



HAL
open science

Research spin-off firms: does the university involvement really matter?

Elisa Salvador, Pierre-Jean Benghozi

► **To cite this version:**

Elisa Salvador, Pierre-Jean Benghozi. Research spin-off firms: does the university involvement really matter?. *Management international = International management = Gestión internacional*, 2015, 19 (2), pp.22 - 39. hal-02091015

HAL Id: hal-02091015

<https://hal.science/hal-02091015v1>

Submitted on 5 Apr 2019

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

This article has been selected by the scientific committee of the V conference Entrepreneurship, Innovation&Development (EIDEV), 21 June 2013 (Aix en Provence) as one of the 7 best articles of the conference.

It is *forthcoming* for the Special Issue EIDEV 2013, published by the Revue *Management International*

<http://www.managementinternational.ca/catalog/>

It can be cited as follows:

Salvador E., Benghozi P.-J. (2015) "Research spin-off firms: does the university involvement really matter?", *Management International*, vol. 19, n. 2, pp. 22-39.

Entreprises spin-off de recherche : l'implication de l'université est-elle si importante ?

Research spin-off firms: does the university involvement really matter?

Empresas spin-off de investigación : La participación de las universidades realmente importa?

*Salvador E., **Benghozi P.-J.

Résumé: Les entreprises spin-off de recherche (RSOs) sont largement reconnues comme une source d'opportunité clé pour le développement potentiel des universités. Cet article vise à analyser le rôle des RSOs en partant de la relation qu'elles ont avec leur institut parent. L'objectif est de mesurer plus spécialement l'importance - ou non - de l'implication des universités dans la nature et la réussite de telles entreprises. La recherche s'appuie sur des données empiriques originales collectées et constituées sur les RSOs italiennes. Le traitement systématique de ce matériau (statistique descriptive, analyse factorielle et de cluster) permet de valider les hypothèses de départ car il montre que la force de l'intérêt de l'université envers une RSO a des conséquences significatives sur l'orientation et la structure de l'entreprise. La recherche permet d'identifier plus précisément deux principaux groupes de RSOs que l'on peut qualifier d'*open-oriented* et *autonomous-oriented*.

Abstract: Research spin-offs (RSOs) are considered as potential key opportunities for universities. This paper aims to contribute to the debate on RSOs through an examination of the relationship between these firms and their parent institute: the goal is to understand in which extent the university involvement could make the difference or not. Original empirical evidence on the Italian RSOs is provided by means of a questionnaire investigation, with a focus on companies that aroused more interest from their university and those that did not. Descriptive statistics is followed by a cluster and a factor analysis. Two main groups of RSOs are identified: *open-oriented* and *autonomous-oriented*. It seems that the strength of university interest towards a RSO has consequences on company orientation.

Resumen: Las empresas spin-off de investigación (o RSOs por sus siglas en inglés) son reconocidas como proveedoras de oportunidades clave para la valorización de las universidades. Este artículo busca detallar este papel al examinar la naturaleza y la importancia de la relación entre estas empresas y sus instituciones matrices: el objetivo es entender en qué medida la participación de las universidades pesa, o no, en su éxito. El artículo se basa en material empírico original sobre las RSOs italianas creado a partir de una larga encuesta por cuestionario. Esta encuesta permite clasificar las empresas según el grado de implicación manifestado por sus universidades de origen. El análisis se basa en estadísticas descriptivas enriquecidas por un análisis factorial y de clusters. El estudio permitió confirmar las hipótesis de inicio: el peso del interés que la universidad otorga a su RSO afecta la orientación estratégica de las mismas. El análisis distingue dos grupos principales: las RSO con orientación abierta, y las RSO con orientación autónoma.

Mots-clés: entreprises spin-off de la recherche; transfert de technologie; entrepreneuriat de haute technologie; analyse cluster; analyse factorielle

Keywords: research spin-offs; technology transfer; high-tech entrepreneurship; cluster analysis; factor analysis
Palabras claves: empresas spin-off de investigación; transferencia de tecnología; iniciativa empresarial de alta tecnología; análisis de clusters; análisis factorial

***Dr. Salvador Elisa:** Researcher, Ecole Polytechnique, Paris, France.

Address: Management Research Center (PREG-CRG) (UMR 7176 Ecole Polytechnique - CNRS), Btt Ensta 828, Boulevard des Maréchaux 91762 Palaiseau Cedex, France, *corresponding author*, e-mail: elisa.salvador@polytechnique.edu, phone (+33) 0181872177

****Prof. Benghozi Pierre-Jean:** Research Director CNRS, and Professor at the Ecole Polytechnique, Paris, France, e-mail: pierre-jean.benghozi@polytechnique.edu

Salvador Elisa holds an international PhD in Institutions, Economics & Law from the University of Turin (Italy). She has worked for the Italian National Research Council (CNR) on several projects focused on innovation policies. She won the CNR award ‘Promotion of Research 2005’ for her project “The financing of research spin-offs: an analysis of the Italian case”. She has recently collaborated with the Polytechnic of Turin, with the Chaire Entrepreneuriat as well as with the Centre d’Etudes et de Recherche Amérique Latine-Europe of the Business School ESCP-Europe. She is currently a researcher at the Ecole Polytechnique in Paris.

Benghozi Pierre-Jean is Research Director at the National Centre for Scientific Research (CNRS) and professor at Ecole polytechnique (Paris, France). He developed, since the early eighties, a pioneering research group on Information Technology, Telecommunications, Media and Culture. Pierre-Jean Benghozi is board member of scientific committees in highest French institutions and numerous international scientific conferences and academic journals. His competencies made him nominated commissioner and member of the executive board of the French national regulatory authority for electronic communications and postal services (ARCEP).

Funding Acknowledgement

This work was supported by the scholarship (2007-2009) of the International PhD Programme in “Institutions, Economics & Law (IEL)”, Collegio Carlo Alberto, University of Turin, XXII Cycle; and by the Italian National Research Council (CNR) award under the ‘Promotion of Research 2005’ programme, Project for young researchers (Elisa Salvador grant number 263/229).

Introduction

In recent years, an increased attention has been dedicated to the research spin-offs (RSOs) phenomenon (Mustar *et al.*, 2006, 2008; Clarysse *et al.*, 2011; Sternberg, 2014). RSOs are considered as one of the main tools for the external transmission of knowledge and economic valorisation realized in a university, usually referred to as the parent institute. The growing importance of the role of universities in local development - the so-called *third mission* (Chapman *et al.*, 2011; Philpott *et al.*, 2011; Goldstein, Glaser, 2012; Carree *et al.*, 2012; Treibich *et al.*, 2013; Algieri *et al.*, 2013) - is linked to a large number of initiatives enhancing the academic entrepreneurship both through the creation of internal structures devoted to technology transfer and the creation of RSOs.

The persistence of close links with the parent institute and the importance of the degree of support that a RSO receives from its university for company success have been underlined in the literature¹. The question surfaces, what about the *effective* link between RSOs and their parent institute? Are there any differences between companies that aroused more “interest” from their university as opposed to those that did not? The international literature on RSOs has focused on several perspectives and has proposed many taxonomies in recent years. Besides the resource-based view and the business model standpoint, the institutional perspective provides a key focus of these researches: it proposes, in particular, alternate evaluations of the structuring and economic success of RSOs and focuses on the more formal or informal relations with the university (Mustar *et al.*, 2006; Rasmussen, 2006; Wright *et al.*, 2007; Freitas *et al.*, 2013). Along this line, this paper aims at nurturing the debate through the analysis of the results of primary data sources coming from a survey undertaken in RSO

¹ See, among others: Westhead, Storey, 1995; Mustar, 1997; Steffensen *et al.*, 1999; Chiesa, Piccaluga, 2000; Shane, 2004; Rothaermel, Thursby, 2005; Treibich *et al.*, 2013; Rasmussen *et al.*, 2014.

founders². Following the management research field with assumptions about stakeholders' interest, particular attention is paid to a comparison between RSOs, according to the "interest" they fostered from their parent institute.

In order to inhibit the various national institutional structures that might influence the development of RSOs, we decided to focus on a single national basis, namely Italy.

Italy is an interesting case-study often developed in the literature: the Italian industrial districts (Becattini *et al.*, 2003) are well known at worldwide level and the country has always been characterized - and taken into consideration - by a predominance of small and medium businesses as well as family businesses. The innovation ecosystem makes Italy an attention-grabbing case in terms of variety of existing firms and potential distinctiveness. A fertile and industrialised context in the North (Nosella, Grimaldi, 2009) concurs with a strong regional and innovation divide, among the sharpest in the European Union (Iammarino *et al.*, 2009). Notwithstanding the general low level of total early stage entrepreneurial activity registered in recent years, a real entrepreneurial ferment (i.e. the propensity to start new businesses) is observable (GEM, 2014) with a particular increasing number of RSOs foundation (Iacobucci *et al.*, 2011; Netval, 2013). Italy is therefore a country with a relevant potential in terms of technology transfer (Varaldo, Di Minin 2009). Nonetheless, the results are generalizable beyond the Italian case, because European RSOs share most of the same characteristics and problems (Mustar *et al.*, 2008; Visintin, Pittino, 2014).

