

Toward a Typology of University Spin-offs

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ABSTRACT. This paper discusses existing definitions of USOs in order to reconcile them and to provide criteria for classifying and understanding the different facets of this multi-headed concept. Drawing the boundaries of this concept and elucidating its variety through a typology are therefore the two main objectives of this paper. USOs are defined as new firms created to exploit commercially some knowledge, technology or research results developed within a university. The proposed typology is based on two key discriminatory factors, namely (1) the status of individuals involved in the new business venturing process (researchers or students) and (2) the nature of knowledge transferred from university to the new venture (codified or tacit), inducing the nature of the USO activities (product or service-oriented).

1. Introduction

Popularised by the development of the legendary "Silicon Valley" and "Route 128" around prestigious universities such as Stanford and MIT, university spin-offs (USOs) have been part of the American academic landscape for decades (Cooper, 1971a, b; Brett et al., 1991; Roberts, 1991). In Europe, the phenomenon of USOs is still in its infancy. Although the first USOs appeared in the mid-1970s, most European academic authorities were indifferent or even opposed to their development (Stankiewicz, 1994; Mustar, 1997). It is only recently that European universities have realized the strategic role of laboratories and research centers in fostering a region's capacity to innovate by creating and diffusing knowledge (OECD, 1998).

Since the seminal studies conducted by Cooper

in the early 1970s on the spin-off activity at Stanford University (Cooper, 1971a, b), university-based venture creation has received increasing attention from scholars, especially in the United States (Etzkowitz, 1989, 1990; Smilor et al., 1990; Brett et al., 1991; Roberts and Malone, 1996; Carayannis et al., 1998) and in Sweden (Stankiewicz, 1986, 1994; Klofsten et al., 1988).

However, an in-depth review of this literature shows that most authors do not clearly define a university spin-off (Pirnay, 1998). In our opinion, the continued adoption of a loose definition for such a key element could harm future research. It can lead to situations where researchers use the same concept (USO) for studying and describing different realities. For instance, when looking at the number of firms that have been spun-out of MIT, Roberts and Malone (1996, p. 44) observed over a 30-year period a yearly rate of 6.4 firms created. At the same time, Bray and Lee (2000, p. 386) estimated this rate to be 25 (over the last 20 years), whereas Carayannis et al. (1998, p. 2) and Steffensen et al. (2000, p. 95), both quoting a 1997 survey by the Bank Boston, state the total number at about 4000, corresponding to an annual rate of at least 140. Who is right? All these estimations are supposedly accurate but probably rely on different definitions of USOs, which are not explicitly clarified by the authors.

The above example clearly illustrates the need for clarifying the concept of USOs. In that respect, inventorying university spin-offs is not straightforward, as Roberts (1972, p. 138) reported from a study of high technology firms in Boston:

"In this one organization, we started by working with the director of personnel and the old-line personnel ladies who supposedly knew everybody from the lab. They only knew of three spin-offs. We had checked our files for duplicates and cross-references and mistaken references that we had picked up, and we gave them four more at the first meeting.

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So, we had seven at the outset, and we finally talked about them into the notion that we would find at least 20, and it would be worth our bothering with. We eventually found, interviewed and studied 39 companies. There is a tremendous iceberg phenomenon at work in these organizations" (quoted by McMullan and Vesper, 1987, p. 354).

This statement shows that USOs are extraordinarily heterogeneous and their borders can vary significantly according to the perception of practitioners and scholars. In that respect, the following statement made by Philippe Mustar is unequivocal and indicative:

"... One cannot speak of USOs as new business venturing by researchers ... We must stop considering USOs as a single and homogenous phenomenon ... It is time to capitalize on the scattered empirical evidence accumulated for more than twenty years and integrate them into a common typology which should be relevant for both scholars and practitioners" (Mustar, 2000).

As a consequence, a general framework specifying the type of phenomena under consideration is necessary to accumulate useful knowledge in this key field of research. The lack of such a framework not only leads to crude generalizations of research results whose domains of validity have not been explicitly specified, but also contributes to poor empirical results due to the non-comparability of both samples and situations studied.

Drawing the boundaries of this multi-headed concept and elucidating its variety through a typology are the two main objectives of this paper.

To achieve this, the paper proposes a definition of USOs and then surveys the relevant literature to develop a typology of university spin-offs that makes up the many facets of a complex and fuzzy reality. The contribution of the typology for further research is finally discussed.

