). On the contrary, they might represent a way to compensate for administrative inadequacy. To some extent, service spin-offs can surrogate TTOs. Everything else equal, the lower the administrative support granted by a university, the higher will be the aim of affiliated academics to establish a technology service spinoff. By spinning-off, they can enjoy higher flexibility, at the expense of losing an anyway weak support from the university. The scarce or virtually null support for in-house technology transfer activities will thus stimulate researchers to 'go out' and spin-off. We expect, as a consequence, higher rates of in the creation of service technology spin-off when and where the administrative support is weak.

The propensity to create service technology spin-offs may be high also in highly bureaucratic environments. The degree of complexity of the administrative and bureaucratic procedures increases with size, with the risk that the large presence of administrative staff deteriorate, rather than improving, the speed and flexibility of procedures (Agasisti & Catalano, 2006), as required for the creation of successful spin-offs. This bureaucratic burden may stimulate academics to look for more flexible alternatives to manage their industry collaborations and technology transfer activities. We therefore expect a U-shape relationship between the level of administrative support and spin-off propensity. When the ratio between administrative and academic staff is too low or too high, academic staff may react by establishing service firms to achieve a better resource management and to fulfill the activities left unsatisfied by lacking or excessively bureaucratic administrative staff.

Based on these arguments, we formulate the following hypothesis:

*Hypothesis 3: There is a U-shape relationship between the amount of administrative support in a university and the rate of creation of service technology spin-offs and of non technology firms.*

## 3. Anecdotal evidence

In this section, we provide a narrative description of two polar case studies of academic spin-offs, selected because they offer an extraordinary setting in which to observe the phenomenon under investigation, and show a close connection between real-life evidence and our hypotheses.

The first explanatory case is a technology-based spin-off founded in 2008 by a postdoctoral scholar with two professors. The company is rooted in a university research group with ten years of experience of applied research and with several industry collaborations, including co-patenting. After five years, the ownership structure of the company has not changed, while three other young researchers and an experienced manager have been hired. At the beginning, the difficulties for university recruitment played a relevant role in the decision to create this spin-off, as cited by the founder post-doc. "In that period, I knew there were no possibilities for job position at university within a commuting distance, and I did not want to relocate without concrete hopes to be able to come back in a not too distant future". The lack of academic job opportunities was clearly among the motivations to establish this spin-off.

The second example is an academic spin-off created in 2004 from a team of four people, two academics and two young graduates. "We [the academics] were frequently working with companies as consultants. Contracts were on behalf of the university, while we were burden with bureaucracy and received virtually no support. With the spin-off, we still benefit from the affiliation with the university, but are much freer to manage the resources and cash flows of the business". Now, ten years after the foundation, this spin-off is still governed by the founding team, with three temporary employees. They do not intend to grow, though. The administrative inadequacy of the parent university is perceived by the founders as the leading motivation to spin-off.

## 4. Research design

### *4.1 Sample*

Our sample is made of spin-offs from Italian universities, founded from 1999 to 2013. We started from 1999 because the possibility for universities to create spin-off companies was defined in Italy in that year (Law 297/1999). Since then, public researchers can be involved in technology-transfer projects while keeping their university position and wage. Using data from the Italian Ministry of Education, University and Research (MIUR), we identified 96 universities in Italy, including 11 distance-learning universities and 6 special institutes dedicated only to advanced studies, enrolling postgraduate students. As in previous studies (e.g. Bonardo et al., 2011; Fini et al., 2011), we defined an academic spin-off as a company with either a university or at least one academic among the founders. The dataset was built using information available from the websites of the universities, where TTOs are required to report the list of affiliated spin-offs. Overall, our sample is composed of 559 spin-offs established between 1999 and 2013 from 54 universities with at least one spin-off. Although we do not know the exact figure for the number of Italian academic spinoffs, our sample is slightly larger than those of existing studies that considered shorter time periods (e.g., Colombo and Del Mastro, 2002; Fini et al., 2009; Fini et al, 2011).

### *4.2. Technology spin-offs*

Technology spin-offs are identified as firms in high- and medium-high technology sectors according to the OECD classification. Hence, firms in Aerospace, Computers, Electronics-communications, Pharmaceuticals,

Scientific instruments, Motorvehicles, Machinery, Chemical, and Transport equipment are considered as technology spin-offs. Among them, as proposed by Pirnay et al. (2003), we distinguish those whose core business is rooted in codified and technological knowledge exploited for industrial purposes from those devoted to the exploitation of tacit knowledge in a logic of expertise providers. The latter are labelled technology service spin-offs. Below we exemplify our classifications of spin-offs, with the name of the spin-offs, its parent university, year of foundation and a brief description of the business.

