Academic spinoff as a value driver of intellectual capital. The case of University of Pisa.

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Abstract

Purpose – This paper discusses academic spinoffs as an expression of the value creation of university technology transfer investments. More recently, scholars have emphasised intellectual capital's (IC) importance, also for universities in obtaining competitive advantages and by creating value. Such spinoffs are key to regional development, as a primary aspect of universities' intellectual capital.

Design/methodology/approach – We tested our aim through a sample of the University of Pisa's spinoffs. We measured the value the university's third mission investment generates on the area by means of entrepreneurship through two different approaches. First, we defined a multiplier of the technology transfer investment (University Technology Transfer Multiplier) and then explored the intellectual capital components' contributions to the academic spinoffs' enterprise value.

Findings – The results show that the University of Pisa's technology transfer investments positively impact on the local community through the spinoff system, both in economic terms and in IC. In the long term, these investments can enrich scientific humus and entrepreneurial mindsets.

Research limitations/Practical implications – This is an exploratory study of the University of Pisa's impacts on the local economy. The results are limited to the context of Pisa and to technology transfer policy. Another limitation is the subjectivity of the enterprise value estimation. Our results can have some practical implications. The large portfolio of university stakeholders (policymakers, families, students, companies, financiers, etc.) ask for information, especially on long-term results: in a simple way the multiplier is able to communicate important feedbacks to support their decision-making process.

1. Introduction

According to scholars and policymakers, the university has a key role in the local economy and in society. Policymakers are increasingly looking to both innovation and technology transfer to fuel economic growth. Although they note that universities have two traditional functions, teaching and research, policymakers assert that these institutions have also assumed a third mission, steering towards entrepreneurship, by favouring the commercialisation of science (Slaughter and Leslie, 1997; Nowotny et al., 2003). Via knowledge development and transfer, universities are promoting an entrepreneurial mindset, stimulating new businesses, and creating new jobs. With these strategic aims, since the early 1980s, U.S. universities have increased their entrepreneurial activities along many dimensions, such as patenting and licensing, building science parks, promoting academic spinoffs, and by investing equity in startups (Mowery et al., 2004; Siegel, 2006). Over the past 30 years, even European academics that support the third mission and, particularly, technology transfer (TT) activities and social engagement, as well as the creation of enterprise value, are developing. In some early studies, some scholars have discussed the factors that could influence TT and its success (Cummings and Teng, 2003; Siegel et al., 2003). After a few years, the focus shifted to technology transfer activities, which planted the seeds of an entrepreneurial mindset among university researchers (O'Shea et al., 2005; Wright et al., 2007) that began by promoting academic spinoffs (ASOs) for economic and social enrichment (Chiesa and Piccaluga, 2000; Fontes, 2005; O'Shea et al., 2005). A real impetus to the lively debate in the literature on the third mission of the university was the EU green paper *European indicators and ranking methodology for university third mission* (2012), which defines universities' third mission and emphasises the importance of measuring and monitoring performance (Thursby and Kemp, 2002; Siegel et al., 2003; Chapple et al., 2005; Secundo et al., 2017).

Although there is no general definition of the third mission, its elements are continuing education, innovation promotion, TT, academic entrepreneurship, and social engagement towards local communities. Academic spinoffs are a key driver of TT activities. Despite the thriving body of literature on academic entrepreneurship, few studies have investigated the performance of academic spinoffs via fine-grained longitudinal panel data (Rothaermel et al., 2007).

The university must lose its research *ivory tower* by developing an *entrepreneurial university* model (Etzkowitz et al., 2000; Etzkowitz, 2003) with a socio-economic development function.

Thus, when we talk about TT from the university, the two research areas of entrepreneurship and intellectual capital (IC) are strongly interconnected; this goes beyond the university's traditional role as a knowledge factory (Youtie and Shapira, 2008; Aronowitz S., 2000).

However, scholars are debating the university's roles in local communities by measuring both their innovation promotion (Etzkowitz, 2003; Shane, 2004; Huggins and Johnston, 2009; Trequattrini et al., 2015) and their wealth creation (Trune and Goslin, 1998; Siegfried et al., 2007; Guerrero et al., 2015; Carlesi et al., 2017). There has only recently been a tendency to assess a university's performance in pursuing its third mission in terms of the creation of IC (Leitner et al., 2014; Secundo et al., 2017; Mariani, 2017).

As noted by Dumay and Guthrie (2012), in the public sector, IC is an intangible asset that is able to create value and wealth, such as social welfare, progress, and other intangibles. While IC has been explored mainly in the private sector, there is a gap in studies of IC creation in universities (Kong and Prior, 2008). Some early studies dealt with IC in universities in terms of management practices (Hellström and Husted 2004; Ramirez, 2010; Secundo et al., 2016), measurement, and reporting (Fazlagic, 2005; Leitner, 2004). Nonetheless, IC's contributions to the value creation process in universities have remained widely unaddressed (Guthrie and Dumay, 2015; Secundo et al., 2017).

This debate is so centred on the importance of university entrepreneurship to IC development, and the effects of both entrepreneurship and IC on local development. However, according to Borin and

Donato (2015), IC research is now in its fourth stage – the analysis has widened to the extra-organisational level.

This exploratory study aims to highlight academic spinoffs' main contributions to the surrounding area as a value driver of the third stream. We pursued this purpose through a case study at the University of Pisa; our analysis considers the university's value creation process and shows how it can be assessed via IC underpinned by TT activities. To assess university spinoffs' impacts on local economies, after a literature framework, we analysed two elements.

First, we considered academic spinoffs' contributions to the local economy in terms of traditional economic parameters (sales, job creation, and new R&D investments), from 2010, the year the University of Pisa set up its TTO, which marked the beginning of its development program, to 2014, the latest year for which the relevant data are available. Following, we have defined the University Technology Transfer Multiplier (UTTM) to synthesise the total effects on the local economy with only a number. Thus, we captured therefore the university's innovation investment's overall effects in terms of value creation of ASOs as an expression of IC. Through a statistical analysis, we then explored IC components and their contributions to the spinoffs' enterprise value. The purpose of this last analysis is to show how much of the IC is recognised in ASOs enterprise value and so, on the multiplier. We close with the conclusions, in which we also discuss implications and avenues for future research.

2. Background and research questions

2.1 The university's third mission and value creation

In some reports of 1997, the European Commission already highlighted the importance of fruitful cooperation between universities and industries for Europe's economic growth and job-creation (ESTA, 1997). This first document acknowledges the importance of the university in economic development and the need to restructure and reorganise the existing university system by designing a new entrepreneurial university.