2. Toward a typology of university spin-offs

2.1. Toward a general definition

To define a typology, we must first clarify the object of study. In particular "spin-off" is a fuzzy and general concept that covers a wide variety of phenomena among which the USO represents only one specific type (Pirnay, 1998). Indeed, any phenomenon can be qualified as a "spin-off" as long as it simultaneously fulfils three conditions:

- it takes place within an existing organization, generally known as the "parent organization";
- it involves one or several individuals, whatever their status and function within the "parent organization";
- these individuals leave the "parent organization" to create a new one.

Thus, creating a "spin-off" necessarily implies an important change in the career path of an individual, namely leaving an existing organization to launch his/her own business venture.

We agree that a USO refers to a spin-off firm that is created from a particular type of "parent organization", namely a university. Table I shows that there have been many attempts to explicitly define USO. They unfortunately do not all fit together. Indeed, there are almost as many definitions of the phenomenon as there are researchers looking at it.

A careful examination of Table I reveals that the same term is sometimes used differently by different authors while some authors use different terms to describe the same phenomenon. Examples of these definitional ambiguities are given below and highlighted in Table II.

For the purpose of clarity, we specify our own definition of university spin-offs as:

"new firms created to exploit commercially some knowledge, technology or research results developed within a university".

This definition, very close to the one of Klofsten and Jones-Evans (2000), draws the boundaries of USOs as

1. New companies . . .

A USO is a new company endowed with a distinct legal status that is neither an extension, nor a controlled subsidiary of the university, but is an autonomous structure pursuing profit-making activities.

2. . . . created from universities . . .

The "parent organization" of a USO excludes technical schools, public/private R&D departments, large national laboratories and research institutes. For these organizations, it is preferable to talk about "research-based spin-offs" (Clarysse et al., 2000) which is a broader concept that encompasses new ventures created from research-oriented organizations such as

TABLE I
Some existing definitions of University Spin-offs (USOs)

Authors	Year	Definitions
McQueen, D. H. Wallmark, J. T.	1982	"... in order to be classified as a university spin-off, three criteria has to be met: (1) the company founder or founders have to come from a university (faculty, staff or student); (2) the activity of the company has to be based on technical ideas generated in the university environment; and (3) the transfer from the university to the company has to be direct and not via an intermediate employment somewhere" (p. 307)
Smilor, R. W. Gibson, D. V. Dietrich, G. B.	1990	"a company that is founded (1) by a faculty member, staff member, or student who left the university to start a company or who started the company while still affiliated with the university; and/or (2) around a technology or technology-based idea developed within the university" (p. 63)
Weatherston, J.	1995	"... an academic spin-off can be described as a business venture which is initiated, or become commercially active, with the academic entrepreneur playing a key role in any or all of the planning, initial establishment, or subsequent management phases" (p. 1)
Carayannis, E. Rogers, E. Kurihara, K. Allbritton, M.	1998	"a new company formed by individuals who were former employees of a parent organization (the university), around a core technology that originated at a parent organization and that was transferred to the new company" (p. 1)
Bellini, E., et al.	1999	"... academic spin-offs are companies founded by university teachers, researchers, or students and graduates in order to commercially exploit the results of the research in which they might have been involved at the university. ... the commercial exploitation of scientific and technological knowledge is realised by university scientists (teachers or researchers), students and graduates." (p. 2)
O'Gorman, C. Jones-Evans, D.	1999	"... the formation of a new firm or organisation to exploit the results of the university research"
Rappert, B. Webster, A. Charles, D.	1999	"University spin-offs are firms whose products or services develop out of technology-based ideas or scientific/technical know-how generated in a university setting by a member of faculty, staff or student who founded (or co-founded with others) the firm" (p. 874)
Clarysse, B. Heirman, A. Degroof, J. J.	2000	"... Research-based spin-offs are defined as new companies set up by a host institute (university, technical school, public/private R&D department) to transfer and commercialize inventions resulting from the R&D efforts of the departments" (p. 546)
Klofsten, M. Jones-Evans, D.	2000	"... formation of new firm or organisation to exploit the results of the university research" (p. 300)
Steffensen, M. Rogers, E. Speakman, K.	2000	"A spin-off is a new company that is formed (1) by individuals who were former employees of a parent organization, and (2) a core technology that is transferred from the parent organization" (p. 97)

universities but also national labs, technical schools, inter-university research institutes,...

3. ... to exploit knowledge produced by academic activities ...