*Technology Spin-offs:*

- Insono (University of Firenze, 2011) supplies electronic optical devices for process controlling in the pharmaceutical, petrochemical and food industry;
- Microtech (University S. Anna of Pisa, 2000) produces medical devices for micro-invasive surgery;
- In3diagnostic (University of Torino, 2012) produces diagnostic reagents for veterinary.

*Technology service Spin-offs:*

- S.TRA.TE.G.I.E. (University of Marche, 2005) offers technology transfer services in the energetic engineering industry;
- Vetogene (University of Milan, 2003) performs genetic analysis for the control of pet geneticic disorders, and offers consultancy on pet behavioral anomalies;
- F&M Fotosintetica & Microbiliologica (University of Florence, 2004) offers know-how and consulting services for the culture of micro algae and cyanobacteria, and on their application in agriculture and renewable energies.

*Other Spin-offs:*

- Wel.Co.Me. (University of Bari, 2012) supports social cooperatives and public institutions by providing general counselling and organizing social and educational events;
- Ius (University of Perugia, 2006) offers training and legal support for local institutions;
- Mint Publishing (University S. Anna of Pisa, 2000) delivers services to support publishing and teaching activities in the juridical field.

Table 1 reports the number of spin-offs per year in our sample, distinguishing technology and technology service spin-offs. Out of 559 spin-offs, 416 are technology-based firms (74.4%). Among them, 86 are technology service spin-offs (15.4%). There has been an increase in spin-off activity over time, with most of the spin-offs being created in the period 2004-2009. A lower number of firms were established in the period 2010-2013, arguably due to the effects of the economic crisis. There is not a clear trend in the evolution of the type of spin-offs, as technology spin-offs account each year for 67 to 89% of the total number of spin-offs. Predictably, most of the spin-offs are located in the richer North of Italy. On the contrary, technology service spin-offs are more frequent in the South, where as much as 23% of the spin-offs are of this type.

[INSERT HERE TABLE 1]

*4.3 Model and variables*

To perform our longitudinal study, we use of panel-data negative binomial regressions, where the dependent variable is the total number of spin-offs (count) per university per year. In practice, we measure the effect of our independent variables on 810 university-year observations (54 universities observed for 15 years between 1999 and 2013). The explanatory variables proxy the lack of opportunities for an academic career and the level of administrative support provided from the university. Our measure for academic opportunities is calculated as the ratio between the number of new positions as assistant professor offered by all universities in a region, and the number of PhD students graduated per year in each university. Administrative support is measured at the university level as the ratio between the number of technical and administrative staff and the number of academics year by year. In order to test whether the relationship between the amount of administrative support and the academic spin-off activity is U-shaped, we also add the squared value of the index calculated above.

We identify two sets of control variables, accounting for the specificities of the academic and the local context, as in Fini et al. (2011). The first category is composed by university-level control variables, and includes a measure of university size (number of students, including Bachelor, Master, PhD and specialization courses), the faculty/students ratio, and a measure of university patenting activity (number of patents). The second category groups regional level control variables: it includes the regional patenting activity (number of patents at the regional level), a measure of number of graduates in science, technology, engineering and mathematics (STEM) graduates, R&D employees (percentage of regional population with a degree in science, technology, engineering and mathematics on the regional population) and the regional R&D expenditure (regional R&D expenditure over regional GDP). In addition to all controls presented above, we will include a set of dummy variables related to the macro regions, to take into account of all potential unobservable differences between these areas. The size of the TTO of each university in 2013 is used to split the sample in the robustness analysis reported in Table 8.

Our sources of data for all control variables are the MIUR (Italian Ministry for University and Research) and the SCOPUS database for university data, while the data referred to the local context are collected from the ISTAT (Italian National Institute of Statistics). Details on the definition of the variables and their sources are reported in Table 2, while the correlation matrix is reported in the Appendix.

[INSERT HERE TABLE 2]

Table 3 reports the descriptive statistics for the 810 university-year observations employed for our empirical analysis, reporting separate statistics North, Central and South of Italy. At the regional level, there are on average 8% opened positions of assistant professorship for each graduating PhD student. Academic career opportunities have been particularly poor in Northern regions (on average, 0.03), while administrative support has been stronger in Central Italy. The ratio between the number of technical and administrative staff

members and the number of academics is indeed on average 1.29 in Italy, and 1.59 in Central Italy. Italian universities enroll on average about 31,000 students, with a faculty per student ratio of 4.2% in North Italy vs 2.7% in South Italy. The average TTO in Italy employees 4.4 persons. Northern universities patent much more (7 patents per year per university with at least one spin-off), which is in line with the higher patenting activity of their local contexts (125 patents per year per million people). The number of graduates in science, technology, engineering and mathematics per thousand people is on average 12 in Northern and Central Italy and 6 in Southern Italy. R&D expenditures for Public Administrations, Universities, and private and public enterprises accounts in Italy only at 1.1% of the GDP.