An extended analysis of the RSO phenomenon has been undertaken thanks to a questionnaire investigation. It started from general descriptive statistics of the answers provided to the several sections of the questionnaire with particular attention to the relationship between RSOs and their parent institute; then, cluster analysis and factor analysis approaches contributed to build some groups and factors useful for understanding the

² In this paper we define as RSOs all the firms 1) coming from the research world, 2) with or without a university share and a patent, 3) established by current or former university/research centre members - professors, researchers, technical and administrative staff, PhD candidates -, 4) aiming to take advantage of research results.

effective nature of this relationship. The cluster analysis revealed the existence of two main kinds of RSOs: “*open-oriented*” and “*autonomous-oriented*”. The factor analysis confirmed and improved these results by underlining the importance of three factors that develop more specifically the various dimensions shaping the openness and governance of the companies. The first factor corresponds to “*managerial competencies*”, therefore, the capacity to support effective company development. The second factor is the “*company orientation*”, therefore the structure and control over exclusive offering (products or services). Lastly, the third factor refers to “*spin-off founders and university choices*”, therefore the dependence of the RSO upon its *Alma Mater*. These findings as well as the descriptive statistics from the questionnaires confirmed the importance of the role played by the RSO parent institute “interest”. Yet, the paper demonstrates that this relation is neither unique nor uniform. Moreover the analysis of the relationship between RSOs and their parent institute underlined that several specificities might be distinguished and, consequently, it calls for different strategies and support from the university towards the various kinds of firms. In particular, the development of managerial competencies and, accordingly, the future economic success seems closely linked to the degree of interest demonstrated by the university. Moreover, when their founders are not keeping an academic position in the university, RSOs are less supported by their parent institute; their founders pursue the economic development of the firm but are not encouraged to fully valorise their dual experience in the mastering of scientific tacit knowledge and in business development.

The paper is structured as follows. Section 1 focuses on the main RSO perspectives and taxonomies suggested in recent literature as well as on the meaning of university’s “interest”: according to the meaning of interest usually used in organisation studies and strategic management, we aim at investigating - on the specific case of RSOs - the impact of the involvement of specific stakeholders (namely universities) on the success of the firms they are

participating to. Data and methodology are presented in section 2. The main results of the empirical investigation are described in section 3: descriptive statistics of the 155 questionnaires received as well as the results of the cluster analysis then a factor analysis approach. Discussion of the results and suggestions for improvement follow.

1. Theoretical framework: main RSO perspectives and taxonomies in recent literature and the concept of “interest”

In recent years, several theoretical perspectives (Wright *et al.*, 2007) have been used to analyse RSOs: they highlight the complexity of the phenomenon. Consequently, different definitions and many taxonomies have been derived. The type of resources, the business model and the institutional link are used to differentiate between RSOs in order to clarify the heterogeneity and diversity of these firms. Recently, Rasmussen (2011) argued that *life-cycle*, *teleological*, *dialectic* and *evolutionary* theories (see Table 1 for details) explain different aspects of the RSO venturing formation process. In particular, the dialectic perspective underlines the influence of the university culture on RSO behavior.

Wright *et al.* (2007) attempted to build spin-off taxonomies to fill the gaps with previous investigations. They classified the scientific production on RSOs (Table 2), distinguishing three main types of companies: the *venture capital backed*, the *prospector* and the *lifestyle* RSOs. This distinction is based on a set of variables identified by the authors and fit into three theoretical perspectives (Table 1). Firstly, the *institutional*, focused on the scrutiny of formal or informal relations with the parent institute and its strategic choices; then, the *business model* perspective, looking at the economic design and efficiency of the activities developed by the firm; thirdly, the *resource-based* view addressing the identification of the key scientific resources, the role they played and how they are coped with.

Shane (2004) focused on *needs and sources of finance*, featuring the assorted funding sources for RSOs. A first category includes firms needing a minimum amount of finance,

because they are financed through personal and family capital. A second category includes those RSOs that need a high level of finance.

If Shane (2004) identified two categories, others identified three or four types of RSOs. Clarysse *et al.* (2002, 2005) and Degroof and Roberts (2003, 2004) classified companies according to the *low selective*, *supportive* and *incubator* models. According to these different models, the creation of RSOs may vary from several companies of low-medium quality to only a few companies with high level potentialities. The parent institute strategy adopted for the creation of these companies and the availability of adequate infrastructures like science parks and incubators are the main determinants of these results. O'Shea *et al.* (2005) analysed not only the impact of university policies and the impact of factors such as the availability of adequate infrastructures and venture capital financing, but they also focused on *personal characteristics* of academics that become managers, with special attention to the desire for independence (Shane, 2004).

Recent focus has been made on *network activities*, *internal communication and adhocracy* (Gupte, 2007): it adopted the diffusion of *innovation* perspective as well. RSOs' potential of technology transfer calls to take into consideration the relation between "tacit and codified knowledge" (Cowan *et al.*, 2000; Powell, Grodal, 2005; Witt, Zellner, 2007). On the one hand, RSOs develop on the market the potential of the tacit knowledge residing in the heads of scientists; on the other hand, the firm knowledge needs to be sustained by an efficient and effective use of internal resources organised in a business model and linked to university rules. Tables 1 and 2 provide a summary of the characteristics of these main perspectives and taxonomies on RSOs.

The contributions of the literature support the assumption that the parent institute plays a key role in the differences among all these perspectives and taxonomies. The university approach towards these particular kinds of firms determines the prevalence of a low,

supportive or incubator model of selection. The company orientation towards a more or less narrow approach with its parent institute may determine the prevalence of a venture capital-backed, a prospector or a lifestyle classification.

Our empirical analysis aims at providing a contribution to the literature on RSO perspectives and taxonomies through a focus on the relationship between these companies and their parent institute “interest”.

The notion of interest is usually associated in the management research field with stakeholders’ interests, which are taken into account in the context of inventory management systems (De Vries, 2013). These interests can be either in conflict or common and they need to be identified and addressed to maximize firm performance (Lansiluoto et al., 2013). Stakeholders may act to protect and achieve their interests (i.e. interest-based view), while Rowley and Moldoveanu (2003) argue that interest intensity is the primary condition driving a stakeholder group to act to influence the focal firm: the stakeholder literature highlights a link between interests and action. In general, the theory and research on interest argues that interest plays a key role in performance optimization, because it may contribute as a mental resource. Interest helps actors accomplish challenging goals: various beneficial outcomes (e.g. heightened attention, adaptive goals, learning) are associated to the presence of interest. Therefore, one can say also that interest is somehow involved in the management and optimization of self-regulatory resources (O’Keefe, Linnenbrink-Garcia, 2014).

In the literature on RSOs, a definition of “university interest” (UnivInt) does not exist. Recently, Treibich et al. (2013) have focused on the development of “interactions” between RSOs and their parent institute in terms of duration and involvement in a co-production of knowledge, but going beyond the underlying features and consequences linked to a native interest from the university of origin. And Sternberg (2014) focused on the influence of the regional environment as a success factor of RSOs, while Rasmussen et al. (2014) underlined

that the interaction between a RSO and its parent institute is complex and often dialectic and argued that the university department context influences the early RSO development process with the local department level playing a role of moderator of general university “support” towards RSOs. Nonetheless, the influence of the local environment on the development path of RSOs was not linked to the presence or absence of “interest”.

Starting from these assumptions, we adopt in this paper a meaning of interest similar to the utilitarian concept and pragmatic perspective generally used in strategic management theory and research when considering the “stakeholders’ interests”. As a consequence, we associate “university interest” to the positive and useful consequences for RSOs performance and optimization of self-regulatory resources. Actually, the results carried out from 155 RSO founders exhibit that the presence or absence of UnivInt towards a RSO initiative has consequences on the company orientation.

Table 1: Summary of the main perspectives on RSO suggested in recent literature

<i>Perspectives</i>	
Resource-based	The resources (technological, human, social and financial resources), and in particular the scientific and social ones, of the firm may be a differentiator and a predictor of competitive advantage (Wright <i>et al.</i> , 2007; Mustar <i>et al.</i> , 2006)
Business model	Three groups: the “first” one analyses the business model focusing on the activities undertaken by RSO (service or product); a “second” group of studies focuses upon the growth orientation of companies by analysing not only how much these firms grow, but also if and when founders decide to implement a growth strategy. Finally, a “third” group of studies examines how technologies or knowledge can be transformed into commercial value (Wright <i>et al.</i> , 2007; Mustar <i>et al.</i> , 2006)
Institutional	The link with the university, usually referred to as “the parent institute”, and the institutional environment are pivotal. Factors like environment support, local group norms and university culture and university institutional framework influence RSO’ behaviour (Wright <i>et al.</i> , 2007; Mustar <i>et al.</i> , 2006; Rasmussen, 2006)
Network activities, internal communication and adhocracy	Factors that enable a research spin-off to grow faster and thus to become more successful: network activities and internal communication. The relationship between network activities and company success is also influenced by the disposition of an organisational culture characterized by flexibility, openness, creativity and dynamism, called “adhocracy” (Gupte, 2007)
Life-cycle	A process or set of events that occur through a necessary sequence of defined steps or stages of phases (Rasmussen, 2006, 2011)
Teleological	The purpose or final goal guides the development process. The process develops from constructive action: a repetitive sequence of goal formulation, implementation, evaluation, and modification (Rasmussen, 2006, 2011)
Dialectic	Embeddedness in a context where environment support, local group norms and university culture affect the company behaviour. Development processes refer to the balance of power between opposing entities (Rasmussen, 2006, 2011)
Evolutionary	The external environment affects the company process by influencing the opportunity, the individuals involved, and the university context. Change processes go through a continuous cycle of competitive selection (Rasmussen, 2006, 2011)