This includes not only technological innovation or patents (McQueen and Wallmark, 1982; Smilor et al., 1990; Bellini et al., 1999), but

also scientific and technical know-how accumulated by an individual during his/her academic activities (Rappert et al., 1999).

4. ... in a profit-making perspective

This means that the whole purpose of a USO is to bring an idea into the business sphere, excluding therefore non-profit organisations.

TABLE II
Examples of some definitional ambiguities

Characteristics	Authors and terms used			
	Smilor et al. (1990)	Bellini et al. (1999)	Rappert et al. (1999)	Steffensen et al. (2000)
	Spin-off	Academic spin-off	University spin-off	Spin-off
The concerned individuals (Who?)	Faculty member; Staff member; Student.	University teachers; Researchers; Students; Graduates.	Faculty; Staff; Student.	Faculty
The relationships between individuals and their university (How?)	The founders may <i>either</i> leave the university to start their company; <i>or</i> remain affiliated with the university.	The founders have to leave the university to manage their venture on their own	Not addressed.	The founders are former employees of a parent organization.
The origin of USO activities (What ?)	Technology-based ideas developed within the university.	Results of research in which the founders have been involved at the university.	Technology-based ideas; or scientific-technical know-how generated in a university setting.	A core technology that is transferred from the parent organization to the spin-off firm.

2.2. Toward a typology of USOs

While the above definition emphasizes the common features shared by all USOs, one must admit that due to constraints of generality and conciseness our four boundaries may devalue the richness and diversity of the USO phenomena. This is why a typology would be helpful to get a better grip on these phenomena.

To proceed in that direction, a close reading of the literature reveals two major dimensions along which authors tend to differ in what they mean by the generic concept of a university spin-off. These factors are:

(a) The status of individuals involved in the new business venturing process

While some authors (i.e. Steffensen et al., 2000) consider only researchers as possible initiators of USOs, others (i.e. McQueen and Wallmark, 1982; Smilor et al., 1990; Rappert et al., 1999; Bellini et al., 1999) are less restrictive in their definition by specifying that a USO can be founded by a faculty member, a staff member or a student.

(b) The nature of knowledge transferred from university to the new venture

While some authors focus mainly on tech-

nology based spin-offs (i.e. Steffensen et al., 2000), others encompass situations where know-how services are also exploited by service-based firms (i.e. Rappert et al., 1999).

2.2.1. Status of individuals involved in the business venturing process

The first factor is the status of individuals involved in the business venturing process. USOs are usually initiated by individuals coming either from the "scientific" community including people with substantial research experience such as professors, assistants, researchers and doctoral students (Mustar, 1997; Clarysse et al., 2000), or from the "student" community with little in-depth research background (Albert et al., 1991; Ivancevich, 1991; Bellini et al., 1999; Laukanen, 2000). Whereas "academic spin-offs" (ASOs) are basically created to exploit, in business, some promising results obtained by university researchers, "student spin-offs" (SSOs) are usually launched to exploit a business opportunity that is rarely grounded on extensive research activities. Further, SSOs tend to be concentrated in sectors with little barriers to entry such as, for instance, internet applications.

The distinction between ASOs and SSOs is relevant because the USO's profile will often vary

to a large extent in terms of activities, financial needs, material requirements and growth perspectives. Similarly, the relationships with their parent organisation (the university) will vary accordingly.

To be considered a "genuine" spin-off, an ASO must be launched by a researcher leaving the university. However, in practice, many researchers are reluctant or not able to be actively involved in the commercialisation of their inventions. In fact, contrary to many authors (McQueen and Wallmark, 1982; Bellini et al., 1999; Steffensen et al., 2000), we do not restrict USOs to firms created by a faculty staff member or a student as long as the knowledge that is actually exploited has been nurtured within a university. Our experience shows that the majority of new firms that are created to exploit a research result or university knowledge do not necessarily coincide with the leave of university researchers. This explains why some ASOs are launched by entrepreneurs who are not the inventors (Roberts and Peter, 1981; McMullan and Melnyck, 1987; Van Dierdonck and Debackere, 1988; Radosevich, 1995; Kassicieh et al., 1996; Franklin and Wright, 1999). Van Dierdonck and Debackere (1988) use the terms, "extrapreneurial spin-offs" and "intrapreneurial spin-offs" to characterise the companies created respectively by researchers who leave the university and by researchers who remain.

Although these situations where spin-offs are actually managed by surrogate entrepreneurs do not strictly correspond to genuine spin-offs, they are nevertheless considered to be USOs. Indeed, the major criteria of our definition refers to "transfer of knowledge from university to a new spin-off firm" not to "leave of a researcher to create and manage a new company".

