International Journal of Business, Human and Social Sciences
ISSN: 2517-9411
Vol:9, No:4, 2015

In Search of High Growth: Mapping out Academic Spin-Off´s Performance in Catalonia

F. Guspi, E. García

***Abstract*—**This exploratory study gives an overview of the evolution of the main financial and performance indicators of the Academic Spin-Off's and High Growth Academic Spin-Off's in year 3 and year 6 after its creation in the region of Catalonia in Spain. The study compares and evaluates results of these different measures of performance and the degree of success of these companies for each University.

We found that the average Catalonian Academic Spin-Off is small and have not achieved the sustainability stage at year 6. On the contrary, a small group of High Growth Academic Spin-Off's exhibits robust performance with high profits in year 6. Our results support the need to increase selectivity and support for these companies especially near year 3, because are the ones that will bring wealth and employment. University role as an investor has rigid norms and habits that impede an efficient economic return from their ASO investment.

Universities with high performance on sales and employment in year 3 not always could sustain this growth in year 6 because their ASO's are not profitable. On the contrary, profitable ASO exhibit superior performance in all measurement indicators in year 6. We advocate the need of a balanced growth (with profits) as a way to obtain subsequent continuous growth.

***Keywords*—**Academic Spin-Off (ASO), University Entrepreneurship, Entrepreneurial University, high growth, New Technology Based Companies (NTBC), University Spin-Off.

I. Introduction

IN the last two decades European Universities have increased their efforts in fostering Entrepreneurship in Universities and Public Research Institutions, emulating US universities evolution in this area. University Entrepreneurship is seen as the last and round-the-circle step of the Transfer Technology process that create new companies with a high growth potential with the aim of generating wealth, qualified job places and economic development.

This view has bring into changes in Universities at the organizational level creating specialized teams on Technology Transfer, science parks, incubators, and at regulatory level redefining the goals and aim of the University as an institution. These structures that have produced an output, mainly in form of patents, licensing contracts and the creation of companies based on the technology transferred. These companies are referred in literature as University or Academic Spin-Off's (ASO's).

Nevertheless, Europe and US exhibit significant differences in ASO's performance. In 1995, European Commission [1] alerted that although the amount ASO's created in Europe is acceptable, they seemed to grow at a significant smaller rate than their US counterpart, not accomplishing by far the social objective of the institution [2]. This situation has been called the "European Paradox", with high public research and knowledge output from academy and scarce level of transformation of this knowledge to wealth. European Commission [3] found in 2002 a large number of *Lifestyle spin-offs* (low investment, internationalization and growth) versus *Growth spin-offs* (high investment, professionalized management, Venture Capital or industry partnerships).

There is the belief that "something is still left" when it comes to study the main variables that influence ASO growth at this macro level that can explain why an average ASO grows faster in some countries, areas, PRI's or universities. Governments, TTO's, local industry, PRI's and universities, seem to exert in fact an influence in ASO's growth. Whereas all the plans, subsidies, structures and actions are being implemented, results are still far from expectations.

In this article we perform an exploratory analysis of the situation and evolution of the long-term performance of ASO created in a European Region (Catalonia, Spain), from 1999 to 2010, by accounting the main balance sheet indicators in two points of time after the creation of the company. We also locate the individual companies that exhibit an abnormal growth and calculate until what extent these High Growth Spin-Off's (HGASO) contribute to aggregated wealth creation with respect to ASO's.

In addition to this main objective this paper aims to contribute to a better understanding of the parameters to take into account when study growth in ASO. In the methodology we profoundly discuss and justify each element taken into account into the study. Instead of taking one or two measures of performance, we draw results from different variables to contrast and assess the validity of each measure in relationship with ASO performance and the stage presumably ASO is in.