Source: Authors’ elaboration

Table 2: Summary of the main taxonomies on RSO suggested in recent literature

<i>Taxonomies</i>	
Venture capital-backed	Attractive for venture capitalists; scientific credibility, visibility, growth process, international market. Number of these RSOs: very limited (Wright <i>et al.</i> , 2007)
Prospector	Attractive for capital from public or private equity funds (Wright <i>et al.</i> , 2007)
Lifestyle	Low-growth oriented at start-up; sometimes high-growth oriented after the start-up phase. Less demanding in terms of human, financial and technological resources (Wright <i>et al.</i> , 2007)
Low selective model	Aim: maximize the number of RSOs: not very competitive, focused on local and national markets, with a low level of capitalisation, and with a weak managerial structure (Clarysse <i>et al.</i> , 2002, 2005; Degroof, Roberts, 2003, 2004)
Supportive model	Focus on RSOs willing to grow and with average resource intensity. Technology licensing and business plan have a key role. Compared with the previous model, the number of RSOs is very limited (Clarysse <i>et al.</i> , 2002, 2005; Degroof, Roberts, 2003, 2004)
Incubator model	Clear plan of development, based on a license and a deep knowledge of a specific technology. Venture capitalists are interested in this type of companies since the beginning (Clarysse <i>et al.</i> , 2002, 2005; Degroof, Roberts, 2003, 2004)
Finance needs	RSOs need a minimum amount or a high level of finance (Shane, 2004)
Characteristics of RSO founders	Desire for autonomy and independence (Shane, 2004; O'Shea <i>et al.</i> , 2005)

Source: Authors' elaboration

2. Methodology

In order to identify and ascertain the intensity of the relation between a RSO and its parent institute, we aimed at investigating the importance and the effective role of the university involvement in a RSO initiative. The building of a sample of RSOs in the Italian context demonstrated that the explicit differences existing with the university are hardly sufficient enough to discriminate the various situations. Consequently, we decided to supplement them with the entrepreneurs' perspective through a specific questionnaire. A dedicated section was focused on the relationship between RSOs and the parent institute, meaning whether or not the university showed any interest towards the RSO initiative, how this was perceived by company founders and which consequences aroused from the presence or absence of the parent institute involvement.

One of the main problems was to identify the actual number of RSOs founded in Italy. In order to define the sample and evaluate the quality of the survey answers, the first step was to look at technology transfer offices and university websites for a list of RSOs and to verify the completeness and updating of this list. Since a large definition of RSOs may be considered, including also companies not participated with the university, this list had to be completed with the Italian science park and incubator tenants list. A final problem was due to

the fact that science parks and incubators do not make any difference between RSOs and start-ups, which refers to firms not created by university personnel and therefore not linked to the academic world. Telephone and e-mail contacts with university staff as well as science park and incubator personnel were pivotal in filling this gap and in excluding start-ups from the final list.

The universe of RSOs identified in Italy was 394 firms³. A questionnaire was sent to these companies and the response rate was 39.5%⁴.

The questionnaire was sent by e-mail to RSO founders between January and June 2008⁵. It was specifically divided in the following sections: a) general characteristics of the RSO; b) funding sources; c) university and RSO relationship; d) incubator/science park and RSO relationship⁶; e) patents; f) industrial partnership⁷; g) geographical location of the RSO.

In order to investigate the consequences of the presence or absence of the parent institute interest towards a RSO initiative, a cluster analysis has been firstly implemented in order to identify the various university strategies at stake *vis à vis* RSOs and in which extent they might determine specific groups of RSOs. Then we used a factor analysis to fine tune the clusters characterization and to isolate and detect the more influential variables and figures shaping the RSOs development. The various questionnaire questions were clustered into homogeneous groups and it was ascertained whether these groups were different from or similar to one another. A table was contrived with qualitative variables transformed into quantitative ones, following the order of questions provided in the questionnaire. These

³ Additional 25 RSOs had the positive approval of the university at the time of the survey, but they were not yet established.

⁴ The location of the 155 respondents was 58% from the North of Italy, 23% from the Centre and 19% from the South and Islands. This distribution was almost the same for the location of the universe of 419 (394+25) RSOs at country level. Therefore, given the response rate and the geographical distribution, this sample could reasonably be considered as representative.

⁵ Some preliminary interviews were undertaken before drawing up the questionnaire as a crucial tool in order to understand the general context and check the main aspects of a deep examination.

⁶ This section has been carefully analysed in Salvador and Rolfo (2011) and Mariotti and Salvador (2014).

⁷ This section has been carefully analysed in Benghozi and Salvador (2014).

variables were organized into groups by means of the cluster analysis methods (Everitt *et al.*, 2001). Cluster analysis approach allows for the identification of groups of objects with small within-cluster variation for discriminating variables and high variation between clusters. The list of variables used for the cluster analysis is provided in Annex A. K-means⁸, one of the most widely used partitional clustering techniques for cluster analysis (Ayrano, Karkkainen, 2006), was applied. K-means clustering is a prototype-based technique that helps to define a user-specified number of clusters (K), which are represented by their centroids (Tan et al., 2005). We used Euclidean (L2) distance and the sum of the squared error (SSE) metric. One of the main problems is to identify the optimum number of clusters. The use of K-means implies the specification of the number of clusters as an input to the algorithm (Gray, Neuhoff, 1998). In order to choose the more efficient of the grouping divisions, the Calinski/Harabasz pseudo-F index was additionally used (Calinski, Harabasz, 1974; Milligan, Cooper, 1985).

Finally, a factor analysis was performed on the main variables that influenced the differences between the two Clusters identified by the cluster analysis in order to make clear the specific variables differentiating the RSOs participating to each group and the characteristics and the consequences of the university involvement (i.e. presence or absence of UnivInt). Principal component extraction factors was the method chosen and the Kaiser-Meyer-Olkin was the measure of sampling adequacy. This last one was quite low, but acceptable (see Annex B). To determine the number of components the latent root criterion

⁸ “This method of clustering is very different from the hierarchical clustering and Ward method, which are applied when there is no prior knowledge of how many clusters there may be or what they are characterized by. K-means clustering is used when you already have hypotheses concerning the number of clusters in your cases or variables” (Burns, Burns, 2009, p. 557). “Ward’s method is the correct hierarchical analog” of the K-means partitional technique (Tan et al., 2005, p. 523). In this specific case, we decided to adopt the K-means clustering technique as we yet had some prior knowledge of how many clusters there may be, taking into account our focus on RSOs with and without UnivInt.

(Eigenvalue > 1.0) was applied: a three-dimensional solution explaining 47% of the variance was obtained.

3. Survey results

This section analyses first of all the contents of the 155 questionnaires fulfilled by Italian RSO founders. The main result confirms that, in our sample, various groups exist and are characterized by different situations. A specific focus is more precisely on the two sub-groups of RSOs that fostered more interest from their parent institute (100 questionnaires) and the ones without their parent institute interest (42 questionnaires)⁹.

Secondly, the data available have been treated through a cluster analysis approach in order to verify whether some specific arrangements of RSOs with university interest emerge or not and how they are shaped. Effectively, this process enabled us to characterize, at first, two sub-groups of RSOs. Finally, a factor analysis was run on the main significant variables identified by the cluster analysis: this final step was required in order to ultimately identify the specificities and orientation of RSOs with and without the parent institute interest.

3.1 The parent institute “interest” towards a RSO initiative: a preliminary outlook

In order to provide an answer to our investigation about the consequences of the presence or absence of university interest on the firm development and efficiency, we firstly focused on the link between a RSO and the parent institute: “interest” towards the spin-off initiative, the time required for administrative procedures, the main difficulties and impediments encountered, the backing and resources expected from the parent institute. Actually, section C of the questionnaire included questions that aimed at highlighting how many companies benefited from receiving positive attention from their university and at understanding the main RSOs’ reasons for looking or not for their parent institute

⁹ The sample is reduced to 142 instead of 155 because of missing answers.

involvement. We complemented this first evidence with additional answers from the questionnaire: this approach enabled to identify the general characteristics and orientation of RSOs with and without UnivInt.

In a nutshell, the results highlighted the emerging attention of Italian universities towards the RSO phenomenon with a high percentage of interest (65% of the questionnaires) and a low level of absence of UnivInt towards a spin-off initiative (27%). The main reasons for searching for a lasting relationship with the parent institute were linked to the benefits deriving from university contacts and the use of university resources in terms of infrastructures and personnel. Otherwise, the companies without any relationship with their parent institute underlined the absence of real benefits, meaning a sort of prejudice linked to a lack of business culture on the part of the university. A positive interest led to the parent institute support for the creation of the RSO, in terms of participation in the capital of the company and/or of other forms of support and promotion (i.e. aid from technology transfer offices, the possibility to use resources and laboratories, the use of the university logo, the possibility to be hosted in the university structures and the employment of the university's PhD candidates in the company). In general, the various forms of support and promotion provided by a parent institute are set in the specific rules for spin-off creation issued by the university itself (Salvador, 2009). As a consequence, a lasting relationship is created between the RSO and its parent institute: this may provide mutually beneficial consequences in terms of RSO performance and university prestige. In the case of lack of interest on the part of the parent institute, the RSO project is created with the autonomy and independence of the founders. The main characteristics of the two kinds of companies - RSOs with and without their parent institute interest - are demonstrated in the following section as well as the reasons for company creation, the solutions to the lack of managerial competences, and the relationship with banks. The results highlighted that most of the companies with patents and

the companies that benefited from regional, national and European grants are RSOs with UnivInt. Nonetheless, a strongly higher level of turnover of RSOs with interest compared to RSOs without their parent institute interest was not registered. Interestingly, companies without UnivInt have a deeper independence attitude compared to the ones with interest. Notwithstanding, answers suggest that they suffer more from a management knowledge gap and from difficulties with banks.

3.1.1 General characteristics of RSOs: year of creation, form of society, capital, turnover

Considering the overall structure of our prototypical sample, the industry sectors showed a strong prevalence of the ICT sector (33%) followed by the biopharmaceutical one (25%). This result is coherent according to the influence exerted by the Internet revolution (Benghozi *et al.*, 2009) and it is in line with evidence found in the literature (Mustar, 1997; Shane, 2004; Gupte, 2007; Clarysse *et al.*, 2007).

