

University spin-offs: a new framework integrating enablers, stakeholders and results

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UNIVERSITY SPIN-OFFS: A NEW FRAMEWORK INTEGRATING ENABLERS, STAKEHOLDERS AND RESULTS

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University spin-offs with patents (USOPs) are entrepreneurial ventures created by exploiting research results and inventions. USOPs are characterised with a high growth potential and are capable of attracting external investments. To explore the challenges apparent in the creation of USOPs, we reviewed the existing framework to identify key missing elements. Our study proposes a new framework that incorporates some missing elements that enhance the creation of USOPs. The new framework focused on the interactions of elements such as national intellectual property regimes, national university assessments, the local entrepreneurship ecosystems where the universities are located, the entrepreneurial orientations and strategies of universities, and stakeholders as independent variables with USOPs as the dependent variable. There is therefore a need for a critical reflection on national and university policies and strategies to enhance the creation of USOPs.

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1. Introduction

Very few USOPs exist when compared to the total number spin-offs. Although these types of spin-offs are few in number, they have a higher potential for growth and investors such as Venture Capital favour them. The advantage of USOPs is that when successful, they can amplify the socio-economic benefits of technology transfer to the universities as well as the milieus where these universities are located. The creation of USOPs is not fortuitous as it involves the committed participation of key stakeholders and enablers within and outwith universities.

It is appropriate to distinguish between university spin-offs (USOs) and university spin-offs with patents (USOPs). Generally, USOs are university spin-offs created by founders that are affiliated with a university while USOPs are university spin-offs that are in addition to being created founders affiliated with a university, they are also commercialising at least one invention that has been granted a patent. Such a patent maybe granted for any invention that comes out from research. This may be a device or a machine, a technology, a substance, a process or a new material. These are the typology of patents considered in this paper although the list is not exhaustive.

There are good reasons why the concept of university spin-offs has gained the attention of national and university policy makers. One reason is that there is increasing pressure on universities to generate revenues especially in times of dwindling financial support from external sources. Another reason is the continuous overlapping of the academic and business environments brought about by close knitted university-industry relations, which facilitates the creation of spin-offs. However, despite the immense potentials inherent in USOPs, their creation is still mired with challenges and obstacles. Evidences from existing research show that some of the obstacles are related to (a) the lack of motivations and incentives for academics to engage in such activities and (b) the ineffectiveness of the national, local and university environments to support such activities. The presence of a mixture

of hostile legislations, regulations and relationships in these environments creates barriers that constrain the creation of USOPs. After identifying some of these barriers, we have developed a new framework that when applied holds the potential to redefine the creation of USOPs.

Prevailing views on university technology transfer focus more on the characteristics of the stakeholders than on the underlying enablers and relationships that influence technology transfer activities such as the creation of USOPs. In particular, extant research on technology transfer tend to ignore the combined influences of national systems of intellectual property, national systems of university assessment, the local entrepreneurship ecosystems of the milieus where universities are located, and university entrepreneurial orientation and strategies. Additionally, the latent effects of the subtle differences in the typologies and sizes of universities are yet to be examined. This limitation in existing research has resulted to a certain extent in the non-identification of critical barriers and obstacles in the creation of USOPs.

The purpose of the paper is to examine the key stakeholders and their relationships in the dominant framework of university technology transfer to identify the limitations of this framework. Secondly, the paper offers a broader perspective based on the influence of national, local and university factors in the creation of USOPs and proposes a new framework to enhance the creation of such spin-offs. The paper is a valuable source for enriching knowledge on the combined effects of national, local and university factors in the creation of USOPs. A major contribution is the new framework, which illustrates the features and interactions of the elements to improve performance in the creation of USOPs. The framework could be useful to academics, practitioners and policy makers.

The structure of the rest of the paper is as follows. Section 2 focuses on a specific literature review. Section 3 examines the existing framework and stakeholders' relationships. The new framework is presented in Section 4. The interaction of the elements in new framework are expatiated in Section 5. Conclusions and further research are presented in Section 6.

2. Background

University technology transfer is the process of transferring research findings, technologies and inventions, developed by academics, to entities beyond university frontiers. It involves the commercialization of technologies, inventions and research findings through which universities contribute directly to the economic prosperity of societies [Perkmann et al. (2013)]. It is a complex, high risk, costly and time-consuming process. There are various forms and degrees of technology transfer which makes studying the technology transfer process very complicated [Bozeman (2000)].

The two main technology transfer approaches considered in this paper are: (i) technology transfer as a process of engagement with existing firms and (ii) technology transfer as a process of commercializing knowledge and technologies through the creation of spin-offs. This approach has the potential to trigger regional economic growth through university entrepreneurship [Shane (2004); Wright *et al.* (2007)]. For this reason, public policy in some countries is encouraging universities to promote entrepreneurial activities.

There is an ongoing debate on the influence of patenting on publishing in the realm of technology transfer, which extends to the creation of USOPs. For example, Azoulay *et al.* [2009] examined how research productivity influences commercialisation. Other studies advocated that collaborations with the business sector are beneficial for university researchers [Agrawal and Henderson, (2002); Breschi *et al.* (2007)]. Some empirical studies have supported a positive dualistic relationship between the activities of patenting and publishing [Van Looy *et al.* (2006); Azoulay *et al.* (2009); Breschi *et al.* (2007)]. It emerged that one of the strongest argument claims that academic orientation towards the commercialisation of research findings may reduce efforts geared towards original inquiry for the extension of knowledge.