2.2.2. *Nature of knowledge transferred from university to the new venture*

A USO constitutes a particular way of generating business with "knowledge" produced within universities and is therefore considered to be a mechanism of knowledge transfer from university to industry (Matkin, 1990; Harmon et al., 1997; Bozeman, 2000). Two kinds of knowledge are likely to be transferred by spinning-off the new firm: the *codified* knowledge and the *tacit* (or embodied) knowledge (Howells, 1995).

Codified knowledge represents the most visible

output of research activities. It takes various forms such as a publication, an experimentation report, a computer program, a technical artefact and equipment. Relying on formal and explicit information, codified knowledge is generally distinct from the human brain that produced it. Consequently, it can be easily transferred, distributed and used (Callon, 1999), but also copied and imitated by others (De Bandt, 1997), inducing the problem of the protection of this knowledge (Rappert et al., 1999). In that respect, two different aspects may be considered: natural protection and artificial protection. Natural protection is based on both the technological level of the results (the degree of innovation) and barriers to imitation that give the results' owners a technological lead for a considerable period of time. However, as most university research results do not enjoy high barriers to imitation coupled with strong technological lead, artificial protection, such as patents or copyrights, is generally more appropriate (Lowe, 1993). In fact, codified knowledge may be protected by such legal means.

Tacit knowledge is much more concerned with pieces of personal knowledge accumulated by an individual during his/her academic activities. Taking various forms (e.g. capability, expertise and experience), this kind of knowledge is closely associated with each individual (embodied knowledge). Tacitness of knowledge implies non-tradability, and non-tradability implies accessibility through interactive learning and explicit co-operation rather than through contractual exchange. This applies both to the process of knowledge creation as well as to its transfer or diffusion (Blankenburg, 1998).

Cassier (1997) observes that codified and tacit knowledge are closely related to one another. Consequently, the economic exploitation of codified knowledge (e.g. technology) by spinning-off new firms can be problematic, particularly when the project is carried out by a surrogate entrepreneur with little technical expertise (tacit knowledge) to really understand and fully exploit the technology (codified knowledge).

This second factor discriminates between USOs whose main activities (core business) are rooted in codified and technological knowledge exploited for industrial purposes (product-oriented spin-offs) and USOs devoted to the exploitation of tacit

knowledge in a logic of expertise providers (service-oriented spin-offs).

To discriminate USOs along that dimension is very important for research. Indeed, issues such as growth potential, the management of patenting and intellectual rights, or seed financing for prototypes can vary enormously among projects.

In addition, it is worth mentioning that this factor plays also a crucial role in the confusion noted in the literature. In that respect, quoting a study by Roberts, McMullan and Vesper (1987) makes sense:

"Roberts considered a venture as a MIT spin-off even if there was a lag of up to nine years between leaving MIT or an affiliate labs and starting the company as long as the technological base of the company was related to research at the lab at the time of employment" (McMullan and Vesper, 1987, p. 356).

According to Roberts' statement, a university spin-off does not necessarily require a direct knowledge transfer. As the business idea leading to the creation of a new venture derives from previous knowledge accumulated by an individual while affiliated at the university (regardless his/her intervening employment experience), Roberts considers this venture as a university spin-off. On the contrary, other authors (such as McQueen and Wallmark, 1982) exclude cases where the founder has spent some intermediate years between his/her departure from the university and the formation of his/her new firm. Thus, in line with these latter authors, we argue that a USO results from a direct transfer from the university to the new company, because one cannot rule out the possibility that the experience accumulated by an individual during his/her intermediate employment could have contributed significantly to the new venture formation.

2.2.3. *University attitude towards entrepreneurship*

To these two factors we would like to discuss a third one, which is the attitude of the university toward the spin-off (i.e. favourable or not). Traditionally, universities were supposed to fill two missions (research and teaching). They used to consider commercially-based activities at best as irrelevant and in most cases vulgar.

