

How to evaluate the impact of academic spin-offs on the regional context

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The paper proposes a model to evaluate the impact of academic spin-offs at local level. Spin-off creation is the most complex way of commercialising academic research, compared to patenting and R&D collaborations, but with the highest potential impact on the local context. We develop a framework that take into account the direct and indirect impacts of spin-offs. In the empirical part of the paper we apply this framework to a sample of Italian spin-offs and to the ones set-up in the Marche region (Italy). The empirical analysis shows that, when measured in quantitative terms, the impact of spin-offs on local economies is rather low; however, there are qualitative direct and indirect effects that must be taken into consideration in the short and in the longer term.

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1. Introduction

The commercialisation of scientific and technological knowledge produced within publicly funded research institutions (PRI) such as universities, laboratories and research centres is increasingly considered by policy makers to be one of the key elements for developing and sustaining regional economic growth. Governments throughout the world agree that universities should be more entrepreneurial and should contribute directly to economic development through business activities such as the formation of spin-off companies, and the patenting and licensing of technology (O'Shea et al., 2005; Martinelli et al., 2008). This paper focuses on one of the most promising ways of transferring research results to the market place: the creation of academic spin-offs. Over the last decade there has been an increasing interest toward academic entrepreneurship, i.e. a direct involvement of academic scientists in the development and commercialisation of their research. Some researchers argue that the direct involvement of academic scientists in commercial activities can solve some of the problems in the knowledge transfer process, and motivates researchers to undertake projects with greater economic and social relevance (Etzkowitz et al., 2000).

In Italy the phenomenon of university spin-offs has started to be relevant during the last decade as a result of regulatory changes that introduced the possibility for universities and research institutions to authorise, on a temporary basis, their staff to participate in business ventures for the exploitation of research results. Academic spin-off is a phenomenon with significant potential for Italy, most of all, in view of the need for the Italian economy to move from the so-called 'traditional' or 'low-tech' sectors to the 'high-tech' ones (OECD, 2005). According to the endogenous growth theory (Braunerhjelm et al., 2009), for which technological innovation is seen as the most important factor for achieving long-term economic growth, Italy needs to rapidly develop activities with a higher knowledge content. The Knowledge Spillover Theory of Entrepreneurship specifically emphasises the role of new firm creation in exploiting knowledge created by university research (Audretsch and Lehmann, 2005; Audretsch, 1995).

Moreover, proximity and agglomeration play an important role in R&D collaborations and knowledge exploitation, so that in assessing the role of universities in technology transfer, we have to consider the local context where the universities are located

(Boschma, 2005; Hewitt-Dundas, 2011). In this paper we focus on the impact of university spin-offs on local development.

After about ten years experience of spin-off promotion by universities and local institutions in Italy, there is a growing concern about the evaluation of the impact of spin-offs on universities' technology transfer and local economies (Carree et al., 2012).

The empirical studies of Italian spin-offs have focussed on analysing the factors that incentive academics to start a spin-off (Fini et al., 2008), the characteristics of spin-offs and their growth processes (Iacobucci et al., 2011), the role of the parent university in spin-off performance (Colombo et al., 2009), and the role of technology transfer offices (TTOs) in promoting spin-offs (Algieri et al., 2011). Less attention has been paid to assessing the impact of academic spin-offs on the local context.

As found in other European studies, the empirical evidence about Italy indicates that most academic spin-offs have experienced a very low growth and that only a few of them can be considered as 'gazelles'. Most university spin-off companies start small and remain small, reflecting their founders' aspirations, capabilities, and resource endowments. Leitch and Harrison (2010), based on a detailed analysis of university spin-offs in Northern Ireland, conclude that academic spin-offs are technology lifestyle businesses not dynamic high-growth potential start-ups. They suggest that the prominence given to spin-offs in the analysis of technology transfer and in discussions of the economic impacts of universities is misplaced. Moreover, there is a growing recognition that the overall significance of the now widely accepted technology transfer model is based on the peculiar experience of technology hotspots, such as the Silicon Valley and the Boston area (Nicolaou and Birley, 2003). Such US contexts, which European policymakers have sought to emulate, involve an atypical concentration of high-tech clusters that are generally absent in Europe. Similar experiences have also been studied in Europe (Lawton Smith and Ho, 2006); however, the spin-off phenomenon in the European context is likely to be different from that in more developed high-tech entrepreneurial environments such as the Boston area or the Silicon Valley, where the capability to select the best projects and allocate resources to them already exists. Moreover, also the overall US experience has often been exaggerated (Lester, 2005). There is a need to assess the effective role played by university spin-offs in advanced economies, starting from the premise that their impact changes significantly when we take into account the differences in local contexts.

The impact of spin-offs may depend on many factors:

- the importance that a university gives to its third mission, the culture of the university, its attitude toward spin-offs and the competence of the technology transfer offices (Lockett et al., 2003);
- the reputation and research eminence of individual universities and their response to political power wielded at international, national, and subnational levels (Di Gregorio and Shane, 2003);
- the sectors in which spin-offs are concentrated and their relation with the local environment.

We adopt a local perspective because proximity is critical to the transfer of knowledge. This is true in the case of university-firm relations, given the importance of face-to-face interactions (Hewitt-Dundas, 2011). It is even truer in the case of spin-offs, which are normally located very close to the parent institution (Rodriguez-Pose and Refolo, 2003; Audretsch and Lehmann, 2005). This is due to several reasons: a) the incubator role played by universities in the start-up phase (Algieri et al., 2011); b) the direct involvement of the academics employed in the university; c) the continuous collaboration between spin-offs and university departments.

Compared to other ways of transferring research results - licensing of intellectual property (patents) and universities-firms collaborations - a spin-off is characterised by the following: a) the start-up of a new company; b) the transfer to that company of specific technological knowledge developed in PRI; c) the involvement of staff from the research institute in the ownership and management of the new initiative (O'Shea et al., 2008).

The effective ability of spin-offs to have a significant impact on local systems depends on two aspects: a) the capacity for rapid growth of at least some of these initiatives, b) the generation of positive externalities in the local system.

If we consider the widespread consensus among scholars and policy makers about the positive role of spin-offs, it comes as a surprise that little empirical evidence assessing the contributions of academic venturing to technological change and local development has been made available so far.

The object of this paper is to cover this knowledge gap. It has two main aims:

- a) developing an analytical framework to evaluate the impact of academic spin-offs on university technology transfer and regional development;
- b) applying this framework to Italian spin-offs set-up during the last decade.