[INSERT HERE TABLE 3]

**5. Results**

Table 4 reports the estimates of negative binomial panel regressions on the total number of spin-offs created per year by the 54 Italian universities with at least one spin-off record. There are four specification for our model: Model (1) includes the variable measuring academic opportunity; Models (2) include the effect of administrative support; Model (3) tests the existence of a linear or a U-shape effect administrative support using the quadratic term; Model (4) tests for both academic career opportunities and administrative support. In all models, we include all university-level and context-level control variables, as well as a set of dummies to control for macro-regional effects. The negative sign of academic opportunities in Models (1) and (4) supports Hypothesis 1, in that a small number of career opportunities (at the regional level) with respect to the number of PhD graduates increases the propension to create spin-off. The positive sign for administrative support in Models (2) and (4) is in support of Hypothesis 2, because we have evidence that a stronger administrative support enhances the probability to observe spin-off activity. Model (3) reports a non-significant coefficient for the quadratic term of administrative support, neglecting the possibility of a curvilinear relationship. Most control variables confirm the expectations. A higher value of the faculty/students ratio increases the probability of spin-offs, arguably because academics have more time to dedicate to transfer activities; a positive regional context, in terms of active patenting activity and presence of STEM graduates, is also correlated to higher spin-off propension. On the contrary, there is no significant effect of university size and university patenting activity.

[INSERT HERE TABLE 4]

In Table 5, we focus on technology spin-offs. Again, we report four specification, testing separately for academic opportunities (1), administrative support in a linear fashion (2) or U-shaped relationship (3), and then (4) for the joint effect of the two determinants. The results show that academic opportunities are negatively related to hi-tech spin-off activity, while administrative support linearly and positively affects hi-

tech spin-off activity. This result offers further support for Hypothesis 2. All control variables show the same effects observed on the full sample.

[INSERT HERE TABLE 5]

In Table 6, we investigate whether the same relationships apply to technology service spin-offs, by using once again the four model specifications presented above. Similarly, in Table 7, we study non technology spin-offs (i.e. spin-offs in low or medium technology sectors according to the OCSE classification). The results are quite different from those observed on the full sample and on the sample of pure technology spin-offs. Academic career opportunities play a negative role, supporting that a lack of opportunities in the career track might create an incentive to spin-off also service firms. With respect to the administrative support, Model (2) does not provide enough evidence to support the existence of a negative linear relationship, while Model (3) suggests a U-shaped effect on service spin-off activity. This result provides support for Hypothesis 3. At low levels of administrative support, there is a negative relationship between administrative support and spin-off activity, pointing to academic staff founding spin-offs also to supplement this deficiency. On the other hand, when the administrative support is very high, service spin-offs might be responsive to a high degree of complexity of the administrative and bureaucratic procedure. The effect of administrative procedure are found indeed to be U-shaped with respect to both technology service spin-off activity and non technology spin-offs, and not linear like in the case of all technology spin-offs.

[INSERT HERE TABLE 6 AND 7]

The line of arguments on administrative inadequacy is further tested as follows. While our measure for administrative support captures the level of technical and administrative activity in a university, it does not necessarily identifies the level of support in the specific field of technology transfer. A university might be characterized by a byzantine administration, and dedicate little effort to the commercialization of research, or it might leverage on the availability of a large staff for a proper activity of technology transfer. An important aspect within the organization of the university is, therefore, its TTO, which is in charge of fostering the spin-off process. Spin-offs are however only one of technology transfer related-activities in which TTOs are involved, that ranges industry co-operation in innovation to commercial licensing and seedcapital investments. Moreover, they have to balance to objective of different stakeholders (e.g., university administration, faculty, and industry) (Jensen et al., 2003; Siegel et al., 2003b). We therefore argue, to fulfill their complex mission, the size of these TTOs matters (Friedman and Silberman, 2003).

As a robustness check, we split the sample between university with a small and university with a large TTO. A TTO is classified as small when its staff is equal or below the sample median of 4, while it is adequate or large in the opposite case. We consider that TTOs with up to 4 members will probably do not have the capabilities and the professional figures needed for a strong support to the spin-off activity. Results are

reported in Table 8[3]. Models (1), (2) and (3) are negative binomial panel regressions on the total number of spin-offs, on technology spin-offs and on technology service spin-offs respectively. These models are run on the subsample of universities with smaller TTOs. Models (4), (5) and (6) report the same analyses for university larger TTOs. We find that in universities with smaller TTOs the increase in the level of administrative support is effective in increasing the number of spin-offs, in particular technology spinoffs. Viceversa, when the TTO is larger, the level of administrative support is not significant, with an exception: the squared level of administrative support is positively correlated to the establishment of service spin-offs. This suggests that the recur to service spin-offs to solve excess of bureaucracy is more likely to be observed in universities with large TTOs.