Thus, some academics drew attention to the emergence of the third mission in an entrepreneurial university (Etzkowitz, 1983). Later, Etzkowitz (2000) explored the entrepreneurial models of Stanford University and the Massachusetts Institute of Technology, focusing on the identification, creation, and commercialisation of intellectual property as concrete examples of the third mission. In universities, teaching and research were re-interpreted. While traditional teaching is designed to support companies' modernisation, research began to investigate economic development via various TT activity types. In a knowledge-based system, the university – as a knowledge factory and disseminating organisation – plays a strategical role in industrial innovation.

Now, the university has become implicitly charged with the key task of fostering innovation and technological transformation – with all of the many social implications that technology had led to over the years. European universities are developing a radical shift in governance, exposing the competitive dynamics and decision logic typical of private companies. This process is the development of the third mission in the principles of accountability and the unifying elements that characterise the modern configuration of the university. It discovers and enhances its relationship with social partners, primarily companies, facing challenging business objectives that for centuries had been considered incompatible with the public nature of produced knowledge.

Universities' third mission covers all the activities through which they contribute to innovation and social change. Several contributions in the literature have identified the third mission activities (Geiger, 2006; Rothaermel et al., 2007; Geiger and Sá, 2009; Laredo, 2007; Hsu et al., 2015). The green paper Fostering and measuring third mission in higher educational institution (2012) identifies a third mission for universities as activities relating to research (TT and innovation, etc.), to education (lifelong learning/continuing education, training, etc.), and to social engagement – a variety of activities that involve many constituent parts of universities. The third mission is designed to encourage the direct application and use of knowledge to contribute to the social, cultural, and economic development of the society.

In this direction, the university has four activities to realise TT and innovation:

1. Formation of an entrepreneurial culture for students and researchers.
2. The protection of intellectual property and the commercial exploitation of patents.
3. Support for academic spinoffs.
4. Collaborations with companies via agreements and projects.

In pointing to this new mission, scholars and policymakers began to refer to an entrepreneurial university model (Etzkowitz, 2003; European Union, 2012). One key effect is the ability to convert knowledge that has been created via research into business ideas by creating industry-university collaborations or spinoffs (Etzkowitz, 2001; Etzkowitz and Klofsten, 2005). Universities are becoming charged with socio-economic development, with benefits for the local area (Huggins and Johnston, 2009; Trequattrini et al., 2015).

Numerous studies have investigated the external factors that influence the success of university entrepreneurship, such as the social context, laws and policies, and local determinants (Mowery et al., 2001; Henrekson and Rosenberg, 2001; Etzkowitz, 2003; Friedman and Silberman, 2003; Jacob et al., 2003; Gulbrandsen and Smeby, 2005). Other scholars have studied the factors that affect TT activities' efficiency (Bercovitz et al., 2001; Feldman et al., 2002; Markman et al., 2005).

Of more interest are the university's impacts on local innovation (Gibb et al., 2006; Wright et al., 2007) and how TT contributes to socio-economic development, especially via startups or spinoffs (Mowery et al., 2001). In the UK, as elsewhere in Europe, the growth of ASOs has steadily increased in response to pressure in the commercialisation of the science base or develop knowledge-based services for larger firms that subcontract R&D activities such as experimental testing.

Most studies of the third mission have explored the performance measures of university entrepreneurship, such as the new company creation rate and their economic results (Chiesa and

Piccaluga, 2000; Di Gregorio and Shane, 2003; Clarysee et al., 2005; Leitch and Harrison, 2005; Link and Scott, 2005; O'Shea et al., 2005). Other research has progressively made clearer other aspects relating to the creation, growth, and weaknesses of spinoffs, such as financial literacy gaps, and the lack of skills on the part of the founders and team members (Clarysse et al., 2005; Carlesi et al., 2017), scarcity of resources, and managerial cultural problems (Rappert et al., 1999).

As for private companies value creation is a business' foundation, for public investment, the need to estimate the impacts a public investment could produce is now well established. Contributions in the value creation a public project or activity produces on regional development have its early roots in studies by Kahn and Keynes.

Since the 1980s, the constant reduction of public funding has made it necessary to verify the achievement of social and economic policies and greater transparency and accountability, also in the public sector. Universities' contributions to economic development and their social engagement, referred to as third mission activities, have become politically relevant (Rasmussen and Borch, 2010). Specifically, the attention is on evaluating universities' contributions to the economic development and social engagement, referred to as TT activities (Siegfried et al., 2007; Rasmussen and Borch, 2010). Given this lively debate, our first research question is:

RQ1: How do we measure the university's technology transfer model's impacts on a local community?

2.2 Intellectual capital in universities' third mission

It has become common knowledge that IC represents a key source for competitive advantage for any enterprises (Quinn et al., 1996; Bartlet and Ghoshal, 2002; Jardon and Martos, 2012).

Several studies have pointed out IC's impacts concerning enterprise value, and not only on profitability. Other scholars have empirically assessed these impacts, along the MERITUM (measuring intangibles to understand and improve management) guidelines (2001) for managing and reporting on intangibles (Lengnick-Hall et al., 2004; Pulic, 2004; Marr et al., 2004; Chen et al., 2005;

Tseng and Goo, 2005; Chen, 2008; Diez et al., 2010; and Kong and Prior, 2008, for not-for-profit ventures). While IC in the private sector has been widely explored, it was only in the last decade that scholars begin to study IC in public and non-profit organisations, with a special focus on higher education and research institutes (Mouritsen et al., 2004; Kong, 2007; Kong and Prior, 2008, Secundo et al., 2017). In recent years in particular, some scholars have discussed IC's importance as the value driver of universities' third mission (Secundo et al., 2017). However, IC's studies on the value creation process in the public sector have remained widely under-researched (Guthrie and Dumay, 2015; Secundo et al., 2017).

While Stewart defines IC as "the intellectual material – knowledge, information, intellectual property, experience – that can be put to use to create wealth" (Stewart, 1997), for Dumay and Guthrie (2012) as well as Secundo et al. (2017), in the public sector, IC is an asset for value creation and wealth, such as social welfare, progress, and other intangibles. Other studies have defined IC components also in terms of social contributions (Petty and Guthrie, 2000; Boedker et al., 2008; Ricceri, 2008; Dumay, 2014; Ferenhof et al., 2015).

The most common breakdown of IC identifies three components: *human capital*, *structural (organisational) capital*, *and relational (or social) capital* (Nahapiet and Ghoshal, 1998; Guthrie et al., 2006; Boedker et al., 2008). Concerning IC in universities, *human capital* refers to people (e.g. researchers, professors, technical staff, administrative staff, and students) and their skills (e.g. expertise, knowledge, and experience). *Structural* or organisational capital comprises databases, intellectual property, research projects, routines, and all the intangible resources that exist in an organisation. *Relational* or social capital refers to the system of relationships between public and private partners that enable them to create value (Secundo et al., 2017).