Looking at the year of creation, the RSOs of our sample are relatively young firms: most of the companies analysed were established between 2003 and 2007. A comparison between RSOs with and without interest from their parent institute revealed that the number of companies with UnivInt increased sharply between 2003 and 2007. Nonetheless, also the number of RSOs without interest from the parent institute increased between 2005 and 2007. This result is in line with the growing number of RSOs in Italy (Netval, 2013) and the increasing issuing of university rules for these companies (Salvador, 2009).

These firms are most of all limited liability companies; some of the few companies in the form of joint-stock companies benefited from the interest of a university. Two thirds of the companies are service oriented while only one third is product oriented: looking at companies with parent institute interest, it emerged that 38% are product companies, while 62% are service companies. On the other hand, RSOs without UnivInt are 24% product

companies and 76% service companies. Less than 20% of the founders left the university position to work full time in the spin-off firm. Furthermore, few companies hold patents: 63% are RSOs with UnivInt, while 37% are RSOs without UnivInt.

Initial and present capital is low (between 10,000 and 20,000 euro) and reveals low increases in the capital registered. A comparison between RSOs with UnivInt and RSOs without it, revealed the absence of strong differences both in the initial as well as in the present capital of the company.

The questionnaire results confirmed the importance of personal and family capital as a source of financing (Roberts, 1991) as well as the availability of public funds. Companies that benefited from regional, national and European grants, and won regional competitions are most of all RSOs with UnivInt.

A comparison of the company turnover in the year 2007 revealed a subtle difference between the two samples of RSOs: in general, RSOs supplemented by UnivInt did not register a strongly higher level of turnover compared to RSOs without their parent institute interest.

The most important reasons for looking for the creation of a relationship between the company and its parent institute were linked to the opportunity to maintain contacts with the parent institute and the possibility to use university resources such as students and laboratories. The most cited disadvantage was bureaucracy. In case the university interest led to university participation in the capital of the company (84%), administrative procedures required in general from three to six months. In case of lack of any relationship with the university, the main reasons were linked to lack of real advantages and a slack of dynamism by the university.

3.1.2 The managerial knowledge gap, its roots and consequences

Main motivations for company creation have been the willingness to use research results and to work independently. Questionnaire results highlighted that companies with

UnivInt have chosen as main reasons for company creation “use research results” (43%) and “move from idea to market” (27%). Alternatively, RSOs without UnivInt have mainly chosen “desire for independence” (31%), “lack of job in university” (20%), “use research results” (21%).

The literature on this particular kind of firms has highlighted a lack of managerial and business competencies (Shane, Stuart, 2002; Lockett *et al.*, 2003; Heirman, Clarysse, 2004; Wright *et al.*, 2004; Shane, 2004; Iacobucci *et al.*, 2011). The existence of a lack of business competence is underlined by the fact that only 21.29% of the sample chose “no lacks” as first answer. The solutions adopted for the knowledge gap revealed by the present survey were mostly “self-training” and “aid by the incubator”. All but few of the respondents that chose “no lacks” are companies with UnivInt as well as most of the companies that chose “aid from industrial partner” as the main solution. On the contrary, aid from an “external manager” and “self-training” have been chosen more by RSOs without UnivInt (17% and 38% respectively).

The knowledge gap has one of its main consequences in the relationship with venture capitalists and banks. Only 11% of the sample is participated by a venture capital. While more than 50% of the sample affirms to have no troubles with banks, the main difficulties are characterized by lack of competence by spin-offs (15%) or by banks (15%). Two thirds of respondents that chose “no difficulties” are companies with UnivInt, while only one third are companies without UnivInt.

3.2 *Two clusters structuring RSOs with and without UnivInt*

The comparison between RSOs with interest and the ones without it highlighted interesting but somewhat contradictory findings. More specifically, even if most of the companies with patents and those companies that benefited from various forms of grants are RSOs with UnivInt, they did not exhibit a strongly higher level of turnover compared to RSO

without their parent institute interest. Interestingly, these last ones suffered more from a management knowledge gap and from difficulties with banks.

Consequently, these results fostered a deeper analysis in order to characterize these distinctive features and understand whether some specific organisations emerge or not in such structure variety. To this aim, we chose to apply a cluster analysis in order to test the existence of groups with similar features amongst the sample of 155 RSOs and verify whether or not the UnivInt somehow influenced the groupings. Actually, confirming our assumptions, the analysis made clear the emergence of two main clusters of RSOs, exhibiting specific characteristics. Interestingly, the main specificities of the two clusters not only reflect the similarities and the differences that emerged in the descriptive comparison between RSOs with and without UnivInt but they also deepen the emerged features and enable to better understand the specificities of RSOs with and without UnivInt.

3.2.1 The cluster analysis results

The results of the questionnaire respondents division into several groups demonstrate that the best partition is the one that differentiates the RSOs into two groups (cf. results for Calinski/Harabasz pseudo-F index). No correlation problems emerged (see Annex C).

Table 3 describes the analysis of variance (ANOVA) results for the grouping into two clusters. ANOVA highlights the variables that most contributed towards the identification of the two clusters: the reasons for company creation (var06&var07) and relationships with banks (var19) were the most influential.

Table 3: ANOVA results for the grouping into two clusters¹⁰

Source	Partial SS	df	MS	F	Prob > F
Model	27.1990905	47	.578704052	7.25	0.0000
Year of foundation in the last five years	var1 .014664458	1	.014664458	0.18	0.6692
Form of society	var2 .302747817	2	.151373909	1.90	0.1561
Number of shareholders between 1 and 5	var3 .367314335	1	.367314335	4.60	0.0346
Some shareholders left the university	var4 .033986453	1	.033986453	0.43	0.5158
Company	var5 .00104984	1	.00104984	0.01	0.9090
Reasons for company creation (first choice)	var6 3.81487294	5	.762974587	9.56	0.0000
Reasons for company creation (second choice)	var7 5.94640363	6	.991067272	12.41	0.0000
Increase in capital	var8 .079836973	1	.079836973	1.00	0.3200
Actual capital under 50,000 euro	var9 .011443786	1	.011443786	0.14	0.7059
Solutions to lack of managerial competence	var10 .577994787	4	.144498697	1.81	0.1338
Market	var11 .126608333	2	.063304166	0.79	0.4556
Use of self-financing	var12 .379004731	1	.379004731	4.75	0.0320
Use of loans from banks	var13 .05869901	1	.05869901	0.74	0.3935
Regional, national and European grants	var14 .067697941	1	.067697941	0.85	0.3596
Start-cup	var15 .468145808	1	.468145808	5.86	0.0175
MIP	var16 .140423298	1	.140423298	1.76	0.1881
Support of credit	var17 .007126594	1	.007126594	0.09	0.7658
Venture capital financing	var18 .008902636	1	.008902636	0.11	0.7392
Relationship with banks	var19 2.02160588	4	.50540147	6.33	0.0002
Agreement benefiting on-park spin-offs	var20 .000365802	1	.000365802	0.00	0.9462
University interest	var21 .093415771	1	.093415771	1.17	0.2823
Hosted by a science park-incubator	var22 .006590482	1	.006590482	0.08	0.7745
Patent	var23 .000116406	1	.000116406	0.00	0.9696
Industrial partnership	var24 .045771821	1	.045771821	0.57	0.4509
Verdict on company location	var25 .430280932	3	.143426977	1.80	0.1535
Aid from the Region	var26 .178077228	1	.178077228	2.23	0.1388
Company location	var27 .155244703	2	.077622352	0.97	0.3821
Residual	7.18496752	90	.079832972		
Total	34.384058	137	.250978525		

More precisely, Table 4 provides a description of the mean values of all the variables in the two groups.

Table 4: Summary statistics: mean values of variables by cluster

Definitions of variables	Var	Cluster 1	Cluster 2	Total
Year of foundation in the last five years	Var01	1.692308	1.69863	1.695652
Form of society	Var02	1.061538	1.150685	1.108696
Number of shareholders between 1 and 5	Var03	1.292308	1.493151	1.398551
Some shareholders left the university	Var04	1.923077	1.69863	1.804348
Company	Var05	1.615385	1.712329	1.666667
Reasons for company creation (1° choice)	Var06	4.569231	2.90411	3.688406
Reasons for company creation (2° choice)	Var07	4.538462	2.671233	3.550725
Increase in capital	Var08	1.8	1.835616	1.818841
Actual capital under 50,000 euro	Var09	1.184615	1.191781	1.188406
Solutions to lack of managerial competence	Var10	3.415385	2.69863	3.036232
Market	Var11	2.353846	2.342466	2.347826
Use of self-financing	Var12	1.184615	1.123288	1.152174
Use of loans from banks	Var13	1.938462	1.863014	1.898551
Regional, national and European grants	Var14	1.723077	1.657534	1.688406
Start-cup	Var15	1.769231	1.90411	1.84058
MIP	Var16	1.953846	1.958904	1.956522
Support of credit	Var17	1.984615	1.986301	1.985507
Venture capital financing	Var18	1.846154	1.945205	1.898551
Relationship with banks	Var19	4.523077	2.917808	3.673913
Agreement benefiting on-park spin-offs	Var20	1.876923	1.849315	1.862319
University interest	Var21	1.276923	1.452055	1.369565

¹⁰ The number of observations was reduced to 138 because of missing values in answers.