II. Literature Revision

A. University Entrepreneurship Impact: ASO Performance

Entrepreneurship has been widely studied as a source of employment generation [4]-[8], and economic growth [9]-[12]. Economic evolution in developed countries to a knowledge-based society [13], make the creation knowledge-based companies a top priority for governments to increase productivity and long-term economic growth [14], [15]. The continuous surge of IT, biotech and other technological companies that generate in record time a huge value for

Felipe Guspi Bori is Ph. D. candidate of the Department of Business Management, Universitat Rovira i Virgili, Spain (e-mail: felip.guspi@estudiants.urv.cat).

Ercilia García Álvarez is with the Department of Business Management, Universitat Rovira i Virgili, Spain (e-mail: mariaercilia.garcia@urv.cat).

shareholders, wealth and hundreds of qualified labor force jobs have made stakeholders realize of the importance of entrepreneurship in creating wealth. The high knowledge component of Entrepreneurship from Universities and PRI's [16] increased the interest in the creation of companies from Universities.

According to [17] an Entrepreneurial University accepts and fosters systematically entrepreneurial activities and has structures and mechanism to monitor and stimulate the process (TTO's, licensing office). Recent authors identify another characteristics of UE, such as having courses to deliver knowledge and skills related to entrepreneurship (Entrepreneurship Education), policies to accommodate, facilitate and reward entrepreneurship in the academic world, having a systematic planning and monitoring of UE, fostering links with industry and robust external and internal networks and recruiting star faculty [18].

UE deployment result in an increase of the number of companies created based in the results of University research, starting at the US [19]-[23] and a few European countries such as U.K. [24] and Sweden [25], [26]. This effort has also been accompanied by an increased research attention and academic output in the area of Academic Entrepreneurship in the last 15 years [27]-[29].

Besides the Bayh-Dole Act (1980) and Federal Technology Transfer Act (1986), [30] appointed other possible reasons for the US leadership in the creation and performance of ASO: changes in patenting laws and financial markets, the boom of the biotech industry and the increase of the university as an equity holder. However, outside the US, ASO produced poor results [31].

The main benefits from ASO creation are increasing the value of the results of R+D [32], job opportunities for academics and researchers, qualified employment, wealth and a significant economic return for universities. However some authors argue that UE economic returns are not enough to cover the expenses of the structures created for commercialization [33]. In Spain, it seems that these returns are minimal: according to red OTRI survey in 2011 [34], returns from ASO investment in shares represent 0.07% of TTO expenses. It is obvious that results are far from desired and that a great part of the success of Universities and TTO's in UE will depend on performance of the companies created.

Spain, as other European countries also legislate to transfer the right to exploit inventions to universities. Spanish and Catalonian Universities and PRI's have also followed the European trend and supporting structures have been created following the recommendations of academics who claim the need to access to industry and institutional networks [35]-[37]. A big number of programs [38] and support structures have been created, with complex relationships between them [39].

When it has been the time to account the results of UE policies regarding ASO's, the measure of success has systematically been the simple accounting of the number of companies created [40]-[48]. In Spain, institutional surveys and studies have also driven its focus on the number of ASO created [49] rather than the type of ASO created [50] and its performance.

Some academics at the same time researched about the process of creation of ASO finding barriers, milestones and stages the company has to go through [23], [51]-[53]. These studies take into consideration the need to study ASO's in each stage and how resources and abilities needed in each stage could be different. According to [52], the last stage to achieve seniority for an ASO is the sustainability stage in which ASO's have reached sustainable profits.

Some studies focused on ASO performance: [23] pointed out that areas with poor EU infrastructure normally create low profile companies in terms of growth and performance. Aligned with [21], they recommend increase selectivity and support to improve ASO performance. Reference [54] openly questioned the economic relevance of ASO after some studies that stated that ASO had slower sales growth, net cash-flows, employees and probability to achieve profits than independent start-ups [55]-[57].

In Spain, [36] put into consideration the need to study long-term performance of the companies, once it has surpassed the early stages and thresholds. According to [58], ASO's had an initial underperformance that disappeared after 2 or 3 years. Productivity grew faster in ASO, and consequently can have more chances to generate wealth than a simple start-up.