IC studies have defined four stages of evolution (Petty and Guthrie, 2000; Guthrie et al., 2012). Stage 1 focuses on the increasing awareness and understanding of IC and how it contributes to the creation of sustainable competitive advantages in private organisations (Petty and Guthrie, 2000). Stage 2 focuses on the strategic management of IC, and on the methods used to measure its contribution to value creation (Sveiby, 2010). Guthrie et al. (2012) introduced a third stage, in which the focus is on studying how organisations understand and apply IC as a management technology. More recent studies have focused on bridging the knowledge created inside and outside an organisation (Borin and Donato, 2015). In this last stage, the analysis of IC has extended outside the organisation to the local, regional, or national level. In this direction, universities interpret their third mission as promoting types of social innovation and entrepreneurship that contribute to the local economy.

In line with stage 4 of research on IC, we analyse the link between the knowledge produced inside the organisation (university) and the knowledge it transmits outside via academic spinoffs. Especially, we explore whether, among human capital, structural capital, and relational capital, it is possible to locate connectivity (Vagnoni and Oppi, 2015) as a fourth dimension (Secundo et al., 2017), or if the components play different musical scores in the value creation process. Given this discussion, our second research question is:

RQ2: How do the components of intellectual capital contribute to the enterprise value of universities' spinoffs?

3. Methodology and data

According to Goldstein and Drucker (2006), the university may be the biggest driver of economic progress, especially in small regions far from large metropolitan areas. Thus, there is an interest in measuring the amount of wealth a university can produce on an area by calculating the socio-economic impacts "that especially the activities of the third mission can produce" (Broad et al., 2007; Gunasekara, 2004).

As depicted in Figure I, the main assumption is that, through technology transfer and innovation investments, (in terms of the establishment of an entrepreneurial culture for students and researchers and by supporting spinoffs), universities start new academic businesses. Thus, ASOs become a university's operating arm in the local economy by realising economic benefits and creating IC. In turn, these benefits, stimulate a scientific atmosphere that feeds this loop and leads to new innovative ideas, research, and businesses.

– INSERT FIGURE I –

Hypothesis 1 is informed by this keen interest of academics and policymakers in evaluating these benefits in terms of socio-economic impacts. To answer research question 1, we first studied the University of Pisa system, so the ASOs on which our study revolves around.

In addition to companies' financial statements and business plans, we gathered the data for this study also through a questionnaire (Annex I) that was structured to gain quantitative and qualitative information to measure ASOs' enterprise value, especially because these kinds of companies usually present their balances sheet in summary form. The interviews were essential to also the IC components, for research question two.

We organised our methodology in three steps. First, to obtain the information needed for our analysis, we submitted a semi-structured questionnaire to the CEOs of the University of Pisa's spinoffs. Then we collected theses ASOs' financial statements and calculated enterprise value for each sample ASO.

Finally, we introduced a multiplier (University Technology Transfer Multiplier-UTTM) to measure the impact of the university's TT investments and ASOs' R&D expenditure on academic spinoff enterprise values, which we used as a proxy for the value created by the university for its local economy. To find the relationships between IC elements and enterprise value, we performed a non-parametric statistical test.

Regarding step 1, we tested a preliminary draft of the questionnaire with two entrepreneurs, to realise the final version (Annex I). The questionnaire had two sections. In Section 1, we asked for general information about the company in order to get a general profile (e.g. age, number of employees, industry, number of shareholders, and R&D expenses). In Section 2, we sought to map ASOs' IC components. The main information obtained on these firms' IC shows the number of patents and awards, the number of research projects, the place in which they made physical investments, the number of partnerships and/or the participation in associations, the presence of managerially skilled staff in the firms, etc. We completed the questionnaires in face-to-face meetings with entrepreneurs (average duration: 45 minutes). This step occurred during the first three months of the study.

The University of Pisa's spinoff population was 30 units in 2014. To assess enterprise value, we selected only those that presented at least one balance sheet and a three-year business plan. Thus, we had to exclude nine ASOs; the final sample consisted of 21 companies whose characteristics are representative of the population, although they differed regarding age, industry, and activity types (Table I). To preserve anonymity, we omitted the spinoffs' names.

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Also, as Table II underlines, the sample is fully representative of the University of Pisa's ASO system.

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With the aim of contextualising the spinoffs, Table III also compares the spinoffs and some features of Pisa's local economy.

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The most salient characteristics of the sample firms are: they are among the most innovative firms in Pisa; their relative importance in terms of R&D among other (university) departments; and their human resources have a strong academic background (Table III). Among these firms, 70% were micro-enterprises with fewer than four employees and with a lower percentage of tangible assets; half had revenues of less than €100,000 per year. Another relevant feature is that the ASOs are entirely composed and managed by scientists who are actively involved but are not always on the firm's payroll. The employees and administrators have scientific backgrounds; only in few cases did they have some entrepreneurial training while employed, such as MBA or other managerial training. These employees are key figures in their company: they deal with both scientific research and company management.

As anticipated above, in answer to our first question, we had to evaluate the University of Pisa's contributions to economic development and social engagement, referred to TT activities. We adopted a micro-approach to analyse the entrepreneurial performance of the University of Pisa's ASOs and the benefits generated for the local area. This is consistent with the social engagement of universities' third mission in the local environment, especially via TT policies. To measure the impact of the University of Pisa's TT investment in the local community area, we applied economic impact studies, with a multiplier analysis well known in literature (Caffrey and Isaacs, 1971; Selgas, 1973; Salley et al., 1976; Salley, 1978; Elliott and Meisel, 1987; Elliott et al., 1988; Siegfried et al., 2007). Many economic impact studies conducted by colleges and universities apply a regional multiplier to all expenditures by an institution. The economic meaning of universities' multiplier role is evident. According to Siegfried et al. (2007), *local economic impact* is obtained by adding up the college community's expenditures (students, faculty, staff, and visitors) generated by a university's presence and by applying a multiplier model to account for the interdependence of economic activity in a regional economy under a demand-side perspective (Segarra I Blasco, 2003).

Since our perspective is on effects on knowledge, to evaluate third mission activities' impacts, we adopted an index that shows the effects a university's investments in innovation produce in terms of enterprise value, University Technology Transfer Multiplier (UTTM), which shows the University of Pisa's value creation as a result of its investments in TT and expenditures in R&D activities promoted by ASOs. The formula is as follows:

$$(1)\ University\ Technology\ Transfer\ Multiplier\ (UTTM)\ = \frac{ASOs'\ enterprise\ value}{TTI + ASOs'\ R\&D\ expenditures}$$

The denominator is composed of University of Pisa TT investments (TTI) and R&D activity expenditures: investments in innovation. TTI considers the cost of the research enhancement unit (REU) and the expenses for patenting between 2010 and 2014. R&D expenditure represents the sample ASOs' research activities between 2010 and 2014, which are often carried out in the university structure with university employees.