The empirical analysis is based on the population of spin-offs and on a sample of 279 spin-offs set-up between 2002 and 2007. For each spin-off, the balance sheet data and

information about ownership and governance have been examined. Publicly available information have been supplemented with a direct survey of spin-offs set-up in Università Politecnica delle Marche (UNIVPM), aiming at collecting qualitative information about the relations of spin-offs with their parent institution and with the local community.

The paper is organised as follows. Section 2 develops a framework for analysing the impact of academic spin-offs at local level and a set of indicators to measure such impact. Section 3 provides information on the data and methodology used in the empirical part of the paper. Section 4 reports the results of the application of the framework to the sample of national academic spin-offs and to the case of the UNIVPM spin-offs. Section 5 discusses the main findings of the analysis.

2. A model for evaluating the local impact of academic spin-offs

The commercialisation of university research can take place through various mechanisms, which can be grouped in three main areas: patenting and licensing, consulting and research collaborations with firms, and spin-offs. They are often addressed as separate, alternative transfer mechanisms; however, in practice commercialising university research may require a variable mix of all those instruments. The question of what instrument is best suited to transfer different pieces of knowledge has been the focus of many recent contributions. Klofsten and Jones-Evans (2000) in their comparison of academic entrepreneurship in Sweden and Ireland describe consultancy and contract work as ‘soft’ activities and spin-outs, licensing and patents as ‘hard’ activities.

The choice of the mechanism of technology transfer depends on several factors and generates different benefits. Figure 1 shows the financial benefits of spin-off activity and compares them with the other forms of technology transfer.

In terms of financial benefits, the most important way of commercialising university research is through contract research. Most of these benefits are directly appropriated by the academics involved in the research and consulting activity. However, a significant share is retained by the university to cover general expenses and to contribute to the

research infrastructure¹. If universities want to develop close links with industry to generate research income, they have to build areas of expertise that firms are interested in. This is a particular problem for mid-range universities that may have a mix of international, national and regional/local objectives. As a result, contract research will tend to be focussed on a small number of departments in each university (Wright et al., 2008).

In the case of patents issued as a result of publicly funded research, the financial benefits go to the university and to the inventors, depending on who is the owner of the patent². In recent years there has been a significant improvement in IP management by Italian universities (NetVal, 2009). However, several studies demonstrate that, even in universities that manage a large portfolio of patents, the revenues from fees hardly cover the expenses.

From the university point of view, spin-offs are not likely to be a major source of income, as compared with licensing or contract research. However, they are the most important in terms of economic impact on the local economy (see Figure 2). This is for two reasons: on the one hand spin-offs have a larger range of potential beneficiaries than just the university and academics; on the other hand, besides the financial benefits, spin-offs have several non-financial benefits, most of which at the local level.

To evaluate the effective role of academic spin-offs, we chose to adopt a local approach due to the fact that there are several differences in local innovation systems and these may depend on the relevance of the three main actors of the triple helix model, university, industry and government. The dimensions of the context are not well-understood and incorporated in the entrepreneurship literature (Wright, 2012). Moreover, we think that the characteristics of local systems should be considered also when evaluating the impact of academic spin-offs.

¹ The share is variable according to university regulations. On average, the cumulative share of university and departmental fees is about 20% of external contracts, 60% goes in remuneration of the people involved and 20% in research costs. Of the 20% appropriated by the university 5% are taxes. An even higher percentage of taxes are raised on academic remuneration (20% or higher depending on the overall personal income).

² Italy has recently adopted the so-called 'professor privilege' for university patents. It means that it is a choice of the academic whether to be the owner of the patent (leaving a share to the university) or to allow the university to patent (and retain a share of its ownership). Depending on the regulations issued by each university, if the patent is owned by the university, the latter gets 70% of revenue and the inventor (academic) 30%; the percentages are reversed if the patent is owned by the academic.

Spin-off creation is the most complex way of commercialising academic research in terms of process, people involved, risks, etc. It is expensive and resource consuming for universities but with little or no prospective financial returns; however, it has the highest impact on the local context, because of:

- possible direct transfer of new knowledge into commercially viable products and services;
- economic benefits for the local community;
- potential knowledge spillovers to other firms in the region.

The literature has already identified a wide range of economic benefits of spin-offs:

1. they generate high-tech entrepreneurship (Etzkowitz and Leydesdorff, 2000),
2. they build new networks to access finance and to develop sales and marketing (Lindholm Dahlstrand, 1999),
3. they retain close linkages with their 'parent' institution, through incubators, technology transfer offices, recruitment of young researchers and research collaborations (Heydebreck et al., 2000),
4. they are sources of technological spillover, and can promote and shape the emergence of regional technology clusters (Di Gregorio & Shane, 2003) (Lawton Smith and Ho, 2006),
5. they stimulate business support services and infrastructure, benefiting other start-ups (Lockett et al., 2003).

Figure 3 defines a set of indicators that can be used to evaluate the quantitative and qualitative impact of the above mentioned benefits.

The first 3 indicators allow to have a measure of the direct impact of academic spin-offs at local level:

- The number of employees and promoters, combined with information on the sectors of activity measures the capability of spin-offs to create hi-tech employment and entrepreneurship (the first and the second indicator).
- The number of grants and contracts with the parent university measures the ability of the spin-off to act as a useful link between research and markets. This is especially true for spin-offs that perform R&D activity for industrial and service companies and that act as technology transfer agencies between the university and the market. This is especially beneficial for small firms that can have problems in directly accessing university facilities.

The indirect effects of academic spin-offs at local level can be measured by:

- The capability of spin-offs to create global networks for finance, technology and market is of specific value at local level; once established, these networks can be beneficial also for other firms in the local context. The ability to create international networks could be evaluated through the number of international collaborations in R&D, the ownership structure of the spin-off and its geographical market.
- Labour mobility is one of the main ways in which knowledge spillovers are propagated at local level. The importance of this mechanism can be evaluated by looking at the turnover of promoters and managers and following their career choices after exiting from the spin-off.
- The number of incubators, start up competitions and entrepreneurship courses that are developed at local level (often by the same university) can be considered not only as factors promoting spin-offs, but also as a side-effect of spin-off activity at local level. These activities typically involve more people than just those involved in spin-off creation. They help setting a favourable environment for entrepreneurship and start-up, which is beneficial for the local community as a whole.

In the empirical analysis we try to measure the direct impact of academic spin-offs using the first 3 indicators.

3. Data and methodology

To apply the framework developed in the previous section we use two sources of data. The first data are taken from a database of Italian spin-off companies developed within the Centre for Entrepreneurship and Innovation of UNIVPM³.