So, it looks convenient to study ASO performance in the long term, to study if ASO created really surpass the last stage of having sustained returns that will guarantee sustainability and give further chances for growth, taking into account the real company output in terms of turnover, employees and profits after its initial stages. This is the main purpose of the study.

B. The Catalonian University System

Catalonia is located in the northeast of Spain. It accounts for the 16% of Spanish population, and its GDP is slightly over (1%) the Spanish media. The Catalonian University System is composed by twelve universities, eight public universities, and four private universities. Bigger universities are public (UB, UAB, UPC) with high university rankings.

We perform the study for the Catalonian private and public universities because of the prevalence of this area in Entrepreneurial University and innovation (Fig. 1) and because is a region that has rapidly changed from an economy based on production competition to an economy of competition based on innovation [59].

Catalonia has developed pioneer research in medical care, energy and urban, economic and social innovation; is well positioned in scientific production by population or GDP with respect to average European country, and has qualified market professionals as well as highly qualified researchers, teachers and students [60].

The same authors [60] stated that although Universities in Catalonia have adopted the UE mission and have created the structures to foster entrepreneurship, there is the necessity to evaluate real effect of UE in the long term. ASO creation of wealth is one of these effects of UE.

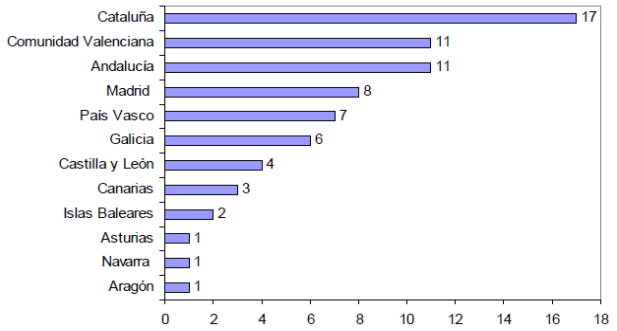

Fig. 1 Number of ASO created in Spain from 1998 to 2005 [36; p. 230]

III. Methodology

In our study, we revised the main methodological points ASO studies have encountered, the problems that have arisen and we made a justified decision on each point.

The research study had seven elements: (i) ASO definition, (ii) Measures of growth, (iii) ASO stages and milestones, (iv) Time period, (v) Relative or absolute variables in growth measurement, (vi) Measure of High Growth, HGASO selection criteria and (vii) Company selection process.

A. ASO Definition

It is a recurrent problem in ASO studies to define the borders of what is considered as an ASO company.

We adopted the definition of ASO from [61]: "new companies created from universities to exploit knowledge created by academic activities in a profit making perspective".

Thus, we considered ASO from a broad perspective, not requiring them to be formed exclusively by teachers or to be partially owned by university. So a company formed by students or entrepreneurs would have worked for the study if a TT process existed.

B. Measures of Growth

Different measures of growth have been used in SME. The ways authors measure growth vary and can lead to different conclusions in each study. Objective measures are normally related with relative or absolute growth on revenues or employees. However, the measure investors normally pursue are measures of return such us net profit, generated cash-flow, EBITDA or ROI. Some studies also use more peculiar measures such as total company asset (related with investment).

Although it is usually justified as a methodological unimportant option, it is obvious that it can have important consequences in results and the difficulty in making comparison between studies. Growth is a desirable situation for all the groups that interact in and with the company (managers, owners, public administrations, workers, unions, suppliers…). However each group has its favorite variable to maximize. Public administration and unions prefer to maximize employment, suppliers prefer purchases and fixed assets, whereas for owners the variable to maximize in the long run is Net Profit or ROI.

Measures on growth based on employees have created some controversy since it can be difficult to sustain because not always were necessarily related with growth in sales or profits. Measures based on employees are used in the early stages of the firm, when the generation of revenues and profits are small related to the investment and in that industries where time to market is long (e.g. biotech).