In the numerator, we used ASOs' enterprise value as expression of the effect created by innovation investments (equation 2):

$$(2)\ ASOs'\ enterprise\ value = \sum_{x\,=\,A}^{U} \frac{EVMM_x + EVWM_x}{2}$$

Where:

A - U = ASOs in the sample

$EVMM_x$ = mathematical mean of the four methodologies estimated for company X (equation 3).

$EVWM_x$ = weighted average of the four methodologies estimated for company X (equation 4).

Since the business evaluation seeks to capture every value driver, it is necessary to integrate several methodologies. Normally, practitioners adopt at least two methodologies. To consider a spinoff's entire value, and these new businesses are operating in an industry with high uncertainty, we adopted four methodologies that address all value drivers: discounted cash flow (DCF), the income method[1] from an accounting perspective, the multiples method, and the venture capital approach to get

[1] Income method is the most commonly used method in Italy, and is based on discounting the net operating profit minus the adjustment for taxes (NOPLAT).

companies' market value. The venture capital approach is one of the most recommended evaluation methods for startups (Damodaran, 2007, 2011).

The DFC method is the main means to assess enterprise value; it works well with company cash flows. According to Damodaran (2007), DCF reduces expressiveness for young small firms, because they have no information about existing assets cash flows, expected growth, discount rates, and the assessment of when the firm will reach equilibrium (to estimate terminal value). To address these valuation challenges, we selected only companies with the available financial information needed to develop the DCF technique at a good reliability level. While the income method works well when assessing a company's ability to generate income, the drawback is that it is not suitable for firms whose operating earnings are negative (Damodaran, 2009); however, we did not have a company with operating earnings in the minus sign. Finally, the multiplier method and the venture capital approach focus on a company's market value. With the four values, it is possible to know the value for both the market and for investors or venture capitalists.

We tested our data using the above four methods and ended up with four values for each spinoff in the sample. We used these four values to obtain two averages: the mathematical mean (EVMM) and the weighted mean (EVWM), which have come to represent a maximum and a minimum value for each firm. EVWM enjoys strong acceptance among Italian accounting practitioners; as an index it is made up of 35% DCF, 35% income method, 15% multiples method, and 15% venture capital approach (as shown in the following formulas).

$$(3)\ EVMM = \frac{EV_{DCF} + EV_{INCOME} + EV_{MULTIPLIER} + EV_{VC\ METHOD}}{4}$$

$$(4)\ EVWM = EV_{DCF} \times (0{,}35) + EV_{INCOME} \times (0{,}35) + EV_{MULTIPLIER} \times (0{,}15) + EV_{VC\ METHOD} \times (0{,}15)$$

We took all the data required for the calculation of the cost of capital (to use the discount flows) from the open database of Damodaran's website[2]. Following the practice of business evaluation, we adjusted the data to take into account the firms' specific characteristics. By using the four abovementioned methodologies, we were able to assess the firms' more tangible assets (cash flow, income, etc.), and their intangible ones (industry performance, R&D investments, number of patents, etc.). The spinoffs' enterprise value can be seen an indicator of the value created by the institutions (university) in both tangible and intangible terms.

In our study, we construed it as follows: for every euro of TT and innovation investments, the University of Pisa generates €X in additional ASO enterprise value. The effect in terms of job creation adds value to this impact (Figure III).

In particular, as noted, since ASOs are an effect of TT activities, they can be considered as an intangible asset of the university, the impacts in terms of IC produced by third stream investments. In fact, ASOs' enterprise value (EV) represents the synthesis of the effects of all investments held within the company that express the value of the ASO researcher-entrepreneurs (human capital), the research projects, patents, etc. (structural capital), the international research networks, venture capital relationships, and reputation (relational capital). In turn, IC value growth feeds the scientific atmosphere. Some authors have recently highlighted that the research must study how IC helps to create value for a university's local economy rather than focus on the single components' performance (Secundo et al., 2017).

To determine IC's influence on enterprise value in spinoffs, we performed two statistical analyses (RQ2). The first is a correlation matrix between variables and EV (Table V); the second is a means analysis via the non-parametric Wilcoxon rank sum test. To choose a good statistical test, consistent

[2] http://pages.stern.nyu.edu/~adamodar/

with the purpose of the analysis, we first performed a Shapiro-Wilk test; the results showed that the normality of the sample was not verified and, this led to the use of a non-parametric test.

We performed the above statistical analysis using the software GRETL with two variable types: economic variables and IC parameters. The economic variables were return on assets (ROA), number of employees (EN), and financial independence ratio (FIR); the IC variables were research and development expenses (R&D), completed research projects (RPW), number of patents (NP), conference participation (CP), and number of participations in business associations (AP).

In our analysis, R&D investment volume is one of the proxies used to assess the spinoffs' impacts. Also, according to Secundo et al., (2017), we used other variables, such as the number of publications, participation in business associations, and the number of research projects. These variables also provide a measure of the spinoffs' contributions (and indirectly, that of the university's third mission policies) to the locally generated scientific knowledge, new ideas, and new scientific proposals for industry. Finally, we compared the different techniques' results.

4. Findings

In relation to RQ1, the study purpose was to assess the impact of the University of Pisa's investment in innovation, between 2010 and 2014, via the ASOs. First, we highlighted that ASOs bring local economic benefits in terms of traditional economic parameters, such as the growth of sales in the local area, which reached €7.485.019 over the period. The R&D investments amounted to about €1.8 million (Figure II). In 2014, ASOs gave work to 101 employees, with 57 new high-tech jobs created over the last four years (Figure III). The number of newly established companies grew from 9 to 21 over the period. Overall, the University of Pisa's ASOs constitute a medium-sized company by helping to develop a scientific environment.

– INSERT FIGURE II –

– INSERT FIGURE III –

We can highlight that the revenues and the R&D expenses increased not only in aggregate terms (owing to the increase in the number of spinoffs) but also in terms of company value. This last datum shows the spinoffs' growth during the period. As shown in Figure I, the value created and the IC growth are among the local benefits of university spinoffs.

The UMMT value of 2.74 expresses a synthesis of the multiplier effect of the investments in innovation and in ASOs' R&D on value creation (Table IV).

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With the multiplier effect, it is possible to appreciate that €1 invested in innovation and ASOs' R&D activities generated about 3 euros on the local community, in terms of spinoffs' enterprise value, which, as anticipated above, include both tangible and intangible drivers of value.

Some studies have highlighted a regional multiplier with a magnitude around 2, essentially in a demand-side perspective, with more variables (Elliott, 1988; Siegfried et al., 2007; Yserte and Rivera, 2010).

Regarding the intangible elements of IC performance, we found that the University of Pisa's ASOs developed 23 research projects and 26 awards. These results are from both the university's innovation processes and its investments in R&D (Figure IV). All these elements are strongly connected to the entrepreneurial team's academic backgrounds and add value to the UMMT.