[INSERT HERE TABLE 8]

## 6. Conclusions

While a number of studies emphasize the impact of individual attributes and dispositions on academic entrepreneurship, researchers involved in creating new ventures may not be motivated solely by an entrepreneurial vision. Besides monetary rewards or self-enhancing goals, there might be other motivations, not necessarily positive, leading to the proliferation of academic spin-offs.

With a longitudinal study of 559 spin-offs launched from 54 Italian universities in the period 1999 to 2013, this paper investigates the 'dark side' of spin-off motivations. We extend the scope of determinants to consider the contingent effects of lack of academic career opportunities and of bureaucratic inadequacies within the university system. First, our results show that a small number of career opportunities at a regional level with respect to the number of PhD graduates increases the propension to establish spin-offs. In practice, academics might sometimes become entrepreneurs as a "second-best solution", when they feel to not have at hand opportunities to start an academic career. Second, while a sufficient level of administrative support is generally required to boost spin-off activity, and this is especially true in the case of technology product-oriented spin-offs, administrative inadequacy of the parent university leads to an increase in the number of technology service spin-offs and non-technology spinoffs. We find evidence of a stimulus to "go out" and establish service and non-technology spinoffs when the university support for technology transfer activity is particularly inadequate, either because it is insufficient or highly bureaucratic. Using service spin-offs as surrogate TTOs, academics might be prone to create service spinoffs in order to enjoy higher flexibility and to freer to manage the human and cash resources. Figure 1 summarizes these results.

[INSERT HERE FIGURE 1]

[3] Non Technology Spin-offs are dropped from this robustness tests because the limited number of spin-offs in the two subsamples does not allow a proper estimation of the model.

We believe that our contribution directly affects potential academic entrepreneurs, academic managers, and policy makers. First, we show how potential entrepreneurs, through the foundation of an academic spin-off, can allow a doctorate holder a satisfactory exploitation of their advanced knowledge in a certain field of expertise. The spin-off may therefore in some cases not be the first-best solution, but rather a compensatory, self-employment opportunity. Second, university managers find here evidence that a satisfactory spin-off activity is not necessarily related to an outstanding performance in the university "third mission", while there might be lack of opportunities for human resources, or administrative deficiencies, at the basis of such results. Third, our results are relevant for policy makers: while the attention on academic spin-offs has been often motivated by the potential ability to advance scientific knowledge as well as to contribute to regional economic growth, we show how important non-financial motivations can be for the creation of academic spin-offs. In fact, our results are of interest for the stream of research highlighting the poor performance records of academic spin-offs (Chiesa and Piccaluga, 2000; Bonardo et al., 2011). We indeed add some insights to understand the poor long-term growth of academic spin-offs, that are often not driven by pure growth orientation. This ultimately casts doubt on the appropriateness of public incentives to establish spin-offs and on their short-term metrics.

We acknowledge that our analysis is not without limitations. First, the abnormal spin-off activity, especially observable in the technology service sector, can be specific of the Italian context that we chose for our analysis; and thus caution should be paid in generalizing the implications. Second, our analysis is limited to the observation of spin-off activity, but does not investigate the performance ability of spin-offs. In future research, we aim to analysis whether spin-off activity generated by lack of career opportunities and lack of administrative efficiency ultimately end in growth, or simply limit their efficacy in solving contingent academic needs.

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**Table 1. Sample.** This table reports the number of academic spin-offs, taking place in Italy from 1999 to 2013. Technology spin-offs are firms in high- and medium-high technology sectors according to the OECD classification. Among them, Technology service spin-offs are firms devoted to the exploitation of tacit knowledge in a logic of expertise providers, distinct from product-oriented spin-offs (Pirnay et al., 2003).

| | Spin-offs | | Technology | | Technology service | |
|---|---|---|---|---|---|---|
| Year | No. | % | No. | % | No. | % |
| 1999 | 15 | 2.7 | 13 | 86.7 | 0 | 0.0 |
| 2000 | 9 | 1.6 | 8 | 88.9 | 1 | 11.1 |
| 2001 | 7 | 1.3 | 6 | 85.7 | 2 | 28.6 |
| 2002 | 7 | 1.3 | 5 | 71.4 | 0 | 0.0 |
| 2003 | 31 | 5.5 | 23 | 74.2 | 3 | 9.7 |
| 2004 | 50 | 8.9 | 36 | 72.0 | 4 | 8.0 |
| 2005 | 43 | 7.7 | 34 | 79.1 | 5 | 11.6 |
| 2006 | 46 | 8.2 | 31 | 67.4 | 6 | 13.0 |
| 2007 | 78 | 14.0 | 54 | 69.2 | 7 | 9.0 |
| 2008 | 71 | 12.7 | 55 | 77.5 | 10 | 14.1 |
| 2009 | 57 | 10.2 | 43 | 75.4 | 13 | 22.8 |
| 2010 | 38 | 6.8 | 32 | 84.2 | 10 | 26.3 |
| 2011 | 40 | 7.2 | 28 | 70.0 | 8 | 20.0 |
| 2012 | 41 | 7.3 | 29 | 70.7 | 12 | 29.3 |
| 2013 | 26 | 4.7 | 19 | 73.1 | 5 | 19.2 |
| Region | | 0.0 | | | | |
| North | 255 | 45.6 | 172 | 67.5 | 32 | 12.5 |
| Central | 195 | 34.9 | 155 | 79.5 | 29 | 14.9 |
| South | 109 | 19.5 | 89 | 81.7 | 25 | 22.9 |
| Total | 559 | 100.0 | 416 | 74.4 | 86 | 15.4 |