ASO literature is not an exception and generally used measures are employee or sales growth [23], [62]-[66],

A majority of studies consider sales or employment and literature commonly assumes that after a growth in sales will lead to employment growth and vice versa. However Reference [67] studied the relationship between these two variables stating that they not always are interchangeable and found that there are variables as asset specificity and behavioral uncertainty that moderate this relationship.

We have compared the results of ASO activities in each Catalonian university in terms of Turnover, number of employees, profits, assets and leverage.

C. Relative or Absolute Variables in Growth Measurement

Gilbart's law stated that the company growth is independent from its size. Several studies have been conducted to state the validity of the law. A majority of them concluded that Gilbart's law can be applied (with some limitations) particularly in the long run but is especially inexact with small companies. Gilbart's law is specially fragile for small companies in the way that small companies grow more than its bigger counterpart when sales or employees are the measure selected [68]-[71].

Differences in growth for small companies along time are significant: [82] found that the mean annual sales growth of gazelles between 1992 and 1996 was 36%, but surviving gazelles grew by just 8% between 1996 and 2001, being unable to sustain growth even in better macroeconomic conditions than the previous five years period. However, [72] for the UK, and [73] for West Germany demonstrate that high growth firms grew faster than the industry average growth in the following periods.

Since ASO companies selected for our study were SME it was wise to try to diminish the size effect by taking a combination of relative and absolute values or consider a minimum size to take data into account [74], [75]. Another way to diminish this effect is to consider the initial point of time some years after the creation of the company, so that relative values are more representative.

As a measure of High Growth we used an index based on Birch index [76] taking absolute and relative measures on sales.

D. Sustained or Fluctuant Growth

Reference [77] explored the different phases in the company early growth. Internal and industry forces and resource endowments force the company to pass through different growth paths with fluctuant, reinforced or reversal growth.

Some studies consider high growth exclusively as a

necessarily steady growth arguing that one or two shot growth can be due to an acquisition or a non-replicable event in the environment. Reference [78] studies the different ways company grow or types of growth classifying companies in super-absolute and super-relative companies, sales growers, acquisition growers, erratic one-shot growers, sales growers and employment growers.

Literature on high growth also show that patterns of growth change over time [78], [79] and high-growth is shown in short periods of time followed by a decline or slower rate [80].

We consider that there is not sufficient evidence to reject fluctuant, one shot growth or any pattern of growth. Besides, growing through acquisitions or heavy investment could be a valid strategy for growth and can lead to further operations in the same way in the future.

So whatever is the origin of growth or its pattern over time, we cannot find a reason invalidate any way or growth pattern. So we accept average compound growth based on measures on Y6 and Y3 as a good measure.

E. Academic Spin-Off Stages and Milestones

Some authors split ASO development in phases or stages the company has to go through to achieve maturity. The resources and knowledge required in each stage evolves and different barriers arise and have to be overcome. Growth will occur depending on the resources the company has or the ability to get these resources from outside. Looking at the knowledge as a key resource, [42] pinpoints that the lack of the different types of knowledge required as the main handicap for a spin-off to develop and grow. Companies need this knowledge to develop and to create a sustainable competitive advantage [81].

The kind of knowledge gets different significance in each stage of the spin-off process (research and development stage and commercialization stage) and to the different participants in the process (PRI, TTO, academics, entrepreneurs, venture capitalists). From this Knowledge Based View perspective, companies need to have technical/scientific knowledge, especially during the development stages and organizational knowledge to develop and growth in the commercialization stage.

An important group of studies are based on Vohora perspective [52], which identifies four critical milestones: opportunity recognition, entrepreneurial commitment, threshold of credibility and threshold of sustainability. The new firm has to develop capabilities and obtain different types of resources to overcome each one of these junctures to achieve growth.

There are few studies on which are the different ages to surpass each milestone, but [62] found that more innovative companies reached credibility threshold as far as year 1 and reach sustainable returns before Y6. On the contrary, low to medium innovative SO encounter credibility threshold at year 4 and failed to reach sustainability at Y6. According to this study 53% of the companies where highly innovative, that is their product or service was a breakthrough or new for the sector and the expenditure on R&D was over 25%.