Technology transfer through USOPs is complicated since these are created in academic environments but launched in a business environment where survival and growth is usually tough due to the change of environment and business competition. USOPs often provide a mechanism for the commercialization of inventions rated with high uncertainty [Etzkowitz (2003)] as well as ensuring

inventor involvement, which is crucial when tacit knowledge is required [Shane (2004)]. Academic inventors are likely to work with new ventures seeking to commercialize their inventions than being involved in established companies where their inventions may not receive priority treatment. These inventors may also find it difficult in coping with the organizational culture of established companies. They may also find it difficult to synchronize their university activities with those of established companies.

University spin-offs do not enjoy a generally accepted definition. Shane [2004, p.4] defined them as “*a new company founded to exploit a piece of intellectual property created in academic institutions.*” Nicolau and Birley (2003), define a spin-off as a new venture spearheaded by a researcher working in a higher academic institution who can gradually shift toward becoming an entrepreneur. Friedman and Silberman (2003) posited that a spin-off is created as a result of leverages on the findings of previous research projects.

These definitions do not elaborate on the type of relationships between academic institutions and spin-offs in the context of intellectual property rights and equity [Matricano *et al.* (2012)]. They also fail to point out the roles of the various stakeholders, the national, local and university factors that influence the creation of spin-offs. In the following section, we provide an overview of the existing basic framework of the stakeholders’ relationships for technology transfer.

3. Basic Framework

Consistent with evidence, key stakeholders in technology transfer fall into two mutually exclusive groups. The first group consists of universities and researchers also referred to as the transfer group. While the second group comprises existing firms and university spin-offs also referred to as the recipient group. There are two main relationships between the two groups. The first one is the academic group relationship with existing firms and the second one is the academic group relationship with USOs.

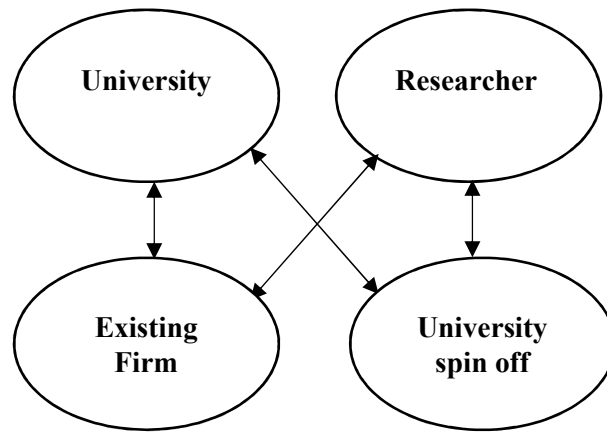


Figure 1. Basic framework of stakeholder relationships.

Figure 1 depicts the key stakeholders' relationships in technology transfer. Universities and researchers represent the academic environment and are placed on the top of the figure since the transfer emanates from them. The researchers are located on the right hand side of the universities since they are both produced and form part of the universities. Existing firms and spin-offs made represent in the industrial and business environment. These are placed on the bottom since they are the recipients of the transfer. The spin-offs are on the right hand side of the existing firms as they are new entrants in the business environment, and they need inputs and support from existing firms for their growth.

The double-ended arrows indicate the interactions and reciprocal benefits between stakeholders. Although the transfer is mainly from the academic group to the industrial or business group, a reverse transfer from the industrial and business group to the academic group is also possible. For example, the transfer of specific business proficiencies.

Universities and existing firms are on the left because both entities usually collaborate directly in terms of consultancies, research contracts and licensing. Researchers and spin-offs are on the right since researchers create most of the spin-offs. We now give an overview of each of the stakeholders.

3.1. Universities

Universities are keystones in technology transfer as they are fountains of knowledge and incubators of technologies for commercialization. Universities provide the learning environment and resources for the development of new technologies as well as nurturing researchers. This has led to a fierce competition among universities to attract and retain talents that boost the development of new inventions. The responsibility for organizing and supporting the transfer process lies squarely with universities. To this end, some universities have established technology transfer offices (TTOs) to manage technology transfer processes. These TTOs handle issues related to patenting and collaborate with researchers throughout the process of establishing USOPs in cases where the university owns the IPR. However, in cases where the researcher owns the IPR, the creation of USOPs is at the discretion of the inventor as he/she directly incurs the costs and risks involved.

Alongside the traditional missions of teaching and research, a ‘Third Mission’ has been introduced in universities. This mission focuses on the transfer of technology, commercialization of inventions and engagement with society. The ‘Third Mission’ has implicitly been in existence with the other two missions of universities, however, it is only recently that it has been officially recognized and universities are still struggling to smoothly incorporate it with the other two missions. This is demonstrated by the fact that national assessment of universities is very strong in the missions of education and research but still weak in the ‘Third Mission’ and universities are interpreting this mission from different perspectives, as there is still no precise definition of the mission.

3.2. Researchers

Traditionally the highest held value of a researcher is the extension of knowledge. Combining the extension of knowledge with the capitalization of knowledge may introduce profound changes in academe. However, researchers are often willing and eager to combine the two activities usually carrying out one activity at universities and the other in firms [Etzkowitz (1998)]. Academics

affiliated with universities such as post-docs, doctoral students and even alumni fall under this category.