According to common definitions of academic spin-offs, three types of companies are included in such a category: 1) companies founded by university teachers, researchers or other staff-members; 2) companies founded by students and graduates in order to commercially exploit the results of the research in which they might have been involved in at the university; 3) companies founded by outsiders that exploit the results of

³ The database is accessible on line at <http://spinoff.dii.univpm.it>

university research. In this paper, by academic spin-offs we mean the first two categories: as a result, spin-offs are defined as "... companies which evolve from universities through commercialisation of intellectual property and transfer of technology developed within academic institutions" (Djokovic and Souitaris, 2008, p. 225).

The database contains information on all the spin-offs set-up by universities and other PRIs in Italy in the period 2000-2012. This database contains financial information (annual report), information about the ownership structure and sector of activity.

The second source of data is a direct survey conducted on the spin-offs of UNIVPM. The direct survey allowed us to collect quantitative and qualitative information which are not publicly available. The questionnaire has the aim of identifying some characteristics of spin-off activities. Questions address the following issues:

- type and number of collaborations with the parent university and other partners;
- characteristics of products and services offered by spin-offs;
- fundamental changes that had a positive impact on spin-offs growth;
- number and location of customers;
- entrepreneurial and organisational factors.

The questionnaire was sent to 23 spin-offs of UNIVPM, 10 of which answered.

On the basis of data collected we perform quantitative analysis on the Italian sample and qualitative analysis on UNIVPM spin-offs.

The choice of the period is because only since the early 2000s, following the adoption of a specific legislation, has the phenomenon of research spin-off become significant in Italy. In particular, a Parliamentary act of 1999 authorises universities and other public research institutions (PRI) to issue regulations that allow researchers and professors, as an exception to existing rules, to participate in the capital and management of newly established companies aimed at the industrial use of research. Following this legislation, in the early years of 2000s, universities developed specific regulations governing the involvement of their permanent (such as professors and researchers) and temporary (such as doctoral students, research grant holders, etc.) staff in spin-off companies.

The number of spin-offs calculated by various sources differs depending on the parameters used to define them. In this paper we consider the spin-offs that are officially

recognised by the parent institutions and that involve the presence of at least one academic as a promoter and owner-manager⁴.

From 2000 to 2012, 679 spin-offs were set-up in Italy. **Errore. L'origine riferimento non è stata trovata.** shows the trend during the period analysed.

The birthrate of spin-offs reached a first peak in 2007, suggesting a boom effect generated by the introduction of this model in the Italian system. In 2008 a slow down in the number of spin-offs can be observed, induced not only by the fact that the maturity stage was reached, but also by the financial crisis that hit the European economies starting from the autumn of 2008.

4. Empirical analysis

To analyse the phenomenon of academic spin-off formation in Italy we use the population of spin-offs set-up from 2000 to 2012. As observed in other countries, also in Italy spin-offs are not uniformly distributed between the different PRIs: the 5 most important universities have developed about 28% of the spin-offs. As a results, there is a strong concentration of spin-offs at regional level, with most initiatives being in the central and northern regions of the country (see **Errore. L'origine riferimento non è stata trovata.**).

The concentration of spin-offs by PRIs and by regions has diminished over time. The Herfindahl index calculated on PRIs fell from 0.12 at the beginning of 2000 to 0.05 in the last few years. The same index calculated on the distribution of spin-offs by regions declined from 0.15 at the beginning of the period to about 0.10 in the last few years. The decrease in the territorial concentration over the years is a positive signal reflecting the increasing awareness of Italian universities in technology transfer activities in general, and spin-off promotion in particular. However, it is also evident that without a critical mass of new ventures located in the same area and operating in similar or connected sectors, spin-offs are not able to significantly contribute to the development of new technology clusters. At the end of 2012 only three universities had more than 30 active spin-offs and 10 universities had more than 20. Overall, about 10% of spin-offs were closed down during the same period.

⁴ The last NetVal report (2012) shows that the Italian spin-offs are 990 up to now. The discrepancy depends on the different definition of spin-offs adopted in NetVal analysis, which includes firms set up before 2000 and start-ups set-up in university incubators.

The number of spin-offs by universities and regions is also critical for stimulating the development of business support services, such as incubators, start-up competitions, etc.

The main sectors of activity are ICT and innovation services (see **Errore. L'origine riferimento non è stata trovata.**). The sectoral composition of spin-offs does not necessarily reflect the research fields in which the university is stronger in terms of research and teaching, but those that are more active in technology transfer activity and in relations with industry. In fact, most of the spin-off companies originate within the engineering faculties.

To assess the quantitative impact of spin-offs we focus the attention on three aspects: the number of promoters and shareholders, the number of employees and the volume of sales. Given the nature of these enterprises, their success on the market is critically important for assessing their capacity to exploit research results.

Data on these issues refer to a sample of 279 spin-offs set-up between 2002 and 2007.

The process of spin-off formation provided for by Italian law and subsequently codified by university rules requires the involvement of at least one or more full time university staff, who are supposed to be involved in the management of the spin-off only in the incubation period, and one or more junior researchers, who are supposed to manage the spin-off after the incubation period. As a result, the ownership and management structure of a spin-off are quite peculiar, with a higher number of owners when compared with high-tech start-ups. The modal value of shareholders at start-up is 6 (see Figure 5).

The large entrepreneurial teams characterising Italian spin-offs are beneficial if we consider that people who had an entrepreneurial experience are more likely to start subsequent firms (so-called habitual entrepreneurs). If we consider the overall phenomenon of spin-offs, this means that during the last decade more than 3000 people from academia were actually involved in the start-up and development of a new venture. In the longer run this could constitute one of the more lasting impacts of spin-offs at local level. Not only do spin-offs have a large number of owners but also with similar shares in the new venture. The average share per owner is about 15% and in about one fourth of spin-off companies there is a majority shareholder (see Table 3).

The ownership share of the PRI is rather small and is aimed mainly at legitimising the spin-off and providing market credibility rather than sustaining it in financial terms. On the contrary firms normally participate with larger shares to support the initial investment and are directly interested in the management of the spin-off. In about one third of spin-offs shareholders are only people; in the remaining cases shares are owned by the PRI or

firms. It is remarkable that in about 50% of cases there is a firm in the ownership of the spin-off which testifies the role of firms as technology transfer link between the PRI and industry.

Although beneficial as a source of potential technology entrepreneurs, the large and complex entrepreneurial teams observed in spin-offs could be a problem because of the difficulties in identifying people who are really interested in playing the entrepreneurial role within the spin-off (Iacobucci et al., 2011).