**Table 2. Variable Definition.** MIUR is the Italian Ministry of Research and Education; SCOPUS is an abstract and citation database by Elsevier; CRUI is the Conference of the Rectors of Italian Universities; ISTAT is the Italian National Statistical Institute. University-level control variables are measured per year and per university; Context-level control variables per region per year.

| Variable | Definition | Source |
|---|---|---|
| Academic opportunities | Ratio between the number of opened positions of assistant professorship at the regional level and the number of graduating PhD students | MIUR |
| Administrative support | Ratio between the number of technical and administrative staff members and the number of academics | MIUR |
| University-level control variables | | |
| University size | Number of students, including Bachelor, Master, PhD and specialization courses (Logarithms are used in regressions) | MIUR |
| Faculty/Students Ratio | Ratio between the number of academics and the number of students | MIUR |
| University patenting activity | Number of patents granted per year per university | SCOPUS |
| TTO size | Number of employees in TTOs | CRUI |
| Context-level control variables | | |
| Regional patenting activity | Number of patents granted by the European Patent Office (per million people) | ISTAT |
| STEM graduates | Number of graduates in science, technology, engineering and mathematics between 20 and 29 years old (per thousand people) | ISTAT |
| R&D expenditure | Percentage of the R&D expenditures for Public Administrations, Universities, and private and public enterprises on the GDP | ISTAT |

**Table 3. Descriptive statistics.** This table shows the descriptive statistics for the sample of 810 year-university observations (54 universities, observed for 15 years from 1999 to 2013).

| | Italy | | North | | Central | | South | |
|---|---|---|---|---|---|---|---|---|
| | Mean | Std de | Mean | Std dev | Mean | Std dev | Mean | Std dev |
| Academic opportunities (%) | 8.40 | 137.1 | 3.22 | 178.3 | 12.98 | 105.9 | 9.56 | 91.2 |
| Administrative support | 1.29 | 0.95 | 1.14 | 0.39 | 1.59 | 1.51 | 1.16 | 0.33 |
| University size (000s) | 31.2 | 27.5 | 30.3 | 32.3 | 32.9 | 27.3 | 30.8 | 23.2 |
| Faculty/Students (%) | 3.6 | 2.9 | 4.2 | 4.2 | 3.5 | 1.5 | 2.7 | 0.7 |
| University patenting (no) | 4.7 | 7.4 | 7.1 | 9.8 | 3.6 | 5.1 | 2.3 | 3.6 |
| TTO size (no) | 4.4 | 2.8 | 4.6 | 3.0 | 4.4 | 3.3 | 4.0 | 1.5 |
| Regional patenting activity | 71.1 | 55.4 | 125.4 | 34.7 | 50.7 | 30.6 | 12.1 | 9.0 |
| STEM graduates | 10.6 | 4.6 | 12.2 | 3.9 | 12.1 | 4.5 | 6.4 | 2.6 |
| R&D expenditure (%) | 1.10 | 0.39 | 1.21 | 0.32 | 1.14 | 0.44 | 0.75 | 0.27 |

**Table 4. Regressions on the number of Spin-offs per year.** This table reports the results of negative binomial panel regressions on the total number of spin-offs created per year by the 54 Italian universities with at least one spin-off over the period 1999-2013. Model 1 includes the coefficient measuring the effect of Academic opportunities; Model 2 includes the effect of the Administrative support; Model 3 adds the curvilinear component of the Administrative support; Model 4 reports the joint test. Controls for the geographic area (North, Central, South) are included in all regressions. ***, **, and * indicate significance at the 1, 5, and 10 percent levels, respectively.