Researchers have to deal with the patenting and publication dichotomy. Those who would like to venture into entrepreneurship may prefer not to disclose their findings through publications before patenting. Patent grace periods might help in dealing with this dichotomy. Researchers interested in entrepreneurship are also inclined to pursue research that is prone to commercialization at the expense of basic research. To forestall potential conflicts between publishing and patenting, universities face the challenge of designing strategies that will encourage researchers to engage in entrepreneurship without losing them entirely to industry or business. For example, a strategy that encourages moderate involvement in entrepreneurship by allowing researchers to embark on entrepreneurial activities while maintaining their researcher's status at the university could increase motivation. Another strategy is to allow the full immersion of researchers in entrepreneurial activities by taking a sabbatical leave and then to return unconditionally to the university. It is normal that researchers' intentions to venture into the creation of spin-offs may be high but their perception of fit for entrepreneurship and often times the lack of entrepreneurial skills and competencies dampen these intentions.

3.3. Existing firms

Large existing firms usually engage with universities in technology transfer activities. Common activities include licensing, joint ventures, research contracts and consultancy. For university inventions funded partially by existing firms, the issue of IPR is mainly settled between existing firms and universities. In cases, where universities develop entirely new technologies on their own, they may scout for existing firms to convert these technologies to products and services. It is often the case that firms targeted as potential beneficiaries have the competencies to execute the transformation. Universities also act as consultants to these firms as well as provide resources such as human capital.

Small existing firms usually need to have access to the inventions or IPRs of universities to enhance their innovative capabilities. This is because such firms lack established R & D departments to carry out breakthrough research that could lead to patented inventions. They rely heavily on informal rather than formal R&D and at times depend on their suppliers to boost their innovation [Tidd *et al.* (2001)]. Such firms therefore approach universities to find solutions to their research challenges. They may also rely on universities to provide backup to their operations and in some cases, outsource some of their work to universities.

3.4. University Spin-offs (USOs) and University Spin-offs with Patents (USOPs)

University spin-offs are channels for research valorisation. However, it is evident that only a few universities are focusing on spin-offs activities. Existing research show strong variances across these universities in their interest and support for these activities [Shane (2004)]. University spin-offs fall into two main categories namely: i) USOs and, ii) USOPs.

Nicolau and Birley [2003] further classified university spin-offs into the following typologies:

- The orthodox spin-off, where the inventor leaves the university to start a company.
- The technology spin-off, where only the technology is transferred while the inventor stays with the university.
- The hybrid spin-off, which is a combination of the other two and the most complicated form of spin-off.

USOs are relatively easier to create compared to USOPs since the latter involves the exploitation of a patent. Both typologies usually undergo incubation before a full-fledged immersion into the main business environment. USOs need to interact extensively with existing firms and other stakeholders to be able to understand and navigate effectively the business environment. USOs may also be established as an extension of the research environment to valorise researchers' tacit knowledge and

circumvent university bureaucracies that constrain individual research endeavours. Such USOs have little interaction with the business environment and their potential for growth is limited.

4. The Proposed Framework for the Creation of USOPs

The existing relationships depicts two main paths for technology transfer. The knowledge transfer path linking universities, researchers and existing firms and the technology transfer path linking universities, researchers and spin-offs. However, these relationships are not based on a broader perspective that takes into consideration the influence of national factors such as the intellectual property regimes and university assessments. The local entrepreneurial ecosystems of the milieu in which universities are located are often times neglected. Furthermore, the entrepreneurial orientation and strategies universities are not considered. Hence, the existing framework shown in Figure 1 seems inadequate in offering a holistic explanation about the dynamics involved in the creation of USOPs.

Figure 2 illustrates a proposed framework that combines the national, local and university factors that enhance or constrain the creation of USOPs. The main elements considered are as follows: the enablers, the key stakeholders, the USOPs and the expected results.