The average sales observed in the sample of spin-offs in 2010 were about 200 thousands Euros. As expected the distribution of sales is highly skewed, with the modal interval between 0-100,000 Euros and just a few cases exceeding 1 million Euros of sales. In analysing this result it is worthwhile remembering that the spin-offs considered in the analysis had already been set-up for at least three years.

The same analysis is conducted using the data available on personnel costs in 2010.

In this case, the distribution of sales is highly skewed, with the modal interval between 0-10,000 Euros. We sum the total expenditure for personnel costs and divide by 30 thousands Euros, that is more or less the average salary for a full time employee. The value obtained (about 540 full time employees) is underestimated because some of the people working for spin-offs have collaboration contracts; in the Italian annual report the costs of these contracts are not included in the item "personnel costs" but are considered within the item "services" considered. Several spin-offs maintain a cautious approach in structuring the organisation and avoid hiring full-time employees.

Adopting the same set of indicators for UNIVPM spin-offs, the analysis shows that after three years of activity, i.e. after the 'incubation' period, the best performers of our sample show a significant growth of sales. In 2001 there was only one spin-off generating 65000 Euros of sales. In 2010 the 19 spin-offs of UNIVPM for which balance sheet data are available had total sales of more than 5 million Euros.

The best performers of UNIVPM spin-offs showed a continuous process of growth with the exception of EcoTechSystem and BINT, which operate in the service sectors and were greatly affected by the economic crisis of the last years (see Figure 8).

Concerning the ability to create jobs, the data show how the spin-offs postponed some choices related to the organisation of the company (in terms of human resources), sometimes even in the presence of a revenue which would have been sufficient to justify

them: around 30% of our sample has no personnel costs. Making the same estimation of how many people are employed in spin-offs and adding the total expenditure for personnel costs and dividing by 30 thousands Euros, the value obtained is about 34 full time employees.

Considering the ownership structure, almost all the research spin-offs have the legal status of limited liability companies, with a few exceptions of corporations and cooperative companies. The use of the legal status of a limited liability company is associated with a relatively limited initial endowment of capital, generally close to the minimum required for limited companies. Three years after set-up, the average stock capital continues to be relatively low. The ownership structure of the spin-off is, in most cases, made up mainly of individual partners. These are supported by PRI shares, companies, finance companies and other institutions.

The data show a clear difference between the financial commitment of the university and the other two types of investors. The university is present in 50% of the spin-offs with an average share of about 10% and a share value of around 5,000 Euros. The university generally enters into the capital of the spin-offs at the time of their set-up with a minority share; the main purpose behind this presence is, in fact, to provide credibility to the new initiative rather than to provide equity capital. In contrast, in the case of industrial companies, their entry is motivated by the aim of contributing to exploiting the technology developed by the spin-off. This leads to a greater entry selectivity and a greater financial commitment (see **Errore. L'origine riferimento non è stata trovata.**).

Analysing the team of promoters, this is made up of several partners, 5 on average. Of these, 1 or 2 are faculty members, while the others are researchers or former students. The role of faculty members is that of promoting the spin-off and providing professional advice during the incubation stage. According to the present rules, faculty member are supposed to recede from managing roles within spin-offs after the incubation, but can retain their ownership share. Even in this case, it is important to underline the fact that a large number of young people are involved in an entrepreneurial experience and it is relevant in the long run, given that these people have a higher propensity to start other companies during their lifetime.

Besides the quantitative impact, the framework developed in section 2 suggests that the phenomenon of spin-offs could have positive qualitative impacts in several directions; moreover, these impacts are not easily measured in the short term. Spin-offs can be important drivers of local economic development because they generate hi-tech

entrepreneurship. It is likely that most of them will remain within the same area and start new firms in the same technological fields. They are companies in high-tech sectors, so they can contribute to the development of knowledge based activities that could improve the quality of the regional innovation system: they should help transforming local economies also by promoting the emergence of local technology clusters. Furthermore, these young technology entrepreneurs represent a connection for other firms to access the know-how and skills within universities, encouraging the expansion of local networks where new technologies and knowledge can be shared. Following the “network paradigm” to analyse a territorial-system (Mosey and Wright, 2007), a primary network is between innovative firms and local sources of scientific knowledge as universities. This relationship contributes to building up the technological environment to support the innovative competences of innovative firms. Academic spin-offs represent a significant example of network between research centres and small firms.

Using the information collected through the questionnaire, we could examine the characteristics of spin-offs activities into more depth. Concerning the relationship with the university, the collaborations are split in consulting services, joint research projects, fellowships and PhD grants. Table 5 shows the financial relationship between spin-offs and UNIVPM concerning the consulting services and the fellowships.

The total amount of joint research projects is 1,456 thousands Euros (298 of this amount concerns research project with universities different from UNIVPM).

The relationships with other institutions are essentially R&D projects, while 20% of them are for market development. Of the collaborations established, 40% are with partners within the Marche region, while only 11% are with foreign partners.

At the beginning of their activity, no spin-offs had a product or service available for sales, 3 spin-offs had a prototype and none had a patent. At the moment of the interviews, there were 9 prototypes and 14 commercialised products or services. This means that most spin-offs start up at a very early stage of technology development and use the incubation phase to develop a prototype and a business concept. Moreover, a few spin-offs rely on the development of a property right strategy based on patenting; only one of the most successful spin-offs owns 8 patents (see Table 6 **Errore. L'origine riferimento non è stata trovata.**).

Spin-offs were asked to indicate which were the most important changes that helped fostering their development. Table 7 shows the frequency of reply (multiple choices were

possible). The most important factors are the collaborations with industrial partners and with the parent university. This confirms the networking role of UNIVPM spin-offs between the industrial companies (mostly located within the Marche region) and the university.

Concerning the entrepreneurial and organisational factors, the analysis confirms the results of previous empirical studies (Iacobucci et al., 2011). There is an imbalance in the team sponsors towards technical functions; only in one of the spin-offs interviewed there was a founding partners with previous marketing and sales experience. In two cases, one of the spin-off promoters had already set-up another company (see **Errore. L'origine riferimento non è stata trovata.**).

The identification of a lead entrepreneur is a critical factor for the development prospect of spin-offs. According to respondents, 4 spin-offs had identified the entrepreneurial figure from the beginning and 3 of them after the incubation period (3 years). In 3 spin-offs there is still a lack of clarity about the people who are genuinely interested in the entrepreneurial career. As a consequence of the growth process there has been a significant increase in the number of part-time and full time employees and in the structuring of functional roles: at the time of interviews 8 people were employed part time and 13 full time.