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| Academic opportunities | -0.643** | | | -0.640** |
| | (0.295) | | | (0.297) |
| Administrative support | | 0.568** | 1.388*** | 1.243** |
| | | (0.265) | (0.521) | (0.508) |
| Administrative support (squared) | | | -0.328 | -0.273 |
| | | | (0.203) | (0.197) |
| University size | -0.050 | 0.027 | -0.021 | 0.006 |
| | (0.175) | (0.186) | (0.187) | (0.190) |
| Faculty/Students Ratio | 1.796** | 1.855*** | 1.883*** | 1.811** |
| | (0.730) | (0.719) | (0.720) | (0.722) |
| University patenting activity | 0.012 | 0.016 | 0.015 | 0.011 |
| | (0.010) | (0.009) | (0.010) | (0.010) |
| Regional patenting activity | 0.006*** | 0.005** | 0.005** | 0.006*** |
| | (0.002) | (0.002) | (0.002) | (0.002) |
| STEM graduates | 0.171*** | 0.189*** | 0.186*** | 0.176*** |
| | (0.028) | (0.028) | (0.028) | (0.028) |
| R&D Expenditure | -1.315* | -1.202* | -1.241* | -1.412** |
| | (0.693) | (0.672) | (0.679) | (0.693) |
| Constant | 0.487 | -1.260 | -1.211 | -1.172 |
| | (1.933) | (2.142) | (2.129) | (2.149) |
| Observations | 810 | 810 | 810 | 810 |
| Pseudo $R^2$ | 0.087 | 0.089 | 0.095 | 0.099 |

**Table 5. Regressions on the number of Technology Spin-offs.** This table reports the results of negative binomial panel regressions on the number of Hi-tech spin-offs created per year by the 54 Italian universities with at least one Hi-tech spin-off over the period 1999-2013. Model 1 includes the coefficient measuring the effect of Academic opportunities; Model 2 includes the effect of the Administrative support; Model 3 adds the curvilinear component of the Administrative support; column 4 reports the joint test. Controls for the geographic area (North, Central, South) are included in all regressions. ***, **, and * indicate significance at the 1, 5, and 10 percent levels, respectively.

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| Academic opportunities | -0.629** | | | -0.628** |
| | (0.297) | | | (0.299) |
| Administrative support | | 0.589** | 1.394*** | 1.253** |
| | | (0.268) | (0.518) | (0.504) |
| Administrative support (squared) | | | -0.325 | -0.270 |
| | | | (0.202) | (0.197) |
| University size | -0.063 | 0.023 | -0.025 | -0.002 |
| | (0.178) | (0.190) | (0.191) | (0.194) |
| Faculty/Students Ratio | 1.782** | 1.824** | 1.853** | 1.794** |
| | (0.735) | (0.726) | (0.727) | (0.728) |
| University patenting activity | 0.010 | 0.013 | 0.013 | 0.009 |
| | (0.010) | (0.010) | (0.010) | (0.010) |
| Regional patenting activity | 0.006*** | 0.005** | 0.005** | 0.006*** |
| | (0.002) | (0.002) | (0.002) | (0.002) |
| STEM graduates | 0.163*** | 0.182*** | 0.179*** | 0.168*** |
| | (0.028) | (0.028) | (0.028) | (0.028) |
| R&D Expenditure | -1.271* | -1.193* | -1.236* | -1.400** |
| | (0.708) | (0.687) | (0.695) | (0.708) |
| Constant | 0.580 | -1.266 | -1.203 | -1.124 |
| | (1.966) | (2.184) | (2.171) | (2.193) |
| Observations | 810 | 810 | 810 | 810 |
| Pseudo $R^2$ | 0.083 | 0.084 | 0.090 | 0.093 |

**Table 6. Regressions on the number of Technology Service Spin-offs.** This table reports the results of negative binomial panel regressions on the number of Technology Service spin-offs created per year by the 31 Italian universities with at least one Service spin-off over the period 1999-2013. Model 1 includes the coefficient measuring the effect of Academic opportunities; Model 2 includes the effect of the Administrative support; Model 3 adds the curvilinear component of the Administrative support; column 4 reports the joint test. Controls for the geographic area (North, Central, South) are included in all regressions. ***, **, and * indicate significance at the 1, 5, and 10 percent levels, respectively.

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| Academic opportunities | -1.387** | | | -0.922 |
| | (0.673) | | | (0.647) |
| Administrative support | | -0.959 | -2.370*** | -2.171*** |
| | | (0.816) | (0.654) | (0.661) |
| Administrative support (squared) | | | 0.366** | 0.359** |
| | | | (0.169) | (0.167) |
| University size | -0.263 | -1.242 | -1.184 | -0.716 |
| | (1.245) | (1.120) | (1.301) | (1.349) |
| Faculty/Students Ratio | 2.594 | 4.391* | 4.129 | 3.332 |
| | (2.647) | (2.644) | (2.924) | (2.953) |
| University patenting activity | 0.018 | 0.025 | 0.023 | 0.019 |
| | (0.024) | (0.024) | (0.025) | (0.025) |
| Regional patenting activity | -0.008 | -0.010 | -0.010 | -0.009 |
| | (0.008) | (0.007) | (0.008) | (0.008) |
| STEM graduates | 0.337*** | 0.347*** | 0.351*** | 0.326*** |
| | (0.083) | (0.084) | (0.084) | (0.085) |
| R&D Expenditure | -1.301 | -1.376 | -0.672 | -0.765 |
| | (1.977) | (1.981) | (2.006) | (2.008) |
| Constant | 0.690 | -1.378 | -1.314 | -1.235 |
| | (1.854) | (2.073) | (2.060) | (2.082) |
| Observations | 465 | 465 | 465 | 465 |
| Pseudo $R^2$ | 0.064 | 0.076 | 0.086 | 0.091 |