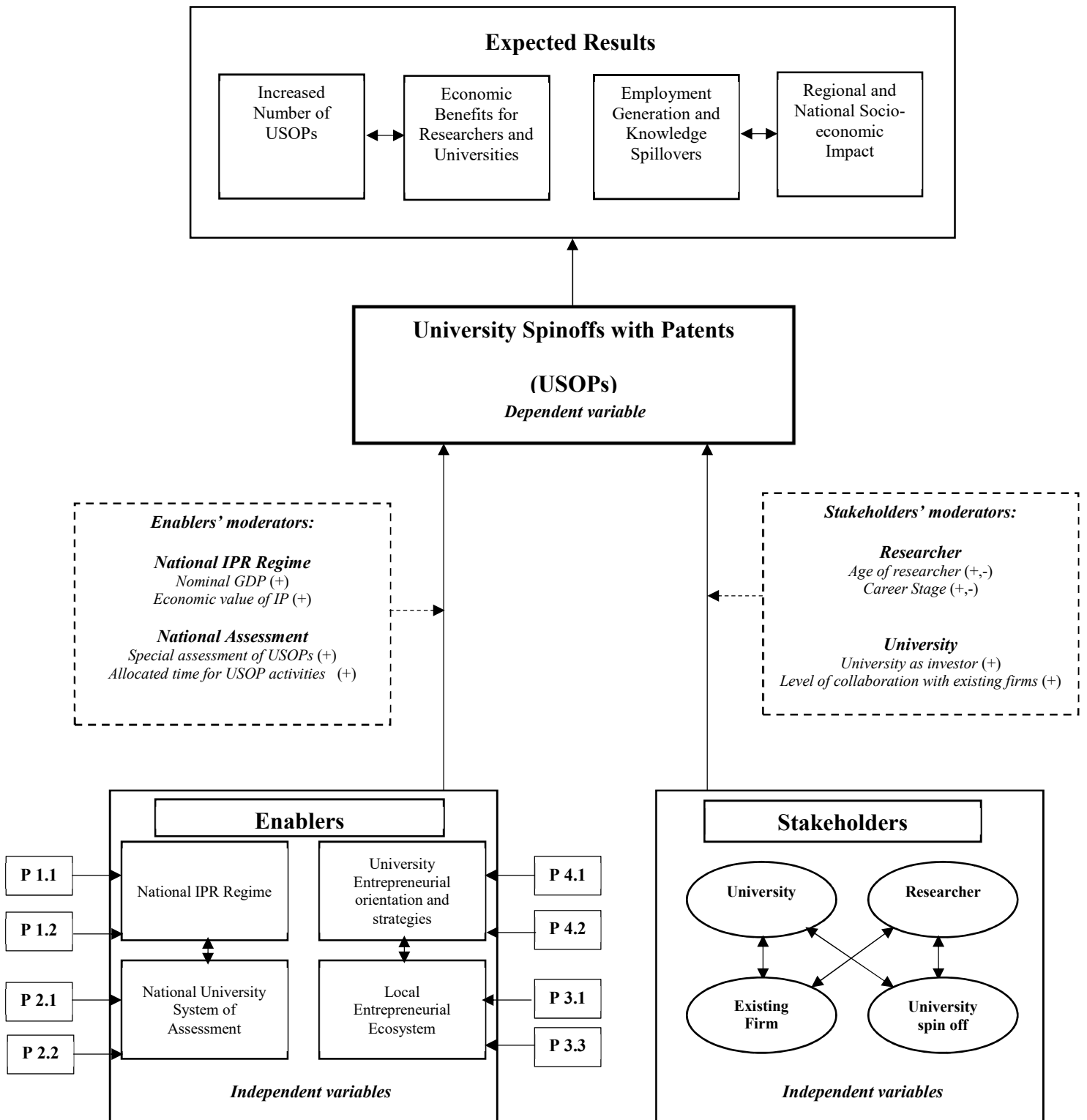


Figure 2. New Framework of the improved relationships

The proposed framework show a set of enablers that can facilitate university technology transfer through USOPs. When applied, it can enhance the performance of researchers in patenting and publishing activities since it allows researchers and practitioners to share information and knowledge in an enabling environment. Improved relationships among key stakeholders through effective interaction and collaboration will positively influence the creation of USOPs.

Specifically for innovative spin-offs, the framework provides a possibility of forging close relationships with existing firms. These types of relationships encourage open innovation especially in an era where research activities are moving towards a more open approach that favour alliances. The huge financial resources and established facilities of existing firms can leverage the technological expertise and flexibility of spin-offs. A skilful combination of these strengths could enhance the performance of incumbent firms as well as USOPs.

At the national level, the two dominant factors that influence the creation of USPOs are the national intellectual property rights regime and the national system of university assessment. These factors are crucial for technology transfer since any change introduced in these factors will have an effect on the productivity of technology transfer. At the local level, the local entrepreneurship ecosystem that consists of various stakeholders that are crucial for the survival and growth of USOPs is a dominant factor. Another factor at the local level is the entrepreneurial vivacity and the innovation competitiveness of a region. University entrepreneurial orientations and strategies play a vital role in the creation and governance of USOPs and modifying these factors will affect the productivity of technology transfer.

The focus of all the stakeholders is on increasing the productivity of technology transfer because of the benefits to each stakeholder and the positive externalities to the milieus where the stakeholders are located. For the relationships to be improved, all the stakeholders are expected to work together to achieve collective impact.

Integration of the stakeholder relationships, national assessment policies, national IPR regimes, university strategies and orientations, and the local entrepreneurial ecosystem will contribute in

improving performance in the creation of USOPs. The expected results are divided into internal results, which will usher in positive changes in universities technology transfer productivity and external results, which will affect society's development through the creation of wealth, new jobs and new solutions to society's problems. The following sections present these factors.

4.1. *The enablers*

There are four enablers namely: the national system of assessment, the national regulation on IPR, the entrepreneurial orientation and strategies of universities, and the local entrepreneurial ecosystem. They are located on the left side of the framework and are responsible for triggering the process. Each of these enablers influence individually and or in combination the productivity of technology transfer focusing on the creation of USOPs.

4.2. *Intellectual property rights*

The ownership of intellectual property rights (IPR) is paramount for the grant of a patent for an invention. A patent give specific legal and enforceable rights to individuals, institutions or organizations over creative works and innovative inventions. These rights give the creator or inventor the legal authority to prevent others from making use of their creation or invention for a limited period. IPRs are categorised in different forms ranging from research inventions, artistic creations, literary works and technology developments. However, one aspect of knowledge especially when incorporated in new products or services is the difficulty in prohibiting others from imitating or copying it.

For a very long time, countries have used IPR regimes to protect inventors as well as to pursue economic interests and competitive advantage and the practice is ongoing. These regimes have changed over time reflecting the different stages of economic development of a country. They have also been adapted to enhance technological progression and to promote industrial policies.

For universities, the ownership of IPR can be conferred to either the institution or the researcher depending on the national IPR regime of the country. Ownership is therefore inconsistent across countries. For example in Europe, many nations have abandoned the ‘Professor’s Privilege’ with the exception of Italy and Sweden [Geuna and Rossi (2011)] to favour university ownership.