F. Time Period

The time frame chosen in literature of growth in small and medium companies is highly variable and normally ranges from 3 to 10 years [82]. In high growth or gazelle's literature is more common to take a 3 to 4 years approach [76], [83], [84], although there are studies with periods of 10 and even 20 years.

In our case it is not a trivial decision because we are interested in companies with a sustainable growth (that is, with profitability) and this can appear in some years after the start of the operations, but it has to be short enough for companies to maintain his ASO characteristics and to have a minimum number of companies with rapid growth.

In consequence a time frame of six years is enough time for this group of highly innovative companies to present high growth and achieve sustainable returns, according to [62]. We chose this time frame because it is our estimated period in which companies had surpassed early stages, had created structures for growth and had to some level achieved the credibility stage. So high growth, if occurs, will show in approximately those years.

As stated, some authors on growth think six years can be a short time frame to measure performance. According to [64], measuring the growth of the ESOs (as compared to non-spin-offs) can be stated about ten years after the establishment of the firm, and this outperformance manifests precisely from the sixth year of life. This is not contradictory with our decision since we are looking for this group of companies that achieve High Growth early in their development. High growth literature also account for HG periods of 2 to 3 years followed and preceded by average industry growth.

However it is to notice that most ASO studies take either established or new firms in a period of time [82], and they evaluate their results each year. The novel approach of our study is that we choose to study a period of three year time after three years of operations for all the companies in the period studied. This way we compare companies at the same time in their development.

The initial time point was set in year 3 for two reasons. On the one hand companies take some time to complete the TT process, create structures, complete product (service) design, and surpassing first stages. Reference [62] set this time between 1 to 4 years. So at Y3 most HGASO candidates would have shown attractive returns and growth. On the other hand, we wanted to diminish size effect and avoid super-high relative growth measures due to the smallness of the firms.

G. Measure of Rapid Growth or High Growth - Gazelles: HGASO Selection Criteria

Some empirical works establish a dichotomy measure for high growth in SME and consider that a firm grows rapidly when it achieves a growth point. A common measure is companies that double their initial size in a period from 4 (most common) to 11 years [85], [74], [83], which represents an annual compound rate from 19% to 7%.

Reference [76] defined gazelles as "growth-orientated companies that have achieved a minimum of 20% compound

sales growth each year over the previous five years, starting from a base of at least $100,000". EU project KITE has also used this measure of rapid growth jointly with other studies [86].

Reference [87] set in 2001 the frontier of rapid-growth for their study in employment risings by at least 15% per year, in a five year period (which represents doubling its size).

One can conclude that there would be a general agreement stating that a company with a continued annual growth of around 20% is commonly considered as a high growth or fast growing one.

So for the reasons explained in this section, we chose to take data in Y3 and in Y6 of operations and we chose a combination of relative and absolute measures of growth to moderate the size effect [74], [75].

Consequently, for our study HGASO candidates should accomplish these three criteria: (i) At least 6 years old, (ii) at least 300k€ of turnover at year 6 and (iii) at least 20% of annual compound turnover growth from year 3 to year 6.

H.Company Selection Process

Since a database on spin-off was not available, first step was to gather information to identify spin-off firms. We obtain the information mainly through the university web page and then validate the information through a short telephone interview to the director or assistant in the TT department of each university. ASO list was collected from the main public and private universities in Catalonia, Universitat de Barcelona (UB), Universitat Autònoma de Barcelona (UAB), Universitat Politécnica de Barcelona (UPC), Universitat Pompeu Fabra (UPF), Universitat Rovira i Virgili (URV), Universitat de Lleida (UDLL), Universitat de Girona (UDG), Universitat de Vic, Universitat Ramon Llull, Univesitat Oberta de Catalunya.