Hosted by a science park-incubator	Var22	1.569231	1.561644	1.565217
Patent	Var23	1.661538	1.808219	1.73913
Industrial partnership	Var24	1.523077	1.712329	1.623188
Verdict on company location	Var25	2.184615	2.109589	2.144928
Aid from the Region	Var26	1.569231	1.520548	1.543478
Company location	Var27	1.446154	1.616438	1.536232

3.2.2 Clusters description

According to the K-means partitional clustering method applied, Cluster 1 comprises 65 questionnaire respondents and Cluster 2 comprises 73 questionnaire elements. One might underline that the size of these two clusters is quite similar. Looking at Tables 3 and 4, the key features of the two groups can be identified. Some specific variables do in fact characterize each group more than others. Both in Cluster 1 and in Cluster 2 the main reasons for the company creation, the solution adopted for lack of managerial competencies and the relationship with banks are the key characteristics (variables 06, 07, 10 and 19).

First of all, some similarities are identifiable. Both the two Clusters are characterized by a similar distribution of RSOs created in the last five years or before; limited liability companies (*srl*) and joint-stock companies (*SpA*) are equally distributed in the two clusters; in both of the two Clusters there is a prevalence of low capital companies as well as few increases in capital; the variables linked to the location (var25-27) have underlined a general prevalence of indifference as a verdict on company location as well as an overall predominance of no aid from the Region, with a subtle prevalence of aid in Cluster 2. Slight differences have been observed in the influence of var22 (hospitality in a science park-incubator).

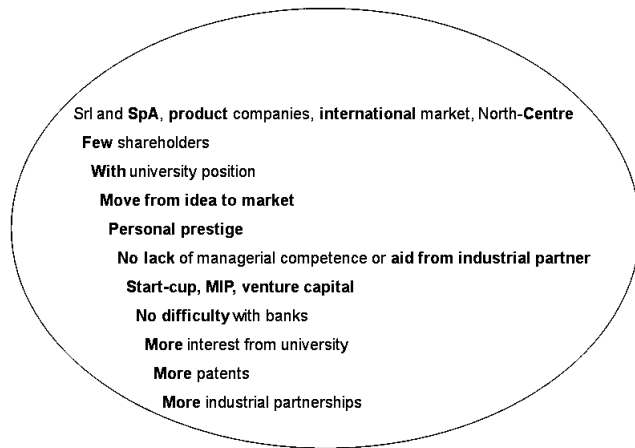
Yet, some differences exist: Cluster 1 shows a predominance of companies located in the North and in the Centre of Italy and a prevalence of product companies with a number of shareholders not exceeding five persons. Cluster 1 comprises all the motivations for company creation about going from an idea to the market and personal prestige. The solutions to lack of managerial competencies (var10) highlighted a prevalence of no lacks or aid from the

industrial partner. Linked to these characteristics, the relationship with banks (var19) underlined a lack of difficulties in Cluster 1. Concerning the market (var11), a prevalence of importance of the international market is observable. A predominance of regional competitions (Start-cup) and venture capital financing is identifiable as main source of financing. Cluster 1 highlighted also a higher presence of patents and industrial partnerships compared to Cluster 2.

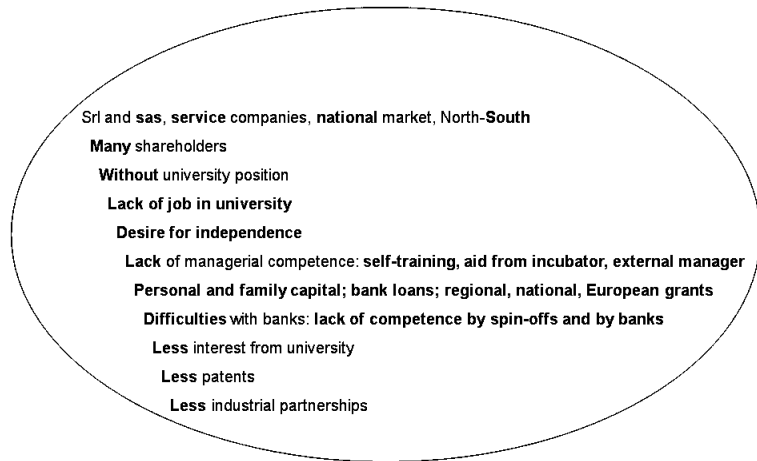
Finally, looking at Cluster 2, it includes RSOs located in the North and in the South of the country and it is characterized by a prevalence of limited partnerships (*sas*) as well as service companies with a number of shareholders over five. Nearly all the few founders that left – or did not have – the university position are included in Cluster 2 that is also characterized by less interest from the parent institute (var21). Looking at the main motivations for company creation, Cluster 2 includes all the choices for company creation concerning lack of job in the university and desire for independence, as well as self-training, aid from the incubator and an external manager as the main solutions to lack of managerial competencies. The relationship with banks highlighted the presence of difficulties due to lack of competencies by spin-offs and by banks. About the market, the national market is predominant in Cluster 2 and the distribution of the sources of financing highlighted a prevalence of personal and family capital, bank loans, regional, national and European grants.

To sum up, the cluster analysis identified two groups. These two clusters mostly confirm and share many characteristics quite similar to the ones that emerged in the descriptive comparison between RSOs with and without UnivInt. Therefore, according to the above description, we suggest to refer to them as “*Open-oriented RSOs*” (Cluster 1) and “*Autonomous-oriented RSOs*” (Cluster 2). Figure 1 provides a summary of the main specificities of these two clusters.

Figure 1: **Cluster 1: Open-oriented RSOs**



Cluster 2: Autonomous-oriented RSOs



3.3 *Three influential factors*

The cluster analysis highlighted the presence of two main Clusters. Then, it turned out necessary to complement the identification of the two groups, precisely featuring the orientation of RSOs with and without their UnivInt and the effective meaning of more and less open-oriented RSOs. The factor analysis made clearer the specific components of the variables distinguishing the two clusters. More precisely, it contributed to highlight three main Factors, identified as follows (Table 5).

Table 5: Factor analysis results

Factor analysis/correlation
 Method: principal-component factors
 Rotation: (unrotated)

Number of obs¹¹ = 140
 Retained factors = 3
 Number of params = 27

Factor	Eigenvalue	Difference	Proportion	Cumulative
Factor1	1.96033	0.28359	0.1960	0.1960
Factor2	1.67674	0.62135	0.1677	0.3637
Factor3	1.05539	0.09274	0.1055	0.4692
Factor4	0.96266	0.03786	0.0963	0.5655
Factor5	0.92480	0.02307	0.0925	0.6580
Factor6	0.90173	0.14204	0.0902	0.7482
Factor7	0.75969	0.07825	0.0760	0.8241
Factor8	0.68143	0.03920	0.0681	0.8923
Factor9	0.64224	0.20723	0.0642	0.9565
Factor10	0.43500	.	0.0435	1.0000

LR test: independent vs. saturated: $\chi^2(45) = 123.53$ Prob> $\chi^2 = 0.0000$

Factor analysis/correlation
 Method: principal-component factors
 Rotation: orthogonal varimax (Horst off)

Number of obs = 140
 Retained factors = 3
 Number of params = 27

Factor	Variance	Difference	Proportion	Cumulative
Factor1	1.65374	0.03558	0.1654	0.1654
Factor2	1.61816	0.19760	0.1618	0.3272
Factor3	1.42056	.	0.1421	0.4692

LR test: independent vs. saturated: $\chi^2(45) = 123.53$ Prob> $\chi^2 = 0.0000$

Rotated factor loadings (pattern matrix) and unique variances

Variable		Factor1	Factor2	Factor3	Uniqueness
Form of society	Var02	-0.4830	-0.0529	-0.1361	0.7454
Some shareholders left the university	Var04	0.3448	-0.1643	0.5367	0.5661
Company	Var05	0.0382	0.8143	-0.0220	0.3350
Reasons for company creation	Var06	0.4820	-0.3479	0.1473	0.6250
Solutions to lack of managerial competence	Var10	0.6469	0.2751	0.1142	0.4928
Market	Var11	-0.1838	-0.3654	-0.4419	0.6375
Relationship with banks	Var19	0.6899	-0.0875	-0.1547	0.4924
University interest	Var21	-0.3299	0.1975	-0.5191	0.5827
Patent	Var23	-0.0442	0.7260	0.1156	0.4576
Company location	Var27	-0.1696	0.1459	0.7594	0.3732

Factor 1 includes the items pertaining to the solutions adopted for lack of managerial competencies and the relationship with banks: therefore it can be labelled “*Managerial competencies*”. Factor 2 groups the items pertaining to product or service orientation and the presence of patents. Therefore, Factor 2 can be labelled “*Company orientation*”. Finally, Factor 3 includes items that show a negative link between company location and the choice of some shareholders of leaving the parent institute on the one hand and the university interest

¹¹ The number of observations was reduced to 140 because of missing values in answers.

towards the RSO initiative on the other hand. Questionnaire results showed that most of the RSOs are located in the North of the country as well as the few founders that left the university position. It revealed that if company founders maintain the university position there is more probability to attract interest from their parent institute. As a consequence, Factor 3 can be labelled “*Founders and university choice*”.

To sum up, these results enable to identify the orientation of RSOs with and without UnivInt. The importance of “managerial competencies” highlighted by Factor 1 confirms the peculiarities of the two clusters: absence of lack of managerial competencies and absence of difficulties with banks were prevalent in Cluster 1, while lack of business knowledge and problems with banks because of lack of competencies characterized Cluster 2. Looking at “company orientation” (Factor 2), product companies (Cluster 1) are more used to hold patents compared to service companies (Cluster 2). Finally, about founders’ “choice” (Factor 3), if RSO founders do not leave the university position there is more probability to have a greater interest by the parent institute (Cluster 1).