– INSERT FIGURE IV –

To highlight the contributions of the IC elements of spinoffs (e.g. intangible drivers) on enterprise value, and to answer to RQ2, we used a statistical approach. The correlation matrix (Table V) shows that the number of employees and the R&D investment levels (which are typical IC elements) are strongly correlated to the enterprise value.

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An interesting aspect that emerged from the correlation matrix and that was confirmed by the statistical test performed (Table VI) is the negative weak correlation between number of patents and enterprise value (Wilcoxon test p-value = 0.078). One possible explanation is that the University of Pisa's ASOs, which focus on R&D activities, neglect the commercial aspects of their inventions. The latter is also confirmed by several studies that have shown a lack of financial and managerial culture in R&D-oriented spinoffs (Colombo et al., 2008; Carlesi et al., 2017). In contrast, this test highlighted meaningful relationships between some IC variables (R&D investments and number of employees) and enterprise value.

[INSERT TABLE VI] – Results from the means analysis

Since these results could be weak owing to the small sample size, we also compared the means. From this last analysis, it emerged that the ASOs with a higher R&D investment level also have an enterprise value that is significantly higher than the other firms in the sample (Table VI). Table VI shows the results of the means difference analysis, using a non-parametric test (Wilcoxon rank sum test).

From our analysis, it is possible to observe that the R&D investments, patents, and number of employees correlated with enterprise value, which thus can also be used as a proxy for IC creation. Moreover, although a statistical significance does not emerge, it is still possible to appreciate the positive contribution of participation in associations (AP) and in new research projects (RPW) on ASOs' EV (Table VI). Another aspect that deserves to be deepened is the negative relationship between conference participation (CP) and EV. A possible explanation is that the largest number of conferences are only scientific and academic, without effects in economic terms and on EV in a short time. However, this network could lead to new knowledge by contributing to the university's social engagement. According to the third stream, spinoffs' activities generate economic benefits, social benefits, and IC creation. This all contributes to the creation of new ideas and the development of a scientific atmosphere.

5. Discussion and conclusion

Secundo et al. (2015) note that the management, measurement, and reporting of IC in the university present still larger challenges to explore. This study sought to propose a way to measure the value created by investment in TTs in terms of both economic benefits and IC creation.

To measure the value created by TT activities, we implemented a multiplier, relating investment volume in innovation and in ASOs' R&S and the spinoff's enterprise value. UTTM could be a proxy of the investment output and expression of IC creation.

Notably, the denominator of our multiplier does not include all the university investments that take place in relation to the third mission, only those in TT. The same applies to the numerator, which does not consider all of the third mission's possible output, only those that can be expressed by the value of the spinoffs that accrue to the specific relevant factors (i.e. innovation, value creation, and jobs created, etc. as a result of investments in TT). In line with academic literature (Trune and Goslin, 1998; Siegfried et al., 2007; Huggins and Johnston, 2009; Yserte and Rivera, 2010: Trequattrini et al., 2015; Carlesi et al., 2017), this study also found a positive impact of the entrepreneurial university on the local area.

The result of a multiplier of 2.74, which has been achieved through careful study, presents a key aspect of a topic that calls for further development. In the EV estimation used here, we have sought to capture all the possible intangible value drivers of the University of Pisa's spinoffs, especially owing to their characteristics as R&D-oriented firms. Intangible value is undoubtedly these companies' main asset.

We compensated for the difficulty in estimating a direct evaluation of the intangible components of these unlisted companies, with budgets in summary form, a brief company history, and a poor managerial culture, by trying to determine the extracted value from IC. The assumption that IC could play a key role in EV, especially in these types of businesses, is also confirmed in the statistical analysis, which detects a strong correlation between R&D investments and EV, demonstrating some ability to transform research into a business.

The empirical analysis also drew attention to the fact that there is still another side to the entrepreneurial mindset coin, because our spinoffs are still struggling to industrialise patents with a strong relevance from an academic perspective but that are remaining under-utilised from a business perspective. A negative correlation emerges between number of patents and EV, in contrast with what has been stated in previous works on large listed firms (Griliches, 1981; Hirschey et al., 2001; Bloom and Van Reenen, 2002). New and micro companies are still unable to turn research into value. Furthermore, they do not realise the strategical role of an informative symmetry for enterprise market value. Even with all the necessary described cautions, particularly the UTTM results seem to confirm scholars and policymakers' strong interest on universities' third mission. Investments in the third mission can create value and wealth, especially owing to universities' ability to fertilise a scientific atmosphere by capitalising on IC.

We have presented several implications for research and practice. From an academic perspective, this study contributes to the literature on IC in universities by showing empirical evidence of the effects that IC has for the local economy. However, the study conclusions are limited to the Pisa local economy, but could also be further investigated in other contexts.

Also the use of ASOs' EV as a proxy of the value created from IC represents an innovative element in literature that opens the debate on measuring IC in higher education institutions following the corporate logic of value creation.

The practical implications are primarily for policymakers who seek to know and communicate their policies' results. The approach through multipliers allows one to synthesise all TT policies' effectiveness, in a single number. This last point is one of the EU's primary goals on the topic, as indicated in the green paper (2012).

Another practical implication of this study is directed at universities since they are subject to stringent spending constraints and are not used to thinking in terms of value creation in the economic sense of the term. Via IC creation, a university can capitalise on its investments and can aggregate knowledge. IC becomes a key driver on which universities and businesses meet. Stimulating a university to think in terms of value creation allows it to give tangible form to IC, which is a strategical intangible asset. By adopting the business logic of value creation in the economic sense, a university begins to speak the language of businesses, reinterpreting the concept of scientific research.

The historical interest in measuring a university's economic impact on its surrounding regions is driven by the need to guide strategic management of third stream activities and policymaker investment decisions. The large university stakeholder portfolio (legislator, families, students, companies, financiers, visitors, etc.) ask for information, especially on long-term results: they want to know the capability of their funds (public and private funds) to create value. In a time when universities can no longer assume that they will be funded, entrepreneurship and new ways to engage are required at every level to bring in the necessary resources (financial, collaborations, access to facilities, etc.) from different sources. This study highlights a difficulty by ASOs to commercialise their research. This underscores low managerial skills on the part of ASO managers who, as highlighted above, are the same scientists who created the company. A key goal for universities and policymakers could be to encourage management training in academic enterprises and the commercialisation of scientific research with the aim of creating value. This would align universities and industry better; since the ability to create value is key information for any investor, this also would increase industry support for universities, reducing their dependence on public funding. From an academic point view, our findings could contribute to an active discussion on the IC's role in the creation value process in the universities.