5. Conclusions

Academic spin-offs are one of the TT mechanisms from university to industry. This process, started in some US universities and many European countries, especially those in northern Europe, has followed the trend observed in the U.S., albeit with some lag. Especially in Italian universities have traditionally operated in an environment where high-tech entrepreneurship is relatively new or undeveloped. The spin-off process in such contexts is likely to be very different from that observed in more developed high-tech entrepreneurial environments such as the Boston area or Silicon Valley.

The approach used in this paper reaffirms the localised nature of knowledge transfer. If knowledge spillover tends to occur only within limited geographic areas, embedding economic activity based on this knowledge within the local context, universities can become important focal points for local economic developments. In this paper we developed a framework for evaluating the impact of academic spin-offs that emphasise their role in the local context.

The empirical section is based on an analysis of the population of academic spin-offs set-up in Italian PRIs during the last decade and of the spin-offs set-up in UNIVPM (the Marche region) during the same period. The Marche region is specifically interesting for our purpose as it is a highly industrialised area but specialised in the so-called traditional sectors, characterised by a low level of R&D investment and a lack of systematic relations with research centres. The period chosen is justified by the fact that the phenomenon of university spin-offs in Italy started in 2000 following a specific legislation of 1999.

In this period (2000-2012) 679 spin-offs were created by over fifty universities, which are more than half of the universities in Italy.

The number of spin-offs created can be considered relevant, and many universities developed specific services to stimulate the creation of spin-offs and support their initial development. From the point of view of the university, up to now spin-offs have not generated significant revenues, because the main beneficiaries (in financial terms) are former students and researchers who promoted the spin-offs. As shown in the empirical section, when the university owns shares in a spin-off (50% of spin-offs), these shares are very small and taken with the aim of providing credibility to the spin-off rather than obtaining significant capital gains.

Overall, the economic impact of spin-offs in terms of sales and employees is rather limited. As usual in the case of innovative start-ups only a few of them attain significant growth; in our sample only about 3% of spin-offs exceeded 1 million Euros of sales after the incubation period.

It is worthwhile underlining that the entrepreneurial teams of spin-offs are rather large: 5 people on average. This means that in the period considered more than 3,000 people from academia were involved in a start-up experience. In our opinion this could be the major long lasting effect of spin-offs, given that people with an entrepreneurial experience have a much higher propensity to start up new companies. This effect seems to be rather important given to the fact that the last GEM (Global Entrepreneurship Monitor) global report (D. J. Kelley, Bosma, & Amorós, 2011) Italy shows the lowest rate of total early stage entrepreneurial activities, especially in new start-ups in high-tech sectors.

The Italian case also shows some peculiarities: a high rate of survival; a high percentage of spin-offs that remain active though with a very low sales; the lack of cases of striking success (gazelles).

The first two peculiarities may be explained by the high share of spin-offs operating in consulting activities. In fact, these activities are rather problematic for the growth prospects of the spin-offs themselves, since consulting activities are fundamentally linked to the skills of the people involved and, for that reason, their potential growth is strongly conditioned by the availability of time of these people.

The prevalence of spin-offs operating in business service activities and R&D is one of the main issues debated in relation to the phenomenon of spin-offs. Some PRIs have also placed more stringent constraints on the activities conducted by their spin-offs and tend not to authorise the set-up of consulting spin-offs. However, it must also be taken into consideration that these consulting spin-offs may play a relevant role in the local system as *trait d'union* between universities and local firms. One of the problems of university-industry interaction in Italy is the cognitive distance between universities and firms, which may hinder the frequency of interactions and their effectiveness (Muscio and Pozzali, 2012). Academic spin-offs have lower cognitive distance with university research and show a deeper absorptive capacity than the existing firms in local context. At the same time, they are more able to collaborate with local firms.

The low percentage of 'gazelles' spin-offs may be the result of the above mentioned business model, which is not oriented towards attaining high-growth. At the same time it can be explained by the weakness of local 'ecosystems' in supporting high tech start-ups. Only in a few northern regions there is a significant presence of business incubators, venture capital firms and other business services specifically oriented towards high-tech firms. The role of the universities is necessarily limited to promoting spin-offs and sustaining their initial incubation. The subsequent growth of successful spin-offs depends on the possibility to find adequate support in the external eco-system. Only recently (December 2012) the Italian government issued a comprehensive law to sustain innovative start-ups, containing regulations referring to the different stages of new venture formation and growth (incubators, venture capital, etc.).⁵

When considering the impact of spin-offs in promoting the development of high-tech clusters at local level, it must be noted that only in a limited number of universities they reached a critical mass (only in 5 universities there were more than 30 active spin-offs at the end of 2012). Moreover, the empirical evidence seems to show that up to now a bottom-up approach has prevailed in the set-up of spin-offs with a little role of

⁵ A synthesis of this legislation is available at:
http://www.mise.gov.it/images/stories/documenti/Exective_summary_ENG_FINAL.pdf

universities and local government in orienting the sectoral patterns of spin-off formation and growth.

The empirical evidence about UNIVPM (the Marche region) spin-offs confirms that in quantitative terms the impact on the regional context is not so relevant. In 2010 there were about 30 active spin-offs with cumulative sales of about 5 million Euros. However, we think that in assessing the impact at local level it is also important to focus on qualitative aspects.

The main finding of empirical analysis is the relevant role of UNIVPM spin-offs as intermediaries between university and industry: these new technology firms represent a link between the know-how and skills owned by research centres and firms located in the region. As observed for the Italian population, the majority of UNIVPM spin-offs is in the sector of business services (consulting and R&D services). In this sense, there is a scant propensity to invest in intellectual property rights and the development of new products, while the networking activities with the parent university and other firms are particularly intense. Service activities also require less start-up capital and have a more immediate marketability of the skills acquired in academic research (Iacobucci et al., 2011). As a result, these firms facilitate the involvement of young researchers and are a vehicle of knowledge spillovers in the local context by providing advanced services to established firms. In the case of the Marche Region this is an important aspect due to the fact that the region is characterised by a strong industrial structure in low and medium tech sectors, thus the need for an upgrading of products and processes.

Further studies of spin-off impact should emphasise the qualitative and long term effects of spin-offs and concentrate the analysis at local level.

The capacity to create or enhance technology clusters is specifically relevant for the local impact of spin-offs activity. The main policy implication for universities and local government is to move from a bottom up approach that simply facilitates spin-offs formation to a more selective approach to stimulate and support spin-offs in specific sectors. In the Marche region we observed a first attempt in this direction. The regional government provided financial support to university spin-offs belonging to those sectors (home automation, energy and smart manufacturing) that have been chosen by the regional government to promote technology clusters in the region.