Over time, the creation of USOs progressively gained respectability and legitimacy in the eyes of

political and academic authorities (Etzkowitz, 1989, 1993, 1998; Etzkowitz et al., 2000; Van Dierdonck and Debackere, 1988; Roberts and Malone, 1996; OECD, 1998; Carayannis et al., 1998; Steffensen et al., 2000). The reasons for change include:

- The growing social pressure on universities to broaden their traditional missions and to adopt a more proactive participation in their region's economic development. This leads universities to define a third mission, namely to be "entrepreneurial universities" (Clark, 1998; Etzkowitz, 1998);
- The increasing inter-relation of science and technology in numerous disciplines such as IT and biotechnology, inducing more collaboration between industry and universities (Mustar, 1997; OECD, 1998; Etzkowitz, 1998);
- The declining proportion of public budgets for funding traditional academic activities (teaching and research) requiring universities to search for alternative financing (Chiesa and Bellini, 2000).

This change in university attitude provides a key dimension to discriminate between USOs created without support from the university and those founded with the proactive compliance and support of universities. Pirnay (1998) classifies these situations as (i) "pull spin-off" when individuals are pulled out of their university by the promising perspectives of a market opportunity, and as (ii) "push spin-off" when the university is playing an important role in promoting entrepreneurial behaviour among its staff members, while pushing them to create new ventures. Analogously, Steffensen et al. (2000) use the terms (i) "spontaneously occurring spin-off" when the new company is established by an individual who identifies a market opportunity and then founds the spin-off with little encouragement from the parent organisation, and (ii) "planned spin-off" when the new venture results from an organised effort by the parent organisation.

While disturbing some habits deeply rooted in academic practice (Nlemvo et al., 2002), this change in attitude modifies fundamentally the context in which members of the university community who wish to create a new business operate. Such a change in attitude can be interpreted as a

paradigm shift to the extent that, initially considered as deviant and unhealthy by most academic authorities, USOs are nowadays legitimised and strongly encouraged by these same authorities (Etzkowitz et al., 2000).

In practice, this paradigm shift did not occur uniformly. There are major differences not only between countries but also among universities within the same country. In that respect, recent research by Clarysse et al. (2000) shows that, although some governments (notably in Anglo-Saxon and Scandinavian countries) have initiated relevant measures to stimulate entrepreneurship within universities, the real "trigger" is taking place amongst senior academic authorities, for instance when a more entrepreneurship-oriented dean or rector is appointed as head of a university.

University attitude plays also an important role in the confusion noted in the literature. Depending on whether authors consider all companies created from a university, or take into account just those created with the explicit support of the university, such as only those in which the university holds shares, the results will vary considerably. In addition, USOs created without the support (and therefore without the control) of their university can be "underground" companies and consequently miss inclusion in the databases. As a result, there is a problem with the completeness of data (McQueen and Wallmark, 1982; McMullan and Vesper, 1987).

Furthermore, it is worth mentioning that there is no general agreement on what scholars mean by "university" (Matkin, 1990). This concept may have multiple meanings depending on whether it refers to public institutions (McQueen and Wallmark, 1982; Klofsten et al., 1988; Chrisman et al., 1995; Fontes, 1998), to private institutions (Roberts, 1991), or even to large national laboratories (Kassicieh et al., 1996; Clarysse et al., 2000).

The friendliness of the *context* in which a spin-off is created can considerably affect its process of development. For instance, the overall job creation, speed of development, or failure rate of USOs can be very different in situations where the university is supportive. Consequently, we argue that context also an important dimension in explaining discrepancies among empirical research of the USO creation process.

Because USOs created without the support of their university are much more the result of an emerging process than an intended one, we will not however consider these in our typology. Thus, we will focus on cases and issues related to USOs actually supported by an institutional university policy. Indeed, what would be the rationale to include, for instance, SSOs in situations where the university does not deal with the support of spin-offs by students?

2.2.4. Toward a conceptual framework of USOs

It follows from our discussion that each of these two relevant factors represents a key facet of the USO phenomena, namely (1) the status of *individuals* involved in the process (researchers or students), and (2) the nature of the USOs *activities* (product or service-oriented) induced by the kind of knowledge transferred. The combination of these two factors leads to an original typology summarized in Figure 1.

This typology relies upon non-ambiguous factors. As a consequence, the assignment of any USO to one of these categories becomes evident.

Now, the problem is to move from abstract concepts to concrete organisations and to check whether our classification can be of some help for both scholars and practitioners. This problem is best addressed by a combination of empirical and theoretical methods. The remainder of this paper provides some suggestions about the nature of the differences that distinguish one category of USOs

		Individual status	
		researcher	student
		(academic spin-off)	(student spin-off)
Nature of knowledge transferred	coded	Type I	Type III
	tacit	Type II	Type IV

Figure 1. A typology of university spin-offs.

from the others. In this vein, the available empirical literature devoted to USOs has been explored to put forward some criteria that appear to differentiate the four categories of USOs. Although it is beyond the scope of this paper to develop a classification in full, each of the relevant criteria will be briefly discussed as a starting point for further empirical investigations.