6. Limitations

This is an exploratory study of the University of Pisa's contributions to the local community. Thus, the results cannot be generalised but are limited to the context of Pisa. The considerations that emerged in this research have uncovered more in-depth insights that this research group is now investigating. First, we created a benchmark to compare our results with other universities; second, our search may be refined by developing models that enable us to estimate EV and to capture the intangible elements of this value, including IC. A limitation of this research is the small sample size, which has its limits from a statistical perspective, even though it represents 70% of the population. Another limitation is in the subjectivity of the EV estimation which, even if it represents the spinoffs' value, is still the result of an assessment of which assumptions depend on the appraiser. Further, in relation to IC creation, we neglected some variables in literature and considered others that have been unexplored.

It would also be useful to extend this analysis to include other elements of IC, to attempt a direct evaluation. This would provide a more complete picture of these factors' impacts on spinoffs' enterprise value and therefore on the multiplier.

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Tables and figures

Figure I: Value creation of technology transfer investments

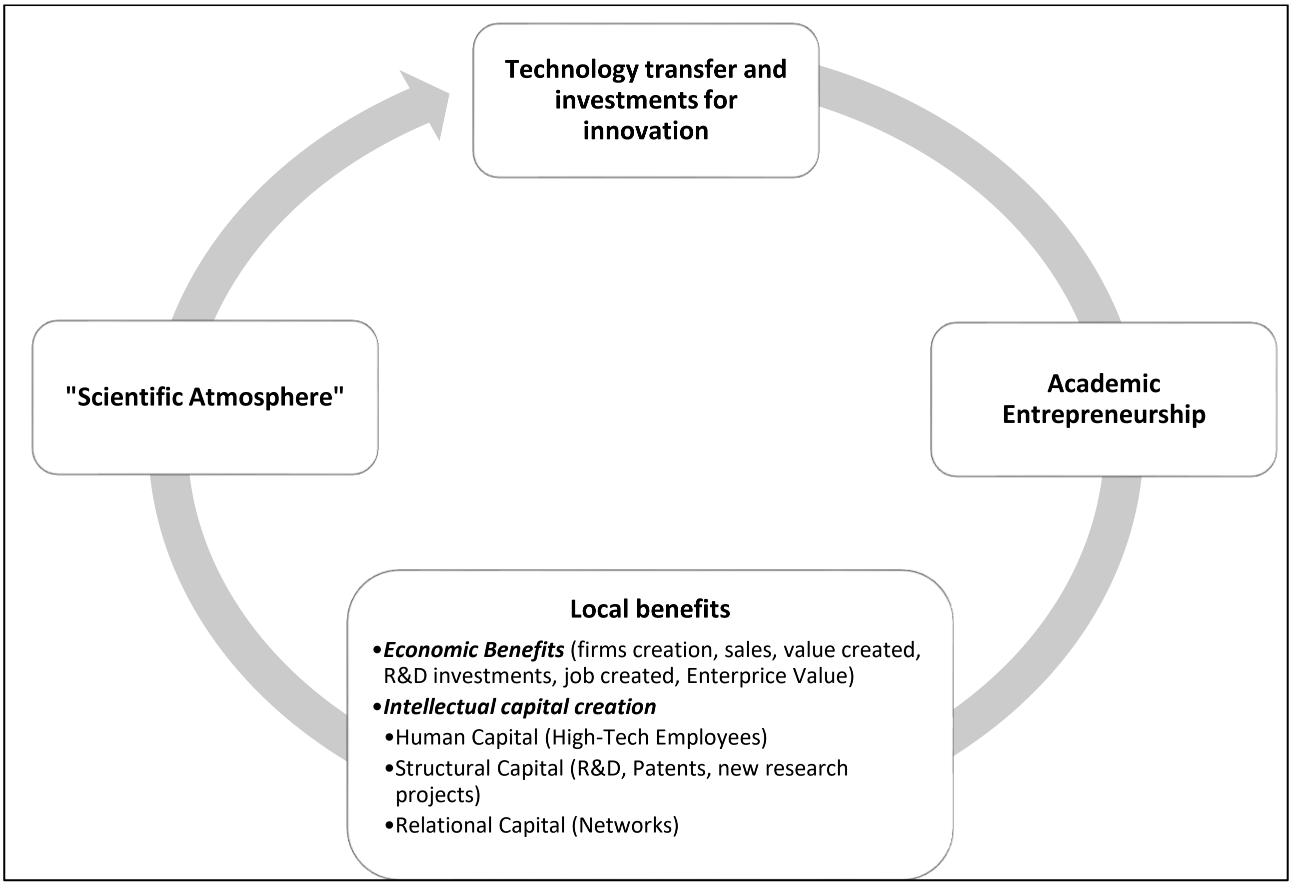

Table I: Descriptive data of the sample

ID	Year of birth	Industry	No. of owners	Sales (2014)	No. of employees
A	2007	Engineering	6	392,446	5
B	2008	Engineering	2	476,459	10
C	2013	Life	7	28,150	0
D	2010	Life	7	36,365	0
E	2012	Life	6	27,930	1
F	2014	ICT	7	37,750	1
G	2014	Life	2	7,867	0
H	2013	ICT	2	0	0
I	2011	ICT	21	400,171	3
J	2011	Engineering	3	100,738	1
K	2003	Advanced instruments	7	103,544	7
L	2006	ICT	8	736,647	7
M	2011	New materials	6	106,740	1
N	2012	Life	2	43,000	0
O	2011	Advanced instruments	6	102,508	n.d.
P	2011	Engineering	8	83,896	0
Q	2009	Engineering	3	16,639	1
R	2011	Advanced instruments	11	576,918	11
S	2009	New materials	10	143,678	1
T	1997	Advanced instruments	10	3,965,353	50
U	2009	Energy & environment	6	200,728	2

(source: own elaboration on questionnaire data)

Table II: Profile of the sample in comparison with population of University of Pisa ASOs

	POPULATION	SAMPLE	% OF POPULATION
A) INDUSTRY			
Engineering	5	5	100.0
Life	6	5	83.3
New materials	2	2	100.0
Advanced instruments	6	4	66.7
Energy & environment	2	1	50.0
ICT	7	4	57.1
Innovation services	1	0	0.0
TOTAL	**30**	**21**	**70%**
B) SALES REVENUE			
Less than €100,000	14	9	64.3
€100,000 to €300,000	8	6	75.0
€300,000 to €500,000	4	3	75.0
€500,000 and above	4	3	75.0
TOTAL	**30**	**21**	**70%**
C) NUMBER OF EMPLOYEES			
< 4	20	15	75.0
4 to 8	5	3	60.0
8 to 11	2	2	100.0
12 and above	3	1	33.3
TOTAL	**30**	**21**	**70%**

(source: our elaboration of questionnaire data)