The execution of research for patenting purposes is dependent on various factors some of which include the ownership of IPR, the availability of research funds, the university policies and to a lesser extent the size and age of universities. The type of university according to the historic period of creation (medieval, contemporary, modern or entrepreneurial), university ownership (public, private or religious) and the existence of joint research centres operated by universities and public research organizations. Other factors include the strength of the TTOs, the commitment of researchers and the national legal framework. The ownership of IPR is pivotal in the patenting process. In situations where the ownership of the IPR is conferred to the institution, we make the following proposition (P1.1) which is linked to the national IPR regime as indicated in Figure 2.

Proposition 1.1 (P1.1) *University ownership of IPR positively influences the propensity of researchers to patent inventions from research discoveries.*

When universities are the owners of the IPR, they usually have a stake in the spin-offs created. Hence, universities play a central role in the creation of USOPs through TTOs. University ownership propels the position of the university in rankings when the creation of USOPs is assessed in the national assessment of universities. A shortcoming of this type of ownership is that it may hinder the participation of external financing entities such as Venture Capital firms.

On the contrary, some scholars in the US such as Kenny and Patton [2009] have criticised the university ownership model suggesting inventor ownership as a replacement. In another study, Kenny and Patton [2011] proposed that inventor ownership has a positive effect on university entrepreneurship. When researchers own the IPR, they are expected to play a central role in the

creation of USOPs. In this case, the ownership of the spin-off created is influenced by the participation of external stakeholders such as investors. However, researcher ownership may affect the position of universities in rankings due to researcher mobility. Since researcher ownership of IPR requires the input of external stakeholders for the creation of USOPs, we propose the following (P1.2) which is linked to the national IPR regime as indicated in Figure 2.

Proposition 1.2. (P1.2) *Researcher ownership of IPR positively influences the propensity of researchers to create USOPs.*

The type of ownership of a spin-off is a major determinant of the link between a university and spin-off. The link is expected to be stronger when universities own spin-offs than when researchers own spin-offs. However, there is yet no agreement on the best type of IPR ownership as the debate between proponents of the university model and those of the researcher model is ongoing.

4.3. Assessment of universities

Research assessment is increasingly becoming a key academic policy issue in many countries. There are significant national economic and social benefits from increasing research output of universities. Because of the potential benefits of the exploitation of research findings, many governments around the world are making efforts to increase research productivity [Iorwerth (2005)]. The preponderance of optimizing research productivity is responsible for the burgeoning attention in the assessment of university research. Consequently, national authorities have introduced some mechanisms to assess university research performance and outputs. Another reason for the growing interest in research assessment is the increasing demand for accountability of public funding in an era of scarce financial resources. Geuna and Martin [2003] have discussed the expectations from universities regarding the effectiveness and accountability in the use of public funding.

Assessment criteria that assesses USOPs created by researchers can influence the propensity of researchers to create such spin-offs. Nevertheless, assessment in this direction seems to be weak at the present. When assessment focuses only on research, researchers might not be individually motivated to venture into extra-curricular activities such as the creation of USOPs. There is also a cultural issue. Being involved in a spinoff might be considered a diversion from knowledge advancement and “exploration” instead of the “exploitation” of knowledge that is typical of a spinoff.

The relationships between the ownership of IPR and the creation of USOPs can significantly influence the productivity of technology transfer when considered in university assessments. An appropriate metric to measure productivity in technology transfer should be the number of USOPs owned by universities and or researchers depending on which ownership is applicable in a country. Such a metric can facilitate comparisons of countries with different IPR regimes.

The method of assessment adopted can also influence the decision of researchers to publish or patent. Current practices of assessment focus on two levels namely: the university level and the national level. The measurement of research performance at each level include metrics that measure the quantity, quality, impact and utility of research. However, countries and universities employ different criteria and methodologies to measure these aspects of research performance.

Universities are professional bureaucracies that depend on the individual initiatives of highly skilled professionals to reach their organizational goals [Mintzberg (1979)]. Since researchers play a central role in developing inventions for patenting and in disseminating knowledge through publications, there is the tendency that one activity might eclipse the other. However, according to Franzoni and Lissoni [2006], researchers who are active in patenting are also present in the ranks of academic entrepreneurs with a brilliant publications record. Publishing and patenting activities of universities are two main activities that are assessed in national assessment exercises.

Assessments should focus on the productivity of researchers, research groups and departments in terms of research outputs. Although all the aspects of research performance are very important, the focus of assessments on technology transfer is on the utility dimension in terms of the generation of technological, economic, social and environmental benefits. For optimal performance in this dimension, assessments will act as a motivating force.

Assessments usually consider three levels namely the micro level (researchers and research groups), the meso level (departments and disciplines) and the macro level (universities). However, universities have different specializations, which implies that research output will differ across universities. The heterogeneity of strategies and organizational structure of universities amplifies these differences. Consequently, assessing and evaluating just at the macro level can be counter-productive. An appropriate assessment for effective technology transfer should involve all the levels since the actors at these levels will be highly motivated by such assessments, which will positively influence technology transfer.

Publications are channels for knowledge transfer while patents and the creation of spin-offs with patents are channels for technology transfer. Emphasis on the production of patents and the creation of USOPs in the assessment of universities will influence significantly the productivity of technology transfer. We therefore summarise the relationship between assessments and the production of intellectual property in the following propositions which are indicated as (P2.1) and (P2.2) in Figure 2.