Figure 2 presents more precisely some particular characteristics of the four types of USOs under investigation. These key characteristics are structured along the three key pillars of any entrepreneurial success (Timmons, 1994), namely the business opportunity, the entrepreneur and the required resources. It's worth mentioning that these portraits are not (yet) empirically tested and validated. They just put aside some suggestions indicative of the potential contribution of our typology on which further empirical studies could/should be based.

3. Implications and discussion

This conceptual framework can be of some help for both practitioners and scholars.

3.1. *Implications for academic authorities*

Academic authorities are increasingly considering setting up supportive policies to foster and encourage the creation of firms out of their respective institutions. This framework provides some indications on working rules that could be useful while setting up their USO policy.

How should universities intervene to help the formation of USOs? What kinds of support do they have to offer? In our opinion, the answer to both questions depends greatly on the type of USOs targeted by universities in their attempt to encourage spin-off formation. The aim of this section is to illustrate how the suggested typology can shed some light on some key issues university authorities should consider while setting up their USO policy.

For sake of clarity and brevity, a closer attention will be paid on two types of USOs, namely the product-oriented academic spin-offs (type I) and the service-oriented student spin-offs (type IV). Indeed, these two types could be considered

as two extreme or contrasting cases in our typology.

USOs of type I are created to exploit commercially-viable research findings in a product-oriented perspective. As their activities rely most of time on codified knowledge (e.g. technology) produced and developed within university, these companies are likely to be active on hi-tech hi-growth markets (Nlemvo et al., 2002). Usually these spin-offs correspond to what Timmons (1994) refers to as "high potential companies" and Albert and Mougnot (1988) as "advanced technology companies". In contrast, USOs of type IV are created by recently graduated students to exploit in the business sphere tacit knowledge that they have personally accumulated during their studies. Because they could hardly survive their founder, these USOs are typically "lifestyle companies" (Timmons, 1994).

Hereafter, we will briefly present and discuss some elements which have to be taken into account by universities in order to conceive a tailor-made policy fitting appropriately the respective needs and characteristics of the USOs targeted. These elements are summarized at Table III.

University mission:

Enhanced vs. Traditional. For most universities, doing business requires radical changes in the way they have traditionally exploited their research results. Indeed, for a long time, the sole purpose of academic research was to increase and enhance human knowledge, regardless of any practical application. Now, this classical conception of science, which considers science as an end in itself, is increasingly challenging by the economic conception, which considers science more as a means to achieve other goals (in particular, making money). So, a suitable policy supporting academic entrepreneurship must therefore take into consideration the question about how to reconcile these two opposite conceptions. As a consequence, promoting the creation of USOs of type I requires from universities the ability to tackle several specific issues such as intellectual property rights management, venture capital funds, incubator facilities, etc. which are far beyond their two traditional missions of research and teaching (Nlemvo et al., 2002).

	researcher		student		researcher		student		researcher		student	
	codified	tacit	codified	tacit	codified	tacit	codified	tacit	codified	tacit	codified	tacit
	Type I	Type II	Type III	Type IV	Type I	Type II	Type III	Type IV	Type I	Type II	Type III	Type IV
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	Type I				Type II							

Figure 2. Description of four cases of USOs.

TABLE III
Distinctive features of policies according to the type of university spin-offs targeted

	researcher student codified Type III tacit Type II Type IV Type I	researcher student codified Type I Type III tacit Type II Type IV
University mission	Enhanced or New	Traditional
Policy focus	Merely on technology	Merely on individuals
Primary objective	Generating economic value	Accompanying students
Kind of intervention	Customised and tailor-made	General and standardized
Required resources	High (mostly available outside university)	Low (mostly available within university)
Nature of liabilities	Results	Means
Selectivity at entry	High	Low
Control and follow-up	High (coercive)	Low (non coercive)

In contrary, those cultural issues are of less importance while considering spin-offs of type IV since students are not so strongly tied to their university. Inciting students to become entrepreneurs does not induce radical changes in the way universities are performing their traditional activities. Supporting the creation of service-oriented students spin-offs does not require from universities the setting up of a specific structure and may be generally achieved by means of traditional teaching courses and training in entrepreneurship. In that respect, the universities of Twente (The Netherlands) and Linköping (Sweden) are well known for having successfully integrated entrepreneurship within their traditional classroom to support the creation of companies by students (Van Tilburg and Van der Sidje, 1998; Jones-Evans and Klofsten, 1997).