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Table 1 – Spin-offs by regions

| | Active | Closed | Total | % closed | Spin-off / population (million) |
|-----------------------|---------------|---------------|--------------|---------------------|--|
| Tuscany | 85 | 12 | 97 | 12.4 | 25.9 |
| Emilia-Romagna | 77 | 4 | 81 | 4.9 | 18.3 |
| Lombardy | 66 | 14 | 80 | 17.5 | 8.1 |
| Veneto | 45 | 9 | 54 | 16.7 | 10.9 |
| Apulia | 48 | 4 | 52 | 7.7 | 12.7 |
| The Marches | 43 | 7 | 50 | 14.0 | 31.9 |
| Friuli Venezia Giulia | 42 | 6 | 48 | 12.5 | 38.8 |
| Piedmont | 38 | 5 | 43 | 11.6 | 9.6 |
| Umbria | 30 | 4 | 34 | 11.8 | 37.5 |
| Sardinia | 26 | 1 | 27 | 3.7 | 16.1 |
| Calabria | 23 | 2 | 25 | 8.0 | 12.4 |
| Campania | 24 | 1 | 25 | 4.0 | 4.3 |
| Latium | 22 | 1 | 23 | 4.3 | 4.0 |
| The Abruzzi | 9 | 1 | 10 | 10.0 | 7.4 |
| Sicily | 10 | 0 | 10 | 0.0 | 2.0 |
| Molise | 9 | 0 | 9 | 0.0 | 28.1 |
| Liguria | 8 | 0 | 8 | 0.0 | 4.9 |
| Trentino Alto-Adige | 2 | 0 | 2 | 0.0 | 1.9 |
| Basilicata | 1 | 0 | 1 | 0.0 | 1.7 |
| Total | 608 | 71 | 679 | 10.5 | 11.2 |

Source: UNIVPM Spin-off database

Table 2 - Univpm spin-off by sector of activity

| SECTOR | Number of spin-offs | % |
|--------------------------------------|--------------------------------|----------|
| ICT service | 68 | 21.5 |
| R&D in engineering field | 41 | 13.0 |
| R&D in architecture and construction | 31 | 9.8 |
| ICT production | 25 | 7.9 |
| Energy and green | 16 | 5.1 |
| Biotech | 15 | 4.7 |
| Biology | 11 | 3.5 |
| Chemistry | 10 | 3.2 |
| Electronics | 8 | 2.5 |
| Other sectors | 91 | 28.8 |

Source: UNIVPM Spin-off database

Table 3 – Shares at set-up by types of owner (% values)

| Owner | Average share | % of spin-offs with a majority shareholder |
|--------|---------------|--|
| People | 15.1 | 14.5 |
| PRI | 9.8 | - |
| Firms | 26.0 | 9.8 |
| Total | 15.9 | 24.3 |

Source: UNIVPM Spin-off database

Table 4 – Spin-offs by ownership share of universities, companies and financial institutions at set-up

| Share of legal entity owners | No shares | < 10 | 10-19 | 20-49 | ≥ 50 |
|------------------------------|-----------|------|-------|-------|------|
| University | 16 | 13 | 3 | | |
| Industrial Companies | 17 | | 4 | 9 | 2 |
| Financial Companies | 32 | | | | |

Source: UNIVPM Spin-off database

Table 5 – Financial relationship between spin-offs and UNIVPM (thousands of Euros)

| | UNIVPM to spin-offs | Spin-offs to UNIVPM |
|-------------|---------------------|---------------------|
| Consulting | 137 | |
| Fellowships | | 192 |

Source: Direct survey of UNIVPM spin-offs

Table 6 – Patents owned by UNIVPM spin-offs in 2011

| | Spin-offs | Patents |
|----------------|-----------|---------|
| Patents owned | 2 | 9 |
| Patents bought | 1 | 1 |
| Applicants | 1 | 1 |
| No patents | 6 | |

Source: Direct survey of UNIVPM spin-offs

Table 7 – Factors that helped fostering the development

| Development factors | Frequency |
|---|------------------|
| Collaboration with industrial partners | 6 |
| Collaboration with university | 4 |
| Investments in commercial assets | 3 |
| Public funds | 3 |
| Enlargement of the products' supply | 3 |
| Entry in a new market | 2 |
| Entry of owner with previous entrepreneurial or managerial experience | 1 |
| Investment in intellectual property management | |

Source: Direct survey of UNIVPM spin-offs

Table 8 – Spin-offs with experienced promoters by area of expertise

| Previous experience | Frequency |
|----------------------------|------------------|
| R&D | 8 |
| Production | 1 |
| Marketing/sales | 1 |
| Accounting | 3 |
| Entrepreneurial | 2 |

Source: Direct survey of UNIVPM spin-offs

Figure 1- Pecuniary beneficiaries of technology transfer activity

| | Contract research and consulting | Patenting and licensing | Spin-offs |
|--|---|---|---|
| University | share in external contracts | Fees | dividends and capital gains (when there is a share in the spin-off) |
| Faculty | direct remuneration | Fees | Remunerations; dividends and capital gains |
| Former students and researchers | | | Salaries; dividends and capital gains |
| Firms | | | dividends and capital gains (when there is a share in the spin-off) |
| Local and national Government | VAT + Taxes paid by University on profits from commercial activity + income taxes | VAT + Taxes paid by University on profits from commercial activity + income taxes | Corporate taxes |