Proposition 2.1 (P2.1) *National systems of university assessment that assess researchers with regards to the created USOPs positively influences the propensity of researchers to create spin-offs.*

Proposition 2.2 (P2.2) *National systems of university assessment that assess USOPs at the university level influences the propensity of universities to engage in entrepreneurial activities.*

4.4. Local entrepreneurship ecosystems

The entrepreneurial characteristics of the milieus where universities are located play a vital role in promoting university entrepreneurship through the creation of USOPs. The entrepreneurial infrastructure, vivacity and innovative competitiveness of a place is crucial for the growth of USOPs. Universities located close to innovation hubs have the possibility of benefiting from knowledge spillovers in the area. They also benefit from the positive externalities of the interactions of the different stakeholders in the business environment. The dynamic innovation and entrepreneurial activities in such a location bring in distinctive advantages that are relevant to university entrepreneurship. As a result, we contend the following proposition which is indicated as (P3.1) in Figure 2.

Proposition 3.1 (P3.1) *Universities located within developed entrepreneurial ecosystems are more likely to engage in entrepreneurial activities such as the creation of USOPs.*

Local entrepreneurial ecosystems can be influential in enabling technology transfer from universities through the creation of USOs. However, for these ecosystems to contribute effectively to the creation of USOPs, the spatial proximity of universities to other stakeholders like local governments, accelerators, support firms, large firms and investors in the entrepreneurship ecosystem is very important. Universities are key stone agents in local entrepreneurship ecosystems since they play a significant role in innovation driven entrepreneurship of regions. Interactions within local entrepreneurship ecosystems are strongly influenced by different types of proximities such as spatial proximity, temporal proximity, processes proximity, organisational proximity and cultural proximity [Sheriff and Muffatto (in press)], which have a direct and indirect influence in the operations of USOPs.

The survival and growth of USOPs require academic inventors to interact with other agents in the entrepreneurship ecosystems. Initial investments needed for the establishment and operations of

USOPs may come from the different types of investors present in an ecosystem. Venture Capital firms that pours in the highest investments in new ventures usually look for places and ventures where there is a potential for profitable investment opportunities.

Investors preferred dealing with individual researchers when negotiating investments in USOPs than dealing with universities. Such behaviour derives from the fact that investors want to avoid the bureaucracies in dealing with universities. Historically, the focus of universities is more on the production of academic output than business outputs. Investors therefore prefer the ownership of intellectual property patented by academic researchers.

The obstacles universities face when creating USOPs can be minimised by effective interactions with other agents within the local ecosystems. Policies are therefore needed that will encourage universities to interact effectively with other stakeholders in local entrepreneurship ecosystems. When it comes to developing favourable policies, universities entrepreneurship strategies and orientations are very important factors that should be considered. The interaction between universities and local entrepreneurship ecosystems is essential for the success of university entrepreneurship. Accordingly, we argue in the following proposition shown in Figure 2 as (P3.2) that.

Proposition 3.2 (P3.2) *Universities that are actively involved in the local entrepreneurial ecosystem have a higher probability of success in establishing USOPs.*

4.5. Universities entrepreneurship strategies and orientations

Universities entrepreneurial strategies and orientations play a crucial role in the ‘Third Mission’ of universities in relation to the commercialization of research results and engagement with society. Some universities have designed explicit strategies to promote their ‘Third Mission’ activities through technology and knowledge transfer while a majority of universities have not yet developed clearly

defined strategies. The 'Third mission' strategies reflect the entrepreneurial strategies of universities, as they are composed of both the commercialization and engagement dimensions. Having explicit strategies for the commercialization of inventions is a first step in encouraging university entrepreneurship. However, these strategies are linked to the entrepreneurial orientation of universities.

The entrepreneurial orientations of universities are influenced by the ownership and type of university. The main categories of ownership are; public ownership, private ownership and religious ownership. These categories influence the entrepreneurial orientations of universities at different degrees with the private universities having a high degree of entrepreneurial orientation. Examples include Harvard, MIT, and Stanford all in the United States.

The type of university also influence the entrepreneurial orientation. For example, polytechnics in Italy, research universities and universities of applied sciences in Germany are more focused in science and technology, and technology transfer is already in their DNA. Instead, Arts and Humanities focused universities tend not to prioritise the creation of USOPs and their relationships with existing companies is not very strong in technology transfer.

Notwithstanding the influence of these factors on the entrepreneurial orientations of universities, there is a dire need for universities to engage in entrepreneurship through the establishment of USPOs. This is due to the recent trends in which universities are expected to augment the funding of research activities from internally generated income as well as contribute to the economic and social development of regions. However, universities' strategies and orientations towards entrepreneurship should be clearly outlined as a first step to achieve success. The interplay of orientation, policies, strategies and support programs is discussed in the following propositions shown in Figure 2 as (P4.1) and (P4.2).

Proposition 4.1. (P4.1) *Universities with a clearly defined orientation and policies towards academic entrepreneurship increase the propensity of researchers to create USOPs.*

Proposition 4.2. (P4.2) *Universities with clearly defined strategies and support programs towards academic entrepreneurship have a higher probability of success in establishing USOPs.*

4.6. The main stakeholders

The main stakeholders located on the right of the framework are universities, researchers, existing firms and USOPs. There are also secondary stakeholders like suppliers and customers that are not considered in the framework since they are not location specific. The main stakeholders operate in the academic and business environments but both environments are quite diverse. Despite this diversity, the interaction and collaboration of these stakeholders is paramount for the successful creation of USOPs and their subsequent survival and growth. The involvement of all stakeholders at the initial stages of the creation of USOPs will enhance the success of such ventures as latent and unforeseen problems affecting USOPs will be revealed and acted upon before they become unmanageable.