Table III: Comparison between the sample and Pisa's local economy

	Years				
	2010	*2011*	*2012*	*2013*	*2014*
Number of high-tech firms in Pisa	201	240	201	232	241
Number of spinoffs in the sample	9	15	17	19	21
Percent of ASOs on total high-tech firms in Pisa	4.48%	6.25%	8.46%	8.19%	8.71%
Number of employees in high-tech firms in Pisa	2,586	4,469	3,780	4,655	5,301
Number of employees in the spinoffs in the sample	44	56	72	81	101
Percent of employees in the spinoffs on total high-tech firms' employees	1.70%	1.25%	1.90%	1.74%	1.91%

(source: own elaboration)

Figure II: Total sales and R&D expenses of the sample firms

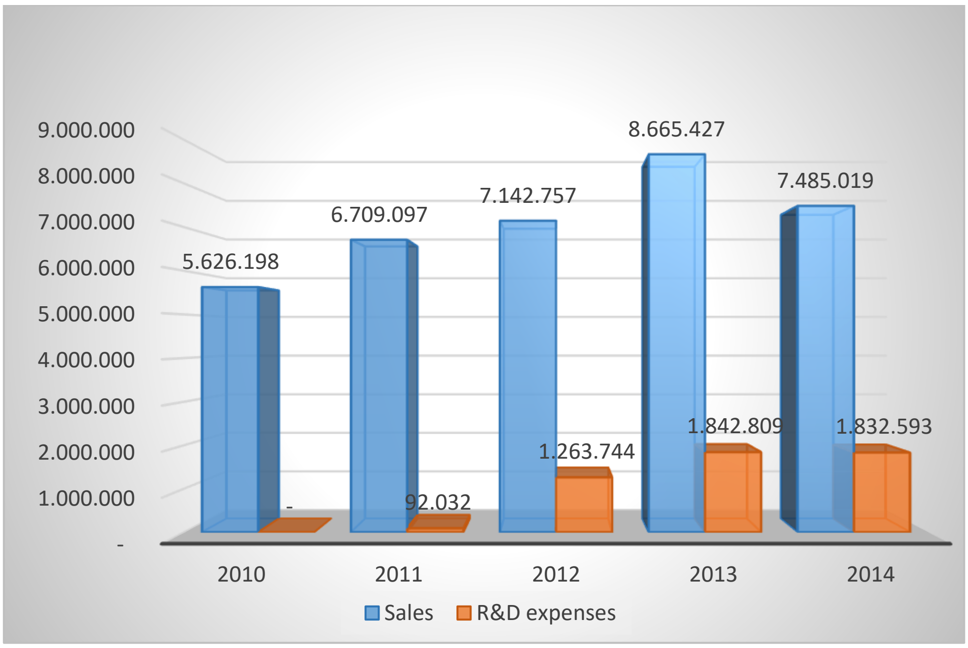

Figure III: Total and average employees of the spinoffs in the sample

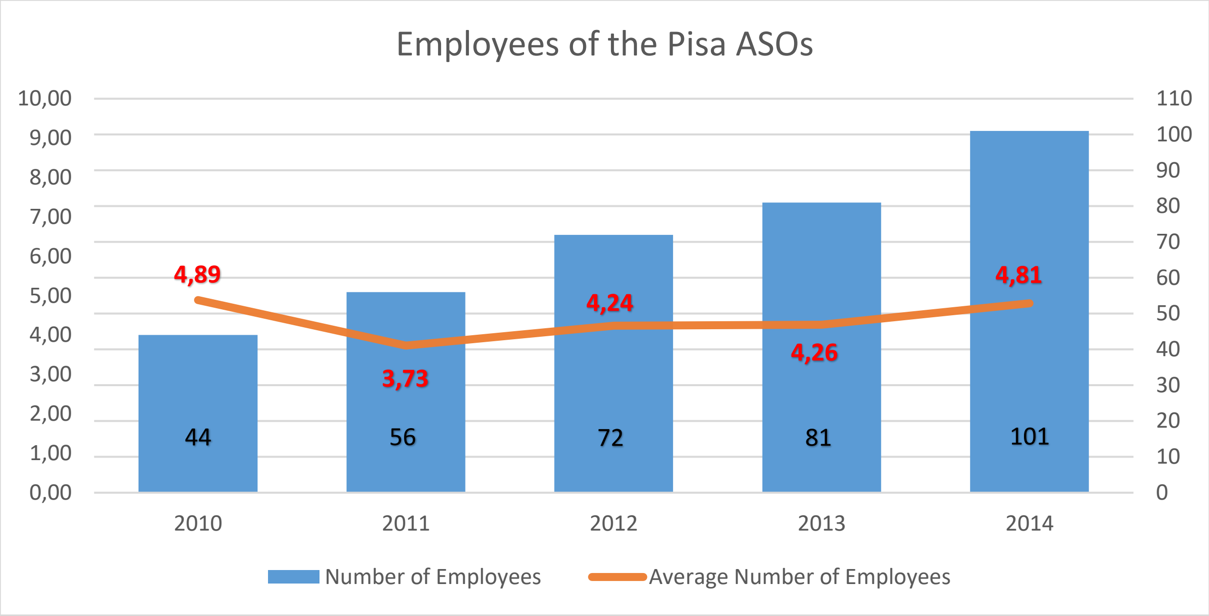

Figure IV: IC performance of the spinoffs in the sample

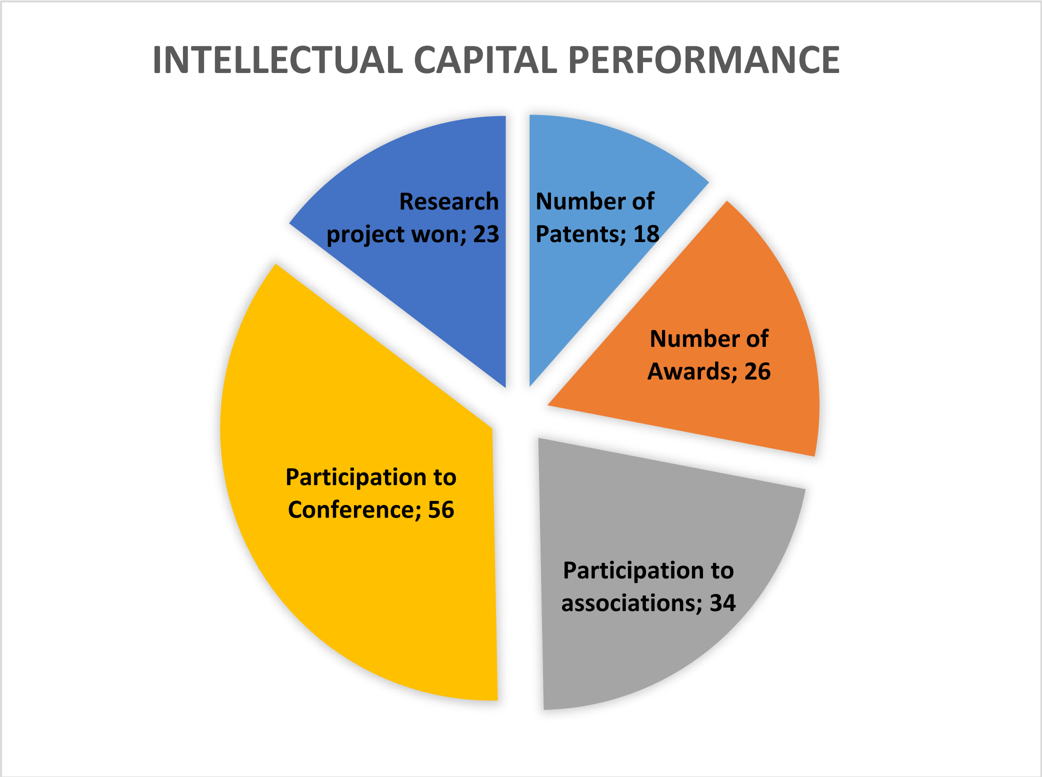

Table IV: Multiplier elements

Variable	Description	Value
ASOs enterprise value (EV)	Sum of the averages EV for each spinoff in the sample	€18,856,493
Invested capital in TT (TTI)	Sum of the capital invested by University since 2010 to 2014 in TTs. It includes the cost of the research enhancement unit (REU) and the capital invested for patenting	€1,840,000
Spinoffs R&D Expenditures (R&D)	Sum of the R&D expenditures made by ASOs between 2010 and 2014	€5,031,178
Multiplier	Represents the effect of €1 invested in TT generates in terms of EV [EV/(TTI+R&D)]	2.74

Table V: Correlation matrix

EV	R&D	RPW	PN	CP	AP	ROA	EN	FIR	
1.0000	**0.9362****	0.2389	-0.2720	-0.2851	0.0413	0.1740	**0.8737****	0.0330	EV
	1.0000	0.2076	-0.3814	-0.3200	-0.1229	0.1314	0.8450	0.0894	R&D
		1.0000	0.0063	0.0064	0.4063	0.1644	0.0241	0.0320	RPW
			1.0000	0.6438	0.1531	-0.0196	-0.2752	-0.2335	PN
				1.0000	0.1066	-0.1016	-0.3004	-0.2356	CP
					1.0000	0.3091	-0.2127	0.1920	AP
						1.0000	-0.0583	0.3708	ROA
							1.0000	0.0813	EN
								1.0000	FIR

Notes: Correlation coefficients, using observations 1 to 21 (missing values were omitted); critical value at 5% (for the two tails) = 0.4329 for n = 21.

Table VI: Results from the means analysis (dependent variable: enterprise value)

T-test between the means (dependent variable: enterprise value)

ENTERPRISE VALUE						
IC		Under the mean	Over the mean	Difference between the means	Wilcoxon rank sum test	Statistical significance
	R&D **	**329,002**	**1,656,500**	**1,327,498**	**0.001**	***
	RPW	868,806	1,021,700	152,894	0.356	
	PN	**1,278,550**	**479,246**	**-799,304**	**0.078**	*
	CP	1,076,070	660,406	-415,664	0.102	
	AP	842,172	972,270	130,098	1.000	
	EN *	**479,933**	**1,942,920**	**1,462 ,987**	**0.043**	**
ENTERPRISE VALUE						
ECONOMIC VARIABLE		Under the mean	Over the mean	Difference between the means	Wilcoxon rank sum test	Statistical Significance
	ROA	1,023,650	847,639	-176,011	0.136	
	FIR	641,463	1,131,080	489,617	0.672	

Questionnaire 1

Interviewee Date

Interviewer

General information about the company

1. Kind of business