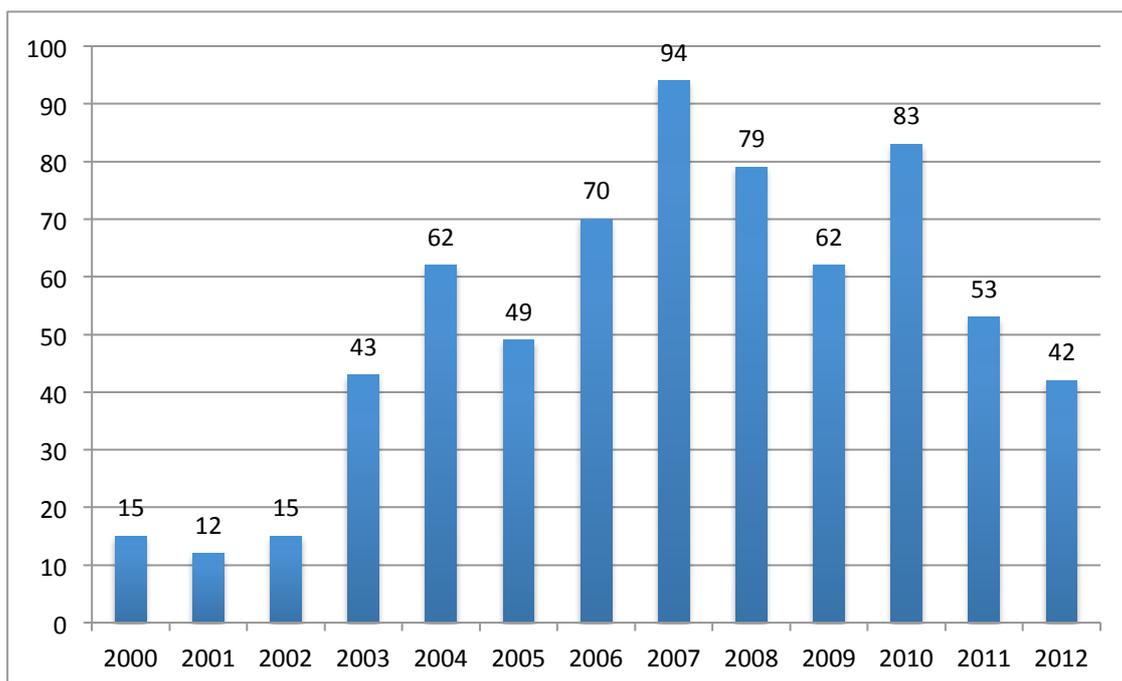
Figure 2 - Geographical impact of technology transfer activities

| | Patenting and Licensing | Contract research and consulting | Spin-offs |
|--------------------------|--------------------------------|---|------------------|
| Local | | ++ | +++ |
| Regional | | +++ | + |
| National / Global | ++ | + | |

+ low impact, ++ medium impact, +++ high impact

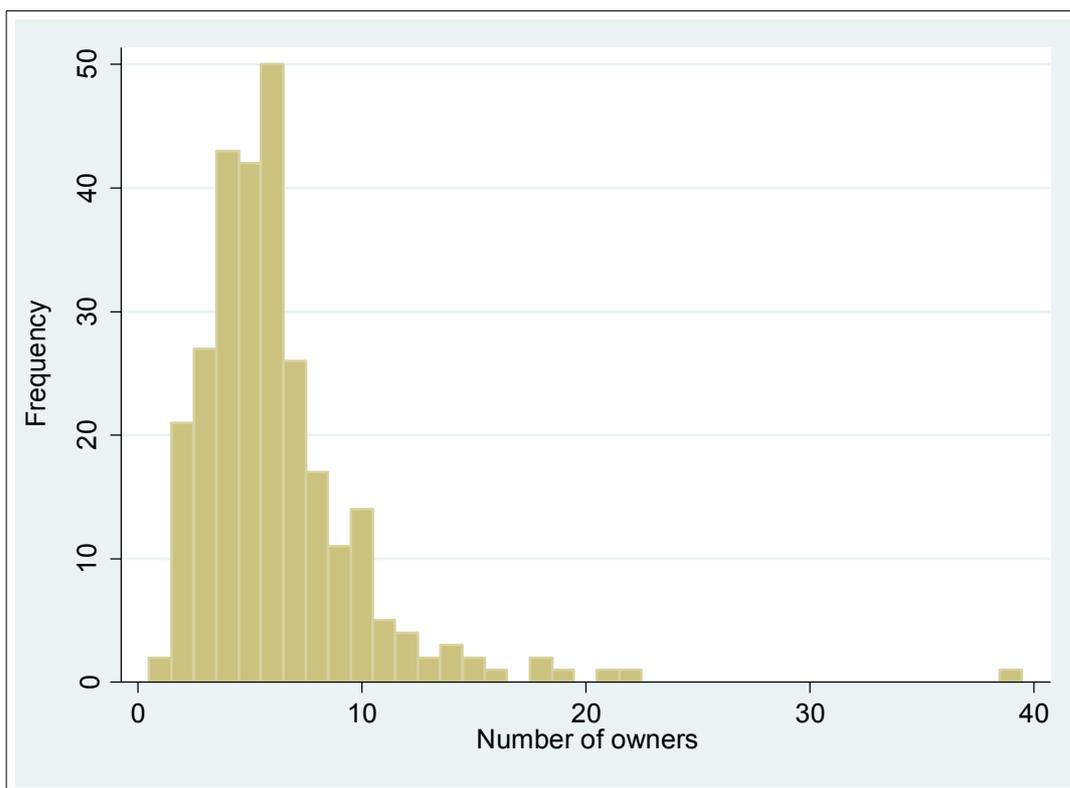
Figure 3 - Set of indicators to measure the impact of academic spin-offs

| Impact | Indicators |
|--|--|
| High-tech employer | Sector of activity Number of employees |
| Source of technological entrepreneurship | Sector of activity Promoters, owners, managers |
| Links with parent institutions | Grants and contracts with the parent university |
| Creation of international networks | Presence of foreign companies in the ownership International cooperations in R&D projects Extension of geographical market |
| Source of technological spillover | Collaboration with other firms at local level Labour mobility Formation of technology clusters |
| Stimulate business support services | Incubators Start-up competitions Entrepreneurship courses |