4. Discussion and concluding remarks

Recently, a great attention has been devoted to the *third mission* of universities (Chapman *et al.*, 2011; Philpott *et al.*, 2011; Goldstein, Glaser, 2012; Carree *et al.*, 2012; Treibich *et al.*, 2013; Algieri *et al.*, 2013). Looking specifically at the RSO phenomenon, two main dimensions have been underlined in the literature: the persistence of close links with the parent institute and the importance of the degree of support that a RSO receives from its university for company success (Westhead, Storey, 1995; Mustar, 1997; Steffensen *et al.*, 1999; Chiesa, Piccaluga, 2000; Shane, 2004; Rothaermel, Thursby, 2005; Treibich *et al.*, 2013; Rasmussen *et al.*, 2014). Our survey confirmed the importance of this support, but it also highlighted some specificities of RSOs with and without their UnivInt. According to our results, RSOs that aroused interest from their university are more product oriented and have

more patents compared to RSOs without their UnivInt. Furthermore, RSOs with UnivInt have less difficulty with banks and fewer knowledge gaps compared to RSOs without UnivInt. Notwithstanding, no significant differences were observed in the capital as well as in the turnover.

Our research highlighted further interesting findings. The two groups of RSOs identified by the cluster analysis exhibit some clear similarities but also several specificities. A first Cluster, named *Open-oriented RSOs*, includes more product companies with patents, internationally oriented, located in the North and the Centre of Italy, with few shareholders with university position and linked to their parent institute interest. These RSOs have been founded for moving from an idea oriented strategy to the market and – in some few cases – for founders' personal prestige. They have more probabilities to be financed from venture capitalists and have few difficulties with banks as well as no lack of managerial competencies as an industrial partner might sometimes provide them. A second Cluster, named *Autonomous-oriented RSOs*, consist of more service companies without patents, nationally oriented, located in the North and South of Italy, with many shareholders without a university position and with less interest from the parent institute. These companies have been founded because of lack of jobs in the university and for the desire of independence. They are financed considerably more by personal and family capital, bank loans and regional, national or European grants. These RSOs face difficulties with banks because of lack of competencies as well as lack of managerial competencies filled by self-training, aid from incubator or from an external manager.

Finally, three main significant factors confirm the importance of managerial competencies, the product or service attitude and the link between RSO founder's position in university, the parent institute interest and the company location.

The first key role is played by *choices* and the second role is given by *managerial competencies*. Choices and managerial competencies influence the company's *orientation*. These three components taken together are the pillars of the cluster analysis grouping and should be taken into account for RSOs policy strategy. Going into details, choices mean reasons for company creation and founder personal choices: the cluster analysis highlighted a positive link between moving from idea to market and RSO founder with a university position on the one hand, and the parent institute interest on the other hand (Cluster 1). Otherwise, the cluster analysis highlighted a link between lack of job in the university and desire for independence with less interest from the parent institute (Cluster 2). Therefore, it seems that RSOs founded by university staff have more probability to be judged as interesting initiatives by their university and consequently receive support from their parent institute. It would be useful to understand *why*: further research could highlight whether this interest is linked to university prestige or to a desire for more revenues. This has consequences on company managerial competencies. In fact, a knowledge gap is observable more in RSOs not founded by university personnel (Cluster 2). Again, possible reasons of this finding can be identified in the more easiness for RSOs supported by their parent institute to fill the knowledge gap through aid from university structures as well as meetings, tutorship, consultancy services, networking with colleagues and not only through self-training. The lack of managerial and business competencies has consequences on the company's orientation - product or service with or without patents - meaning that entrepreneurial competencies have a pivotal importance. Notwithstanding, the overall performance of Italian RSOs seems to be lower compared to other start-ups (Salvador, 2011a). It is also true that spin-off founders with a university position have to balance a trade-off between the time devoted to teaching and research and the daily management of the firm. This could be one of the possible reasons for the absence of marked differences in turnover between RSOs more or less open-oriented.

Therefore, from these considerations it can be assumed that spin-off founders without a university position should be more encouraged and aided in fostering the potentialities of their codified and tacit knowledge. This means first of all that they need to be helped in filling the knowledge gap of managerial and business competencies, that is one of the main weaknesses of RSOs underlined in the literature (Shane, 2004; Wright *et al.*, 2007, 2004; Mustar *et al.*, 2008; Clarysse *et al.*, 2011; Iacobucci *et al.*, 2011). In order to fill this knowledge gap, entrepreneurship education could be a crucial factor in fostering not only entrepreneurial attitude but also entrepreneurial competence and growth of this particular kind of firms (Gorman *et al.*, 1997; Pittaway, Cope, 2007; Fayolle, 2008; Bureau *et al.*, 2012). RSOs have some peculiarities that need to be valorized in order to become successful. To this aim, key actors that could help RSOs are not only universities but also business schools (Wright *et al.*, 2007) in partnership with science parks, incubators and technology transfer offices. The “brand name” of science parks and incubators could be an important signal of credibility (Salvador, 2011) and the proactive role of technology transfer offices should not be underestimated (Clarysse *et al.*, 2007; Jain, George, 2007). Therefore, if the cluster grouping and the factor analysis results are reasonable, and if the overall performance of these companies is not brilliant (Mustar *et al.*, 2008; van Geenhuizen, Soetanto, 2009; Bathelt *et al.*, 2010; Visintin, Pittino, 2014), as a consequence it is important to focus more on *autonomous-oriented RSOs*. This focus could help in understanding why in general RSOs do not show a rapid growth with consequent suggestions for improvement. This means first of all that *autonomous-oriented RSOs* should receive more interest from their parent institute – and encouraged to fulfil this aim even if they have an independence attitude – and should have the possibility to fill the knowledge gap. Secondly, the time devoted to the spin-off initiative by founders with a university position should be strictly balanced: neither the research and teaching duties nor the company management have to be neglected to the detriment of one

over the other. In other words, personal prestige and self-celebration should not overcome the enlargement of the scientific perspective and wealth creation. Last but not least, business schools in partnership with science parks, incubators and technology transfer offices should have the chance and should be encouraged to play a more active role not only in filling the entrepreneurship education gap but also in fostering the potentialities of the codified and tacit knowledge held by this particular kind of firms for company creation and employment opportunities.

Nevertheless, this empirical investigation is not without limitations. First of all, the population of RSOs did not cover the universe. Secondly, the study is limited to the Italian context and does not attempt at providing a cross analysis with other European countries. Thirdly, the analysis relies on data covered within a given time period. Nonetheless, these limitations and potential biases do not affect negatively the significance of the findings, because the sample was more than representative, Italy is an interesting case-study about RSOs and the survey covers a period of RSOs growing at EU level. Furthermore, the originality of this empirical investigation is given by the provision of original data taken directly from “effective” RSOs through a questionnaire investigation. Given the lack of reliable official data, this analysis provided primary data and highlighted interesting findings and served to foster a better understanding of the perceptions of Italian RSOs that might stimulate further research. Future research along this line and with a focus on other EU countries could highlight further consequences of the presence or absence of “interest” of the parent institute for a RSO. The focus on the presence or absence of the parent institute interest and its main reasons and consequences may be a key step in order to shed more light and to improve future policy strategies for a particular kind of firm like a RSO.