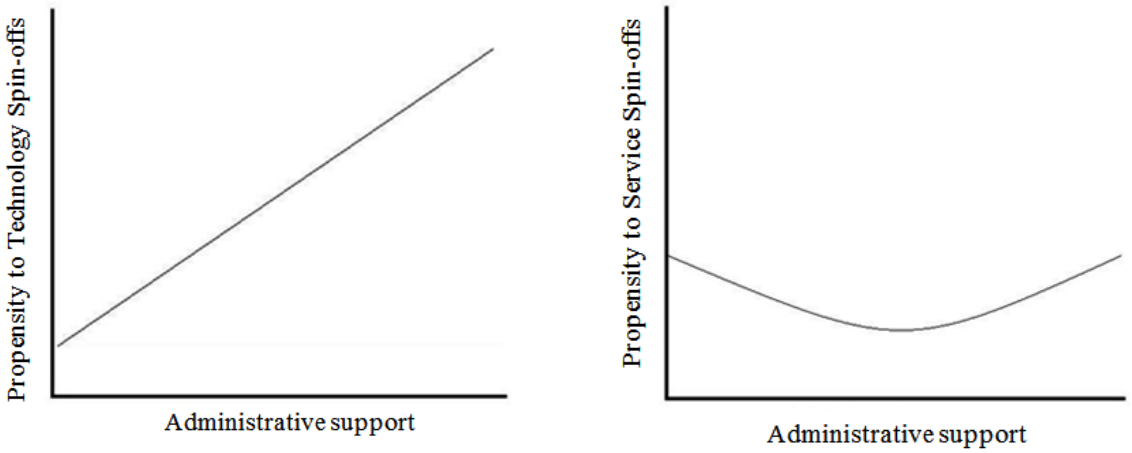
**Table 7. Regressions on the number of non Technology Spin-offs.** This table reports the results of negative binomial panel regressions on the number of non Technology spin-offs created per year by the 14 Italian universities with at least one non Technology spin-off over the period 1999-2013. Model 1 includes the coefficient measuring the effect of Academic opportunities; Model 2 includes the effect of the Administrative support; Model 3 adds the curvilinear component of the Administrative support; column 4 reports the joint test. Controls for the geographic area (North, Central, South) are included in all regressions. ***, **, and * indicate significance at the 1, 5, and 10 percent levels, respectively.

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| Academic opportunities | -0.983* | | | -0.304 |
| | (0.520) | | | (0.288) |
| Administrative support | | -3.279 | -2.843* | -2.806* |
| | | (2.598) | (1.525) | (1.538) |
| Administrative support (squared) | | | 1.028*** | 1.013** |
| | | | (0.382) | (0.392) |
| University size | -0.881 | -1.935 | -1.349 | -1.203 |
| | (2.832) | (2.937) | (2.849) | (2.994) |
| Faculty/Students Ratio | 7.918 | 10.973 | 8.229 | 7.980 |
| | (6.482) | (7.258) | (6.124) | (6.309) |
| University patenting activity | 0.057 | 0.060 | 0.009 | 0.009 |
| | (0.040) | (0.039) | (0.041) | (0.041) |
| Regional patenting activity | 0.012 | 0.015 | 0.011 | 0.012 |
| | (0.013) | (0.014) | (0.015) | (0.015) |
| STEM graduates | 0.445*** | 0.453*** | 0.432** | 0.425** |
| | (0.165) | (0.160) | (0.177) | (0.182) |
| R&D Expenditure | -2.705 | -3.847 | -3.642 | -3.743 |
| | (4.175) | (4.271) | (4.436) | (4.497) |
| Constant | 2.991 | 3.733 | 2.345 | 2.709 |
| | (4.221) | (4.779) | (4.374) | (4.154) |
| Observations | 210 | 210 | 210 | 210 |
| Pseudo $R^2$ | 0.059 | 0.072 | 0.081 | 0.089 |

**Table 8. Splitting Universities with small vs large TTOs.** This table shows the results of negative binomial panel regressions on the number of spin-offs created per year, splitting the sample between universities with small vs large TTOs. Models 1 to 3 report the results for the sample of Universities with TTOs with a number of components smaller or equal to the median value (4), respectively on the total number of spin-offs, on Hi-tech spin-offs only, and on Service spin-offs only. Models 4 to 6 report the results for the sample of Universities with TTOs with a number of components larger than the median value (4), respectively on the total number of spin-offs, on Hi-tech spin-offs only, and on Service spin-offs only. Controls for the geographic area (North, Central, South) are included in all regressions). ***, **, and * indicate significance at the 1, 5, and 10 percent levels, respectively.