Continued interaction of the stakeholders will facilitate the combination of expert knowledge and location knowledge that is crucial for the survival of USOPs. Therefore, advancing stakeholder participation beyond consulting offers a range of benefits for USOPs growth and scaling up. The identification of the intervention options of the various stakeholders is a key component of technology transfer through USOPs. However, considerable national and regional variation exist on how the interaction takes place.

4.7. The expected results

The expected results are shown in the right side of the framework. The interactions of the main stakeholders in the middle enhanced by the enablers on the left side of the framework will produce the outputs shown in the right side. These expected results are shown in four areas:

- (1) An increase in the number of USOPs: Universities will increase the quantity and quality of USOPs created and will strive to maintain a continuous improvement in this dimension. Excellent universities in technology transfer through USOPs will sustain such results.
- (2) Economic benefits for universities and researchers: The income generated by universities and the financial and economic benefits that accrue to researchers will increase intrinsic motivations and act as incentives for universities and researchers to engage actively in the creation of USOPs.
- (3) Employment generation and knowledge spillovers: USOPs will generate employment in the regions where they are established. Spillovers of knowledge across local and regional boundaries can enhance local and regional entrepreneurial activities that will facilitate the creation of new entrepreneurial ventures thus increasing the entrepreneurial capacity of the area.
- (4) Socio-economic impact on society and regions: An influx of USOPs will attract investors, suppliers, customers and entrepreneurs. The interaction of these entities will generate vibrant entrepreneurial communities, which can lead to economic and social development of the milieu where universities are located.

5. The interactions of the elements in the new framework

The factors that influence the creation of USOPs can be summarised into four main levels videlicet: (a) the national level, (b) the local level, (c) the university level and (d) the individual level. A positive interaction of the national factors consisting the national IPR regime and the national assessment of universities with the local factors consisting the local entrepreneurship ecosystem and the geographic location and researcher factors consisting of researcher motivation and entrepreneurial intentions contributes to the emergence of a favorable and

enabling environment that will generate collective impact for innovation driven entrepreneurship championed by universities at the local and national levels.

Virtually, a harmonious intersection of all the factors i.e. national, local, university and researcher will reinforce excellence and sustain the increased creation of USOPs. Additionally, such an intersection produces a win-win situation for all the stakeholders. It promotes dialogue among the stakeholders that will facilitate continuous collaboration in enhancing the development of regions through university entrepreneurship. The interactions of the stakeholders will raise not only the quantity of USOPs but the quality as well as contribute to the survival and growth of these ventures.

All the factors either individually or in combination influence the participation of the key stakeholders. The factors have three different but related dimensions of space, time and relations that affect stakeholders in diverse ways. Policies and mechanisms that support these factors need to be modified or reformulated to meet the exigencies of the stakeholders for envisioned improvements. The dominant discourse on university entrepreneurship centers of the creation, survival and growth of USOPs. This implies a shift towards USOPs, which is the dependent variable. However, for an accelerated transition, the effects of the independent variables in the multi-level, multi-factor and multi-stakeholder environment should be identified and understood. These variables are discussed in the next section.

5.1 The dependent and independent variables

The greatest success of university entrepreneurship is the increased creation of USOPs. We have therefore designated the number (count) of USOPs from a given university in a given year as the dependent variable. We identified four sets of independent, time-variant variables as predictors of university spin-off creation. The first set, consists of the national-level variables, the second set consists of the local-level variables, the third set consists of university level variables and the fourth set consists of the researcher level variables.

Each of these independent variables have some degree of influence in the creation of USOPs. This might account for variances in the creation of USOPs across regions. It is therefore important to be able to predict the combined influence of the independent variables to be able to develop systems or mechanisms for improvement in the creation of USOPs.

5.2 *Moderators Variables*

A moderator is a qualitative or quantitative variable that influence the direction and or the strength of the relationship between an independent and a dependent variable. A moderator variable affects the correlation of two variables and if found to be significant, can cause an amplifying or weakening effect between the independent variable and the dependent variable. We have identified eight moderator variables that may affect the relationships between the independent variables and the creation of USOPs. Enablers' moderator variables are subdivided into two groups. The national IPR regime moderators, which include the following:

- Nominal GDP
- Economic value of IP

The national university system of assessment moderators include the following:

- Special assessment focusing on USOPs;
- Allocated time for USOPs activities.

In a similar vein, stakeholders' moderator variables are subdivided into two groups.

Researcher moderators, which include the following:

- Age of researcher
- Career stage of researcher

The institutional moderators include

- University as investor
- Level of collaboration with existing firms.

These moderators are expected to amplify positive as well as negative relationships between the dependent variable (USOPs) and the independent variables.

6. Conclusion and further research

We have identified the enablers and stakeholders for the creation of USOPs and developed a more comprehensive framework to enhance the creation. By developing a framework that is based on the intersection of national, local, university and individual factors, we have been able to identify the independent variables that influence the creation, survival and growth of USOPs. The paper has shown that the pillars of support for university entrepreneurship should be constructed at the university, local and national levels. In addition, the paper advocated for the engagement and commitment of all key stakeholders for an increased productivity of technology transfer through USOPs.