References

- Algieri B., Aquino A., Succurro M. 2013. Technology transfer offices and academic spin-off creation: the case of Italy. *The Journal of Technology Transfer*. Vol. 38, pp. 382-400.
- Ayramo S., Karkkainen T. (2006), "Introduction to partitioning-based clustering methods with a robust example", Reports of the Department of Mathematical Information Technology Series C. Software and Computational Engineering No. C. 1/2006, University of Jyväskylä, Finland, pp. 1-36.
- Bathelt H., Kogler D. F., Munro A. K. (2010), "A knowledge-based typology of university spin-offs in the context of regional economic development", *Technovation*, vol. 30, n. 9-10, pp. 519-532.
- Becattini G., Bellandi M., Dei Ottati G., Sforzi F. 2003, *From industrial districts to local development*, Cheltenham, Edward Elgar.
- Benghozi P.-J., Salvador E. 2014. "Are traditional industrial partnerships so strategic for research spin-off development? Some evidence from the Italian case", *Entrepreneurship&Regional Development: an International Journal*, DOI: 10.1080/08985626.2013.860194, vol. 26 (1-2): 47-79.
- Benghozi, P.-J., Bureau, S., Massit-Folléa, F. (2009), "*The Internet of Things, What Challenges for Europe?*" Editions de la Maison des Sciences de l'Homme, Paris.
- Bureau S., Salvador E., Fendt J. (2012), "Small firms and the growth stage: can entrepreneurship education programs be supportive?", *Industry and Higher Education*, vol. 26 n. 2, April, ISSN 0950-4222, pp. 1-22.
- Burns R. P. Burns R. (2009), "Business Research Methods and Statistics using SPSS", Sage publications.
- Calinski T., Harabasz J. (1974), "A dendrite method for cluster analysis", *Communications in Statistics- Simulation and Computation*, vol.3, n. 1, pp. 1-27.
- Carree M. Della Malva A., Santarelli E. 2012. The contribution of universities to growth: empirical evidence for Italy. *The Journal of Technology Transfer*, DOI 10.1007/s10961-012-9282-7, first available on-line.
- Chapman D., Lawton Smith H., Wood P., Barnes T., Romeo S. (2011), "University enterprise: the growth and impact of university-related companies in London", *Industry&Higher Education*, vol. 25, n. 6, pp. 1-10.
- Chiesa, V., Piccaluga, A. (2000), "Exploitation and diffusion of public research: the case of academic spin-off companies in Italy", *R&D Management*, vol. 30, n. 4, pp. 329-340.
- Clarysse B., Lockett A., Quince T., Van de Velde E. (2002), "*Spinning off new ventures: a typology of facilitating services*", Institute for the Promotion of Innovation by Science and Technology in Flanders, *IWT-Observatory, Innovation, Science, Technology*, n. 41.
- Clarysse B., Wright M., Lockett A., Mustar P., Knockaert M. (2007), "Academic spin-offs, formal technology transfer and capital raising", *Industrial and Corporate Change*, vol. 16, n. 4, pp. 609-640.
- Clarysse B., Wright M., Lockett A., van de Velde E., Vohora A. (2005), "Spinning out new ventures: a typology of incubation strategies from European research institutions", *Journal of Business Venturing*, vol. 20, n. 2, pp. 183-216.
- Clarysse B., Wright M., Van de Velde E. (2011), "Entrepreneurial origin, technological knowledge and the growth of spin-off companies", *Journal of Management Studies*, doi: 10.1111/j.1467-6486.2010.00991.x, vol. 48, n. 6, pp. 1420-1442.
- Cowan R., David P. A., Foray D. (2000), "The Explicit Economics of Knowledge Codification and Tacitness", *Industrial and Corporate Change*, vol. 9, n. 2, pp. 211-253.
- De Vries J. (2013), "The influence of power and interest on designing inventory management systems", *International Journal of Production Economics*, vol. 143, pp. 233-241.
- Degroof J.-J., Roberts E. (2003), "*Spinning-off new ventures from academic institutions in areas with weak entrepreneurial infrastructure: insights on the impact of spin-off processes on the growth-orientation of ventures*", MIT Sloan School of Management, Working Paper 4311-03.
- Degroof J.-J., Roberts E. (2004), "*Overcoming weak entrepreneurial infrastructures for academic spin-off ventures*", MIT, Industrial Performance Center, Working Paper Series, MIT-IPC-04-005.
- Everitt B., Landau S., Leese M. (2001), *Cluster Analysis*, Edward Arnold, London.
- Fayolle A. (2008), "Entrepreneurship education at a crossroads: towards a more mature teaching field", *Journal of Enterprising Culture*, vol. 16, n. 4, pp. 325-337.
- Freitas J. S., Gonçalves C. A., Cheng L. C., Muniz R. M. 2013. Structuration aspects in academic spin-off emergence: a roadmap-based analysis. *Technological Forecasting & Social Change*. 80. 1162-1178.
- GEM (2014), *Global Entrepreneurship Monitor, Italia 2013*, edited by Muffatto M., Garengo P., Iacobucci D., Micozzi A., Saaed S., Università degli Studi di Padova, Università Politecnica delle Marche.
- Goldstein H. A., Glaser K. (2012), "Research universities as actors in the governance of local and regional development", *Journal of Technology Transfer*, vol. 37, pp. 158-174.
- Gorman G., Hanlon D., King W. (1997) "Some research perspectives on entrepreneurship education and education for small business management: a ten-year literature review", *International Small Business Journal*, vol. 15, n. 3, pp. 56-77.
- Gray R. M., Neuhoff D.L. (1998), "Quantization," *IEEE Transactions on Information Theory*, vol. 44, n. 6, pp. 2325-2383, October 1998, (Commemorative Issue, 1948-1998).
- Gupte, M. (2007), "*Success of University Spin-offs. Network Activities and Moderating Effects of Internal Communication and Adhocracy*", Kiel, Deutscher Universitäts-Verlag.
- Heirman A., Clarysse B. (2004), "How and why do research-based start-ups differ at founding? A resource-based configurational perspective", *Journal of Technology Transfer*, vol. 29, n. 3-4, pp. 247-268.

- Iacobucci D., Iacopini A., Micozzi A., Orsini S. (2011), "Fostering entrepreneurship in academic spin-offs", *International Journal of Entrepreneurship and Small Business*, vol. 12, n. 4, pp. 513-533.
- Iammarino S., Sanna-Randaccio F., Savona M. (2009), The perception of obstacles to innovation. Foreign multinationals and domestic firms in Italy, *Revue d'Economie Industrielle*, n. 125, 1er trimestre, pp. 75-104.
- Jain S., George G. (2007), "Technology transfer offices and institutional entrepreneurs: the case of Wisconsin Alumni Research Foundation and human embryonic stem cells", *Industrial and Corporate Change*, vol. 16, n. 4, pp. 535-568.
- Lansiluoto A., Jarvenpaa M., Krumwiede K. (2013), "Conflicting interests but filtered key targets: Stakeholder and resource-dependency analyses at a University of Applied Sciences", *Management Accounting Research*, vol. 24, pp. 228-245.
- Lockett, A., Wright, M., Franklin, S. (2003), "Technology Transfer and Universities' Spin-Out Strategies", *Small Business Economics*, vol. 20, n. 2, pp. 185-200.
- Mariotti I., Salvador E. (2014), "On-park and off-park research spin-offs: some insights from an empirical investigation on Italy", *International Journal of Entrepreneurship and Innovation Management*, Special Issue on Inspired by Silicon Valley: a Cheap Copy or a Masterpiece?, *forthcoming*.
- Milligan G. W., Cooper M. C. (1985), "An examination of procedures for determining the number of clusters in a data set", *Psychometrika*, vol.50, n. 2, pp. 159-179.
- Mustar P. (1997), "Spin-off enterprises. How French academics create hi-tech companies: the conditions for success or failure", *Science and Public Policy*, vol. 24, n. 1, pp. 37-43.
- Mustar P., Wright M., Clarysse B. (2008), "University spin-off firms: lessons from ten years of experience in Europe", *Science and Public Policy*, vol. 35, n. 2, pp. 67-80.
- Mustar P., Renault M., Colombo M., Piva E., Fontes M., Lockett A., Wright M., Clarysse B., Moray N. (2006), "Conceptualising the heterogeneity of research-based spin-offs: a multi-dimensional taxonomy", *Research Policy*, vol. 35, n. 2, pp. 289-308.
- Netval 2013. Seminiamo ricerca per raccogliere innovazione, 10° rapporto Netval sulla valorizzazione della ricerca nelle università italiane. Lucca: Maria Pacini Fazzi Editore.
- Nosella A., Grimaldi R. (2009), "University-level mechanisms supporting the creation of new companies : an analysis of Italian academic spin-offs", *Technology Analysis & Strategic Management*, vol. 21, n. 6, pp. 679-698.
- O'Keefe P. A., Linnenbrink-Garcia L. (2014), "The role of interest in optimizing performance and self-regulation", *Journal of Experimental Social Psychology*, vol. 53, pp. 70-78.
- O'Shea, R. P., Allen, T. J., Chevalier, A., Roche, F. (2005), "Entrepreneurial orientation, technology transfer and spinoff performance of U.S. universities", *Research Policy*, n. 34, n. 7, pp. 994 - 1009.
- Philpott K., Dooley L., O'Reilly C., Lupton G. (2011), "The entrepreneurial university: Examining the underlying academic tensions", *Technovation*, vol. 31, n. 4, pp. 161-170.
- Pittaway L., Cope J. (2007), "Entrepreneurship education: a systematic review of the evidence", *International Small Business Journal*, vol. 25, n. 5, pp. 479-510.
- Powell W., Grodal S. (2005), "Networks of Innovators", in Fagerberg J., Mowery D. C., Nelson R.R., eds. (2005), "*The Oxford Handbook of Innovation*", Oxford, Oxford University Press.
- Rasmussen E. (2006), "Spin-off venture creation in a university context. An entrepreneurial process view", paper presented at the 14th Nordic Conference on Small Business Research in Stockholm, Sweden.
- Rasmussen E. (2011), "Understanding academic entrepreneurship: exploring the emergence of university spin-off ventures using process theories", *International Small Business Journal*, vol. 29, n. 5, pp. 448-471.
- Rasmussen E., Mosey S., Wright M. (2014), "The influence of university departments on the evolution of entrepreneurial competencies in spin-off ventures", *Research Policy*, vol. 43, n. 1, pp. 92-106.
- Roberts, E. (1991), "High Stakes for High-Tech Entrepreneurs: Understanding Venture Capital Decision Making", *Sloan Management Review*, vol. 32, n. 2, pp. 9-20.
- Rothaermel, F. T., Thursby, M. (2005), "Incubator firm failure or graduation? The role of university linkages", *Research Policy*, vol. 34, n. 7, pp. 1076-1090.
- Rowley T. J., Moldoveanu M. (2003), "When will stakeholder groups act? An interest-and identity-based model of stakeholder group mobilization", *Academy of Management Review*, vol. 28, n. 2, pp. 204-219.
- Salvador E. (2009), "Evolution of Italian universities' rules for spin-offs: the usefulness of formal regulations", *Industry&Higher Education*, vol. 23, n. 6, pp. 445-462.
- Salvador E. (2011), "Are science parks and incubators good "brand names" for spin-offs? The case-study of Turin", in *Journal of Technology Transfer*, ISSN 0892-9912 (Print) 1573-7047 (Online), DOI 10.1007/s10961-010-9152-0, vol. 36, n. 2, pp. 203-232.
- Salvador E. (2011a), "How effective are research spin-off firms in Italy?", *Revue d'Économie Industrielle*, n. 133, 1er trimestre, ISSN 0154-3229, pp. 99-122.
- Salvador E., Rolfo S. (2011), "Are incubators and science parks effective for research spin-offs? Evidence from Italy", *Science and Public Policy*, DOI: 10.3152/016502611X12849792159191, vol. 38, n. 3, pp. 170-184.
- Shane S., Stuart T. (2002), "Organizational endowments and the performance of university start-ups", *Management Science*, vol. 48, n. 1, pp. 154-170.
- Shane, S. (2004), "*Academic Entrepreneurship. University Spinoffs and Wealth Creation*", Cheltenham, UK, Edward Elgar.
- Steffensen M., Rogers E. M., Speakman K. (1999), "Spin-offs from research centers at a research university", *Journal of Business Venturing*, vol. 15, n. 1, pp. 93-111.
- Sternberg S. (2014), "Success factors of university-spin-offs: Regional government support programs versus regional environment", *Technovation*, vol. 34, n. 3, pp. 137-148.