Policy focus:

Technology vs. Individual. A supportive policy

towards the creation of USOs of type I requires the establishment of specific mechanisms aiming (i) to identify (detect) the most promising ideas within research centers and laboratories, (ii) to assess the economic potential of these ideas and, eventually, and (iii) to protect legally these results by means of patents. It's worth noting that these mechanisms are much more specifically focused on output of research activities (detecting promising research results, assessing their economic potential, protecting by means of patenting) rather than on the people having performed the research.

In contrary, USOs of type IV are characterised on the one hand by the perfect identity between the bearer of the idea (idea-haver) and the bearer of the project (idea-exploiter) and, on the other, by the tacit nature of knowledge transferred, thus their success depends greatly on the founders. Indeed, the business of such USOs terminates when the founders leave the company. Therefore,

from a policy point of view, the emphasis relies primarily on individuals (students), not on their tacit knowledge.

Primary objective:

Creating value vs. supporting individuals. To a large extent, codified knowledge may be seen as a technology platform that could be hardly exploitable in the business sphere without any further technological development. The purpose of technological development is to check whether production can be extended to a larger industrial scale and also to demonstrate to potential customers and partners what the technology can achieve. But, building up a prototype requires the availability of facilities (such as equipment, instruments, machinery, and so forth) which are sophisticated and very expensive to acquire. In that respect, universities may play the role of technical incubator and, if necessary, of seed capital provider when no capital fund is available to finalize genuine business projects.

For service-oriented student spin-offs (Type IV), the university involvement may be weak due to, among others, its lesser capacity of control and follow-up in the process, students being weakly tied to their university. In this respect, the university is bound more in a means-type obligation than in a result-type obligation. As a result, the primary objective of the university should merely be to support the individual in the process of launching a new venture, regardless of the potential value to be created in terms of economic repercussions or reputation for the university and the region considered.

Nature of intervention:

Customized vs. Standardized. Each case of type I USOs is unique as far as its economic potential is concerned. This uniqueness derives from several factors: the multiplicity of funding sources, the diversity of conventions established between funding organizations and teams of researchers, the collaboration between different research centers (public or private), the various status of people carrying out research activities (professors, contractual researchers, doctoral students) and, last but not least, the broad range of research conducted within the university (from information technology to pharmaceuticals and biotechnology), for which the range of possible applications is usually

extremely wide. As a consequence, projects related to USOs of type I are so specific that a particular attention/approach is needed regarding for instance the intellectual property rights management, the commercial and technological development (e.g., innovative products), the resources required, etc.

In contrast, USOs of type IV do not need to receive such a customized attention. Indeed, the two major difficulties faced by students are first their lack of entrepreneurial background and second their weak credibility vis-à-vis external partners (e.g., financiers). In that respect, being able to elaborate a feasible business plan can help them assess not only the viability of their business opportunity but also the extent to which they are willing and able to create their own firm to exploit commercially this business opportunity. This might explain why universities support the creation of type IV USOs through a much more standardized approach, merely focused on entrepreneurship courses (e.g. what is an opportunity and how to seize it, how to write a business plan, etc.)

High selectivity and control vs. weak selectivity and control. A supportive policy towards USOs of type I may require implementation of costly support structures (such as liaison offices, entrepreneurship centers, venture capital funds, incubators, etc.). However, these costs are offset by expectations of high economic returns. Nevertheless, due to its costs, the policy toward USOs must be selective – both for deal flow and project follow-up.

Regarding type IV spin-offs, selectivity and control are likely to be weak as far as the objective is much more to support students wishing to launch their own firm and not necessarily to generate economic value (employment, investments, revenues, etc.).

3.2. Implications for scholars

Our typology provides an answer to an increasing number of puzzled researchers who, as Mustar (2000), do not consider the USO as a single and homogenous phenomenon, arguing that it is time to capitalise on the scattered empirical evidence accumulated for decades in order to integrate them

into a common typology. This paper provides a conceptual framework on which researchers can rely for specifying the type(s) of USOs they investigate. So doing, this will enhance the comparability of respective studies and allow a better assessment of the applicability of findings.