Figure 4 - Spin-offs by year of foundation

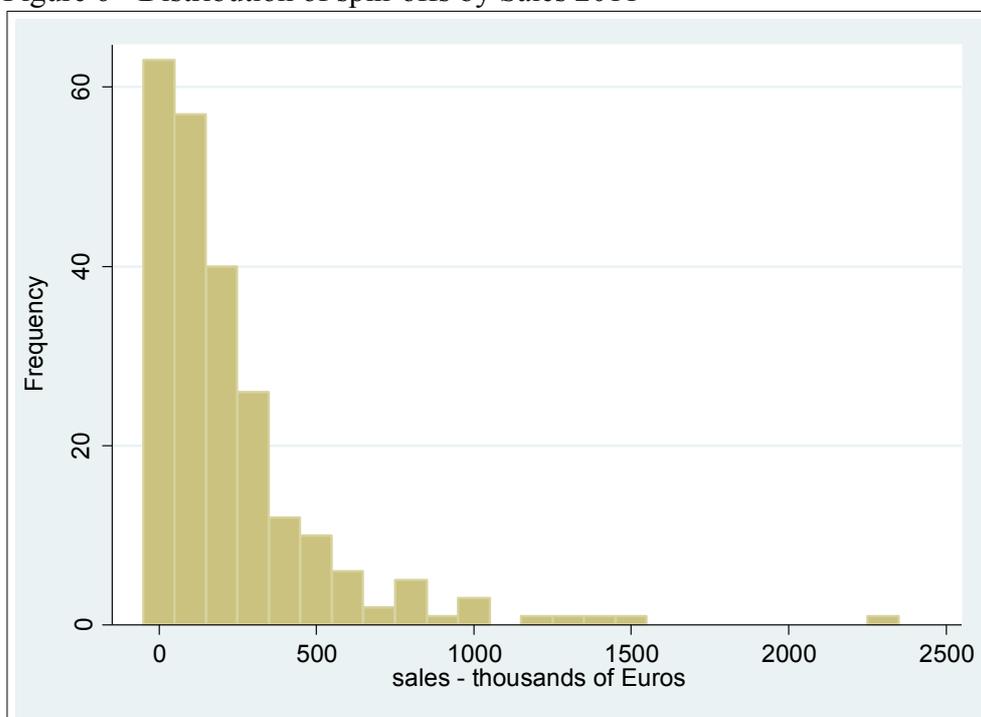
Source: UNIVPM Spin-off database

Figure 5 – Distribution of spin-offs by number of shareholders



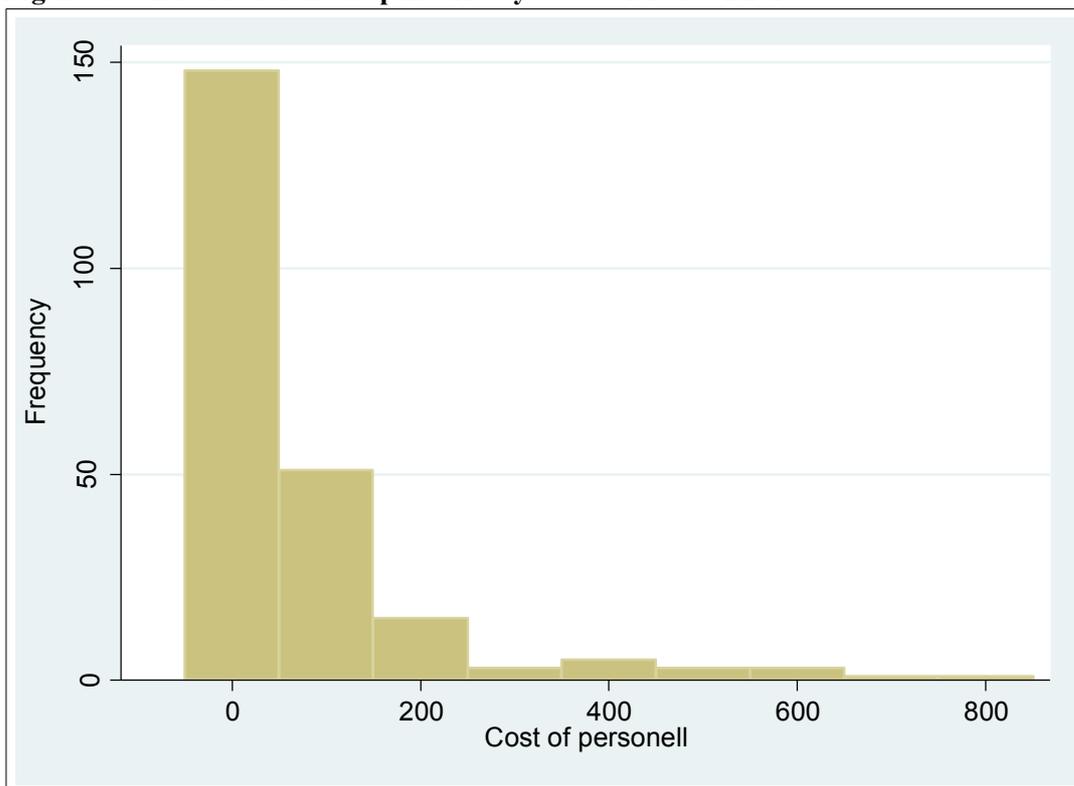
Source: UNIVPM Spin-off database

Figure 6 - Distribution of spin-offs by Sales 2011



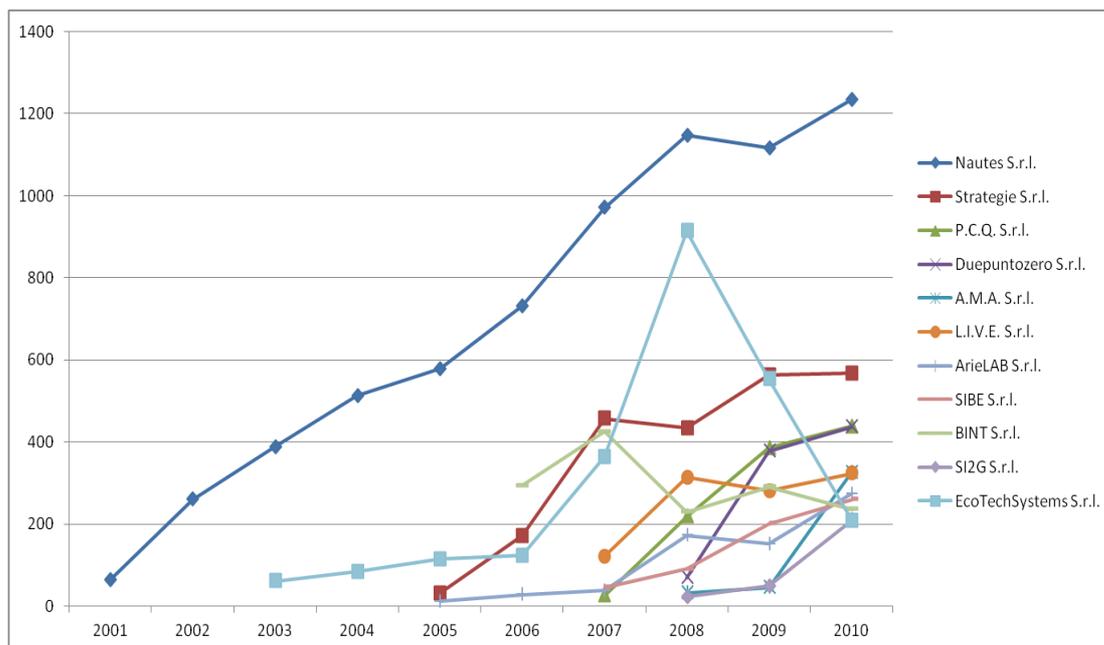
Source: UNIVPM Spin-off database

Figure 7 – Distribution of spin-offs by Cost of Personnel



Source: UNIVPM Spin-off database

Figure 8 – Best performers in terms of sales of UNIVPM spin-offs



Source: UNIVPM Spin-off database