We have shown the multidimensional nature of the creation of USOPs. Second, we have describe the national, local, university and individual factors associated with the creation of USOPs, extending recent literature on the factors that influence the creation of USOPs. We have addressed the connection between the creation of USOPs, multi-level factors, multi stakeholders and the expected results through a new framework.

The framework could be used to inspire multiple areas for further research in technology transfers especially in the realm of university spin-offs with patents creation. Future studies could convert the propositions into testable hypothesis and test them through empirical research. Considering the increasing attention devoted to technology transfer through USOPs for regional economic development, such studies will draw causal inferences of the factors on the creation of USOPs at the local and national levels. Another strand of further research will be to apply the framework to compare countries with different IPR regimes.

References

1. Agrawal, A. and Henderson, R. M. (2002) 'Putting patents in context: exploring knowledge transfer from MIT', *Management Science*, 48, pp.44–60.
2. Azoulay, P. *et al.* (2009) 'The Impact of Academic Patenting on the Rate, Quality, and Direction of (Public) Research Output', *Journal of Industrial Economic*, 57, 4, pp.637-676.
3. Baldini, N. *et al.* (2015) 'The Transition towards Entrepreneurial Universities: An Assessment of Academic Entrepreneurship in Italy', in Link, A.N. *et al.* (eds) *Chicago Handbook of University Technology Transfer and Academic Entrepreneurship*, University of Chicago Press, Chicago, IL, pp.218-244.
4. Bozeman, B. (2000) 'Technology transfer and public policy: a review of research and theory', *Research Policy*, 29, pp.627–655.
5. Breschi, S. *et al.* (2007) 'The scientific productivity of academic inventors: new evidence from Italian data', *Economics of Innovation and New Technology*, 16, 101.
6. Breschi, S. *et al.* (2008) 'University patenting and scientific productivity: a quantitative study of Italian academic inventors', *European Management Review* 5, pp.91–109.
7. Etzkowitz, H. (1998) 'The norms of entrepreneurial science: Cognitive effects of the new university-industry linkages', *Research Policy*, 27, 8, pp.823–833.
8. Etzkowitz, H. (2003) 'Research groups as 'quasi-firms': The invention of the entrepreneurial university', *Research Policy*, 32, pp.109-121.
9. Fini, R. *et al.* (2016) 'Institutional determinants of university spin-off quantity and quality: A longitudinal, multi-level, cross-country study', *Small Business Economics*, pp.1-31.
10. Franzoni, C. and Lissoni, F. (2006) *Academic entrepreneurship, patents, and spin-offs: critical issues and lessons for Europe*, Centro di Ricerca sui Processi di Innovazione e Internazionalizzazione (CESPRI). Università Commerciale Luigi Bocconi.
11. Friedman, J. and Silberman, J. (2003) 'University Technology Transfer: Do Incentives Management and Location Matter?', *Journal of Technology Transfer*, 28, pp.17-30.
12. Geuna, A. and Martin, B. R. (2003) 'University research evaluation and funding: An international comparison', *Minerva*, 41, 4, pp.277-304.
13. Geuna, A. and Rossi, F. (2011) 'Changes to university IPR regulations in Europe and the impact on academic patenting', *Research Policy*, 30, pp.1068-1076.
14. Iorwerth, A. (2005) *Methods of evaluating university research around the world*. Working Paper 2005-04. Department of Finance. Canada.
15. Kenney, M. and Patton, D. (2009) 'Reconsidering the Bayh-Dole Act and the current university ownership model', *Research Policy*, 38, pp.1407–1422.
16. Kenny, M., and Patton, D. (2011) 'Does inventor ownership encourage university research-derived entrepreneurship? A six university comparison', *Research Policy*, 40, pp.1100-1112.
17. Matricano, D. *et al.* (2012) 'The Creation of Academic Spin-offs: Evidences from Italy', *Essays in Management, Economics and Ethics*. McGraw-Hill Italia.
18. Mintzberg, H. (1979) *The structuring of organizations: a synthesis of the research*. Prentice-Hall International, Englewood Cliffs; London.
19. Nicolau, N. and Birley, S. (2003) 'Academic Networks in a Trichotomous Categorisation of University Spinouts', *Journal of Business Venturing*, 18, pp.333-359.
20. Perkmann, M. *et al.* (2013) 'Academic engagement and commercialization: A review of the literature on university-industry relations', *Research Policy*. 42, pp.423-442.
21. Shane, S. (2004) *Academic Entrepreneurship: University Spinoffs and Wealth Creation*. Edward Elgar Publishing, Aldershot, UK.
22. Sheriff, M and Muffatto, M (In Press) 'High-tech entrepreneurial ecosystems: Using a complex adaptive system framework.' *International Journal of Entrepreneurship and Innovation Management*.
23. Tidd, J *et al.* (2001) *Managing Innovation: Integrating technological, market and organizational change*. 2ed. John Wiley & Sons, West Sussex, UK.

24. Van Looy, B. *et al.* (2006) 'Publication and patent behaviour of academic researchers: Conflicting, reinforcing or merely co-existing?' *Research Policy*, 35, 4, pp.596-609.
25. Wright, M. *et al.* (2007) *Academic entrepreneurship in Europe*. Cheltenham: Edward Elgar.