When looking at empirical studies already carried on USOs, to our best knowledge, they all rely on the analysis of a sample of companies characterised by indicators such as the inception date, the sector, the founder's status, the turnover or the number of employees. Most of these studies attempt to establish contingency relations between the aforementioned companies' characteristics and their respective performance expressed in terms of profitability, export, growth, jobs created, and investments (Doutriaux, 1992; Mustar, 1997; Kassicieh et al., 1996; Bellini et al., 1999;

Clarysse et al., 2000). In Table IV, we revisit these samples in light of our typology.

From this table, it appears that half of the authors did not characterise the nature of activity of the companies under study. Moreover, some of these samples comprised companies as different as student spin-offs and academic spin-offs (i.e. Smilor et al., 1990; Doutriaux, 1992; Bellini et al., 1998).

Regarding future research on USOs, our typology opens new perspectives and the opportunity for scholars to specify unambiguously the type of phenomena under study. So doing, this should hopefully enhance the comparability of both samples and situations studied and consequently strengthen the cumulative process of knowledge production in that key field of research.

TABLE IV
Breakdown of samples used in empirical studies on university spin-offs

Authors	Year	Area	No. firms	Concept used	Composition ^a
McQueen Wallmark	1982	Chalmers (Sweden)	38	Spin-offs	Researcher/Student: ?? Product/Service : 12/26
Doutriaux	1987	Canada	38	University technology- based spin-offs	Researcher/Student: 38/0 Product/Service : 16/22
Smilor et al.	1990	Austin (Texas)	23	Spin-offs	Researcher/Student: 17/6 Product/Service: ??
Doutriaux	1992	Canada	58	Academic entrepreneurial firms	Researcher/Student: 55/3 Product/Service : ??
Samson Gurdon	1993	Canada U.S.A.	22	Scientist-started high-tech ventures	Researcher/Student: 22/0 Product/Service : 22/0
Chrisman et al.	1995	Calgary (Canada)	155	Faculty entrepreneurship	Researcher/Student: 155/0 Product/Service: 25/130
Mustar	1997	France	250	Spin-off enterprises	Researcher/Student: 250/0 Product/Service: ??
Carayannis et al.	1998	U.S.A. Japan	7	High-technology spin-offs	Researcher/Student: 7/0 Product/Service: 7/0
Bellini et al.	1999	Sweden Italy	12	Academic spin-offs	Researcher/Student: 9/3 Product/Service: ??
Chiesa Piccaluga	2000	Italy	48	Academic spin-offs	Researcher/Student: 48/0 Product/Service: 19/29
Nlemvo et al.	2000	Belgium	106	University spin-offs	Researcher/Student: 106/0 Product/Service: ??
Steffensen et al.	2000	New Mexico	6	Spin-offs	Researcher/Student: 6/0 Product/Service: 3/3

^a The question mark means that relevant information was missing.

4. Conclusion

While the number of studies dedicated to "university spin-offs" (USOs) is increasing rapidly, most of them not only neglect to define the USO concept but also comprehend USOs as very different realities. The main objective of this paper is to overcome this drawback that makes the comparison of studies difficult and the building of a sound body of research problematic. To address this, this paper first clarifies the USO concept and then categorizes USOs into a basic typology on which further studies may be grounded to gain both in discipline and rigor.

The two key dimensions along which this paper discriminates USOs are (1) the status of persons involved in USOs and (2) the nature of knowledge transferred from the university to the new venture.

The status of persons involved in USOs (first dimension) is a relevant topic for research because, depending on whether it is launched by a student or a researcher, a USO's profile in terms of activities, financial needs, material requirements and growth perspectives is likely to vary considerably. To discriminate USOs according to the nature of technology transferred from the university to the new venture (second dimension) is also very important for research. Indeed, issues such as growth potential, the management of patenting and intellectual property rights, implication of researchers or seed financing for prototypes can vary enormously among projects.

Consequently, we argue that these dimensions are keys to explaining some discrepancies that may occur among empirical research on the USO creation process. Therefore, future empirical research would gain by considering the differences put forward by our typology. As a consequence, the failure to account for differences identified by our typology may cause misleading conclusions.

These features are not (yet) a set of empirically tested and validated factors but just some suggestions indicative of the potential contribution of our typology on which further empirical studies could/should be based. The four portraits can be considered as the first steps towards the construction of a robust and homogeneous conceptual framework that may be of some help for both practitioners and scholars. For practitioners, the proposed typology provides guidelines that could

be useful while setting up a university USO policy. For scholars, the typology provides the opportunity to specify unambiguously the type of phenomena they are speaking about and, consequently, to strengthen the cumulative process of knowledge production in that field of research.

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