____

____

2. Year of birth ___________________

3. ATECO code ___________________

4. Shareholders:

Name and surname	Percentage of shares (%)	Role within company	Education

5. Corporate changes from the year of constitution

   - ☐ Yes
   - ☐ No

6. If yes, complete the following table:

Year	Type of change

7. Information about the company

Year	Sales	R&S expenses	No. of employees	Employees gross salary	Employees net salary	Country	No. of employees in R&S	R&S employees' gross salary

ANNEX II

Questionnaire 2

Interviewee Date

Interviewer

Detailed information about companies

1. In the past two years, your research unit has committed (indicate the change compared to the previous year):

	Unit	Variation	Salary	Variation	Country	Collaboration type
Professor						
Researcher						
PhD						
Research fellows						
Technical staff						
Foreign staff						
Other staff						

2. Did you complete research project during the period 2010 to 2014?

- ☐ Yes
- ☐ No

3. Describe it:

Project type	Role in the project	Organisation	Year	Country	Obtained loan for the project	Achieved results

4. With the research projects completed, did you have the opportunity to buy tools?

	For research	For the trials	For teaching	For other uses
€1,000 or under	☐	☐	☐	☐
€1,001 to €3,000	☐	☐	☐	☐
€3,001 to €5,000	☐	☐	☐	☐
€5,001 to €7,000	☐	☐	☐	☐
€7,001 to €10,000	☐	☐	☐	☐
> €10,000	☐	☐	☐	☐

5. The above purchases were made using suppliers located in the region (indicate the city)
   Yes ☐ No ☐ City ____

6. If yes, for what percentage of the total amount? _______________

7. Partnerships with other organisations:

Organisation	Country	Year	Collaboration type	Results obtained	Profit (€)

8. Patents and awards

Award	Patent	Year of filing of the patent	Patent's book value

9. Are you developing new projects?

Period	Project type	In collaboration with	Country	Aim	Project value	Project result(s)

10. Have you done:

1 New products Yes ☐ No ☐

2 Scientific publications Yes ☐ No ☐

3 Other (describe) ____

11. If you have not realised new patents, this is due to:

1 Lack of innovations subjected to patent

2 Technical difficulties

3 Bureaucratic difficulties

4 Other (specify) ____

12. Have you funded:

Kind	Period	Collaboration type	Department	Aim	Finance (amount)
Scholarships					
PhD scholarships					
Research grants					
Contracts					
Instrumentation					
Training					
Other (specify)					

13. Have you done staff training?

Yes ☐ No ☐

If yes, what kind? ☐ Managerial training ☐ Technical training ☐ Language training

14. The company participates in associations?

Yes ☐ No ☐

If yes, specify the number of associations in which the company participates: ______________________

15. Paper presentation and participation in conferences over the past two years:

Year	Conference type	Country	Effects on the company

16. In the company, are there persons with managerial skills?

Yes ☐ No ☐

If yes, describe:

Role	Education type	Experience (years)	Salary