| | Small TTOs | | | Large TTOs | | |
|---|---|---|---|---|---|---|
| | (1) All spin-offs | (2) Technology spin-offs | (3) Technology Service | (4) All spin-offs | (5) Technology spin-offs | (6) Technology Service |
| Academic opportunities | -0.443 | -0.380 | -1.499 | -0.815 | -0.862* | -0.232 |
| | (0.379) | (0.381) | (0.953) | (0.497) | (0.499) | (0.954) |
| Administrative support | 1.291** | 1.313*** | -3.988* | -1.192 | -1.202 | -1.418 |
| | (0.504) | (0.497) | (2.325) | (2.324) | (2.327) | (0.928) |
| Administrative support (squared) | -0.326 | -0.320 | 0.475 | 0.787 | 0.787 | 0.447** |
| | (0.207) | (0.207) | (1.148) | (0.834) | (0.834) | (0.183) |
| University size | -0.056 | -0.042 | -0.558 | -0.645 | -0.613 | -1.151 |
| | (0.280) | (0.289) | (2.009) | (0.456) | (0.456) | (2.246) |
| Faculty/Students Ratio | 2.981*** | 2.886** | 3.498 | -1.276 | -1.368 | 0.642 |
| | (1.115) | (1.133) | (4.079) | (1.775) | (1.799) | (7.219) |
| University patenting activity | 0.016 | 0.013 | 0.013 | 0.005 | 0.004 | 0.017 |
| | (0.026) | (0.026) | (0.049) | (0.011) | (0.011) | (0.032) |
| Regional patenting activity | 0.011*** | 0.012*** | 0.002 | 0.001 | 0.001 | -0.021* |
| | (0.004) | (0.004) | (0.012) | (0.003) | (0.003) | (0.013) |
| STEM graduates | 0.243*** | 0.228*** | 0.277** | 0.155*** | 0.153*** | 0.397*** |
| | (0.042) | (0.042) | (0.120) | (0.041) | (0.041) | (0.138) |
| R&D Expenditure | -1.654 | -1.598 | 0.343 | -0.786 | -0.820 | -2.750 |
| | (1.010) | (1.035) | (2.961) | (1.058) | (1.060) | (3.008) |
| Constant | -0.255 | -0.526 | 2.424 | 5.260 | 4.963 | 2.781 |
| | (3.363) | (3.468) | (8.627) | (4.748) | (4.757) | (6.156) |
| Observations | 480 | 480 | 270 | 330 | 330 | 195 |
| Pseudo $R^2$ | 0.150 | 0.140 | 0.088 | 0.103 | 0.101 | 0.115 |

**Figure 1.** This figure shows the effects of Administrative support on the propensity to Hi-tech Spin-offs vs Service Spin-offs creation



**Appendix. Correlation matrix.** This table shows the correlation matrix for the variables used in the empirical analysis. * indicates significance at 5 percent level.

| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Spin-offs | 1 | | | | | | | | | | |
| 2 | Technology | 0.926* | 1 | | | | | | | | | |
| 3 | Technology service | 0.460* | 0.476* | 1 | | | | | | | | |
| 4 | Academic opport. | -0.026 | -0.034 | -0.023 | 1 | | | | | | | |
| 5 | Administrative support | 0.052 | 0.057 | -0.018 | -0.009 | 1 | | | | | | |
| 6 | University size | 0.118* | 0.109* | 0.048 | -0.071* | -0.458* | 1 | | | | | |
| 7 | Professors/Students | -0.017 | -0.015 | -0.033 | -0.043 | 0.179* | -0.598* | 1 | | | | |
| 8 | University patenting | 0.227* | 0.184* | 0.101* | -0.090* | -0.112* | 0.353* | 0.007 | 1 | | | |
| 9 | TTO size | 0.071* | 0.083* | 0.056 | -0.053 | -0.056 | 0.085* | 0.092* | 0.220* | 1 | | |
| 10 | Regional patenting | 0.122* | 0.081* | 0.022 | 0.017 | -0.003 | -0.021 | 0.171* | 0.253* | 0.098* | 1 | |
| 11 | STEM graduates | 0.225* | 0.201* | 0.092* | -0.032 | 0.005 | -0.017 | 0.177* | 0.347* | 0.068 | 0.458* | 1 |
| 12 | R&D expenditure | 0.052 | 0.025 | -0.048 | -0.036 | -0.058 | 0.079* | 0.135* | 0.242* | 0.093* | 0.284* | 0.609* |