- Tan P.-N., Steinbach M., Kumar V. (2005), "Introduction to Data Mining", USA, Addison-Wesley.
- Treibich T., Konrad K., Truffer B. (2013), "A dynamic view on interactions between academic spin-offs and their parent organizations", *Technovation*, vol. 33, n. 12, pp. 450–462.
- Van Geenhuizen M., Soetanto D. P. (2009), "Academic spin-offs at different ages: a case study in search of key obstacles to growth", *Technovation*, vol. 29, n. 10, pp. 671–681.
- Varaldo, R., Di Minin, A. (2009), "A new form of entrepreneurial capitalism based on innovation and research in Italy", Occasional Paper Ufficio Studi Finmeccanica, July.
- Visintin F., Pittino D. (2014), "Founding team composition and early performance of university—Based spin-off companies", *Technovation*, vol. 34, n. 1, pp. 31–43.
- Westhead P., Storey D. J. (1995), "Links between higher education institutions and high technology firms", *Omega*, vol. 23, n. 4, pp. 345–360.
- Witt U., Zellner C. (2007), "Knowledge-based entrepreneurship: the organizational side of technology commercialization", Malerba F., Brusoni S., eds., (2007), "*Perspectives on Innovation*", Cambridge, Cambridge University Press.
- Wright, M., Clarysse, B., Mustar, P., Lockett, A. (2007), "Academic Entrepreneurship in Europe", Cheltenham UK, Edward Elgar.
- Wright, M., Vohora, A., Lockett, A. (2004), "The Formation of High-Tech University Spinouts: The Role of Joint Ventures and Venture Capital Investors", *Journal of Technology Transfer*, vol. 29, n. 3–4, pp. 287–310.

Annex A: Definitions of variables used for cluster analysis

Var01	Year of foundation in the last five years (1=yes; 2=no)
Var02	Form of society (1=srl; 2=sipa; 3=sas)
Var03	Number of shareholders between 1 and 5 (1=yes; 2=no)
Var04	Some shareholders left the university (1=yes; 2=no)
Var05	Company (1=product; 2=service)
Var06	Reasons for company creation (first choice)
Var07	Reasons for company creation (second choice)
Var08	Increase in capital (1=yes; 2=no)
Var09	Actual capital under 50,000 euro (1=yes; 2=no)
Var10	Solutions to lack of managerial competence
Var11	Market (1=local-regional; 2=national; 3=international)
Var12	Use of self-financing (1=yes; 2=no)
Var13	Use of loans from banks (1=yes; 2=no)
Var14	Regional, national and European grants (1=yes; 2=no)
Var15	Start-cup (1=yes; 2=no)
Var16	MIP (1=yes; 2=no)
Var17	Support of credit (1=yes; 2=no)
Var18	Venture capital financing (1=yes; 2=no)
Var19	Relationship with banks
Var20	Agreement benefiting on-park spin-offs (1=yes; 2=no)
Var21	University interest (1=yes; 2=no)
Var22	Hosted by a science park-incubator (1=yes; 2=no)
Var23	Patent (1=yes; 2=no)
Var24	Industrial partnership (1=yes; 2=no)
Var25	Verdict on company location (1=advantage; 2=indifference; 3=disadvantage)
Var26	Aid from the Region (1=yes; 2=no)
Var27	Company location (1=North; 2=Centre; 3=South and Islands)

Annex B: Kaiser-Meyer-Olkin measure of sampling adequacy

Variable	Kmo
Var02	0.7278
Var04	0.6589
Var05	0.4685
Var06	0.7013
Var10	0.6214
Var11	0.6651
Var19	0.6612
Var21	0.5202
Var23	0.4803
Var27	0.6197
Overall	0.5807

Annex C: Correlation matrix

	var1	var2	var3	var4	var5	var6	var7	var8	var09	var10	var11	var12	var13	var14
var1	1.0000													
var2	0.0216	1.0000												
var3	-0.2014	-0.1431	1.0000											
var4	-0.1674	-0.1804	0.1403	1.0000										
var5	-0.0668	-0.0374	0.1361	-0.0000	1.0000									
var6	0.0283	-0.1341	0.0104	0.2662	-0.0981	1.0000								
var7	-0.0812	0.1202	-0.1144	0.1048	0.0030	0.0356	1.0000							
var8	-0.2702	-0.1958	0.0755	0.1949	0.1863	0.0489	-0.1448	1.0000						
var09	0.0770	0.0979	-0.0137	-0.1828	-0.2097	0.0355	-0.0142	-0.3989	1.0000					
var10	0.0667	-0.1693	0.0228	0.1257	0.1257	0.1289	0.0396	0.0852	0.1003	1.0000				
var11	0.0882	0.1034	-0.1408	-0.1023	-0.1193	-0.0072	-0.0682	-0.0381	0.0563	-0.2650	1.0000			
var12	-0.0705	0.0842	-0.0976	0.0055	-0.1284	-0.0431	0.0051	0.0421	0.1570	-0.0891	0.0218	1.0000		
var13	-0.1179	-0.0862	-0.0206	0.0763	-0.0339	0.2319	-0.0599	0.0289	0.0391	0.0461	-0.0049	-0.0581	1.0000	
var14	-0.0030	-0.1645	0.1322	0.0231	0.0221	0.1121	-0.0029	-0.0321	0.0441	0.0667	-0.0253	-0.2377	0.3440	1.0000
var15	0.0991	0.0669	-0.1711	-0.0152	0.1120	-0.0594	-0.1138	-0.0507	0.0580	-0.0790	-0.1028	-0.0911	0.1815	-0.0793
var16	-0.0638	0.0563	0.1010	-0.0156	0.0754	0.0248	-0.0144	-0.1003	0.1027	0.0332	-0.1606	-0.1075	0.1637	-0.0667
var17	-0.0802	0.0320	-0.0251	-0.0598	0.1715	-0.0233	-0.1022	-0.0570	0.0584	0.0963	0.0655	-0.1174	0.1601	-0.0816
var18	-0.0136	-0.0862	0.1755	0.1368	0.2715	-0.0202	-0.1715	0.2158	-0.4519	0.0093	-0.1166	-0.3254	-0.1129	-0.0188
var19	-0.0067	-0.0869	-0.2619	0.2023	-0.0562	0.1771	0.0738	0.0441	0.0167	0.2321	-0.0024	0.0350	0.1525	0.0665
var20	0.0099	0.1055	-0.0184	0.1210	0.0744	0.0010	0.0057	0.0305	-0.1839	0.0756	-0.0780	-0.0649	0.0050	-0.1326
var21	0.0823	0.1626	-0.1327	-0.2657	0.1911	-0.1494	-0.0269	-0.1466	0.0150	-0.1824	0.1226	-0.0318	0.0086	0.0613
var22	-0.0718	-0.1236	0.3258	0.1202	0.0000	-0.0063	0.1109	0.0809	0.0114	0.2037	-0.1844	-0.1168	-0.0042	0.1043
var23	-0.1060	-0.0035	0.0791	-0.0434	0.4201	-0.1551	-0.0880	0.3204	-0.3468	0.0292	-0.1147	-0.0699	-0.0903	-0.1503
var24	-0.0593	-0.0126	0.0221	0.0311	0.0846	-0.0943	-0.1075	0.1778	-0.0460	-0.1160	-0.0908	-0.0869	0.0359	0.0903
var25	0.0348	0.0713	-0.0152	0.0563	0.0109	0.0343	0.0713	-0.0673	0.1223	0.0722	-0.1662	0.0845	0.0007	0.0370
var26	-0.1320	-0.0054	0.1221	-0.0120	0.1234	0.0483	0.2343	0.2110	-0.0421	0.1258	-0.1600	-0.0167	0.1739	0.0744
var27	-0.0291	-0.0230	0.0834	0.1708	0.1281	0.0115	-0.1251	0.0801	0.0013	0.0925	-0.2072	-0.0066	0.1652	0.0402

	var15	var16	var17	var18	var19	var20	var21	var22	var23	var24	var25	var26	var27
var15	1.0000												
var16	0.3925	1.0000											
var17	0.1128	0.2715	1.0000										
var18	0.0504	-0.0716	-0.0407	1.0000									
var19	0.0220	0.0442	0.1236	-0.0229	1.0000								
var20	-0.0017	0.2242	0.1275	0.0747	0.0487	1.0000							
var21	0.0464	0.0160	-0.0328	0.0584	-0.1405	-0.0426	1.0000						
var22	-0.0625	0.2431	0.1383	-0.1010	-0.0228	0.2011	-0.2370	1.0000					
var23	0.0568	-0.0457	-0.0720	0.2376	-0.0577	0.0021	-0.0922	-0.0550	1.0000				
var24	0.1107	-0.0191	0.0308	0.2340	-0.0451	-0.0503	0.0377	0.0118	0.0148	1.0000			
var25	-0.0170	0.0327	0.1470	-0.0247	-0.0022	0.1504	-0.0062	0.1655	-0.0661	0.0560	1.0000		
var26	0.0778	0.1613	0.0106	-0.0670	-0.0402	0.0138	-0.0518	0.2820	0.1181	-0.0522	0.1098	1.0000	
var27	-0.0050	0.1429	0.0813	0.0452	-0.0324	0.0312	-0.1191	0.2224	0.0888	0.1287	0.1177	0.1961	1.0000