Only six universities reported to have companies that surged from university or officially have support from them through a Technology Transfer process. They were asked to validate the companies and qualify them as properly ASO because there has been Technology Transfer or simply start-up companies. We eliminate from the list those considered by the TTO's as simple start-ups. We also ask about the university holding any stock in the companies and if there were any venture capital firm as stockholder.

In Spain companies are due to register their financial data in "Registro Mercantil". Registration normally takes a year (December 2011 already have data from 2010). The year of spin-off creation was considered year zero.

Balance sheets from 1999 to 2010 were gathered from "Registro Mercantil" and SABI database and analyzed for each company by indexing seven variables: Turnover, Number of Employees, Profits, Total Assets, Leverage and Equity Value.

Although it is compulsory in Spain to register records in "Registro Mercantil", there are many reason not to have them available: some companies presented particular company structure (cooperative or not limited liability…), others were in a closure process, are too young and do not have 3 or 6 years of life or others simply do not comply with the norm, which is usually an indication of poor activity level. Some others have been found with different names since universities normally use its commercial name, rather than the company name. Other companies could have suffered a corporate operation (merge or takeover) that transform company in a different one or have moved headquarters to another country.

To compare company data we have considered year 1 as the first year with turnover different from zero or the following tax year after formation. Most companies reported sales the same year of foundation and if no sales are reported, the following year was considered year 1.

From an initial pool of 168 companies, we ask TTO's to discriminate proper ASO from start-ups, and 38 companies were disregarded for not being proper ASO according with the given definition.

We also did not consider 40 more companies for not having accounting records in the official "Registro Mercantil", leaving 90 companies to study. In a similar study performed by [58] from 496 Spanish companies they could only find accounting records in 104, which is an abnormal percentage of 21%. We found records on 67% of ASO, which is also a fairly low percentage anyway, taking into account that is legally compulsory to register financial data in Spain.

From these 90 companies, 63 were more than three years old (Y3), and only 35 have records at year 6 (Y6).

So there are 27 companies that are too young and although they have been located in "Registro Mercantil" database, did not had records for Y3.

And 28 companies with data in Y3 but not in Y6. Possible reasons for these are probably because either they had not released their data to "Registro Mercantil" at the time of the study, or they have been extinguished, or had a very limited activity, or in more rare cases they have been merged or acquired by another company or moved outside Spain.

TABLE I
TURNOVER DISTRIBUTION OF ASO COMPANIES IN Y3 AND Y6

Turnover (Euro)	with data in Y3	with data in Y6
< 100KE	13	2
<300KE	25	7
<1ME	16	16
<3ME	7	5
>3ME	2	5
Total	63	35

TABLE II
NUMBER OF ASO WITH DATA AT Y3 AND Y6 BY UNIVERSITY

University	Y3	Y6
UAB	18	6
UB	17	9
UDG	4	3
UPC	21	17
URV	3	-
Total	63	35

We can appreciate the increase in size on ASO with data on Y6 shown in Table I. A majority of ASO's have a turnover of less than 1 million EUR at Y3, but only 13 sell less than 0.1 million EUR. At Y6 only 9 out of 35 do not achieve the minimum size to be a HGASO candidate.

Table II shows the amount of ASO created by each university.

From 63 companies with Y3 records, 28 were in the Biotech industry (6 HGASO) and the other 35 were in the engineering and computer and IT industry (7 HGASO). From 63 companies with Y3 records, the bigger three university account for the total of HGASO (Table III).

TABLE III
NUMBER OF HGASO AND BIOTECH ASO WITH DATA BY UNIVERSITY

University	HGASO	BIOTECH HGASO
UAB	3	1
UB	6	4
UPC	4	1
Total	13	6

Regarding VC and university involvement in form of equity, from 63 companies with Y3 records, 17 reported to have Venture Capital (27%). Only 4 of these 17 accomplished HG criteria (23%).From 63 companies with Y3 records, 9 reported to have University as a shareholder. Only one of these 9 achieved HG criteria.

IV. RESULTS

A. ASO Performance by University

Aggregated measures of Turnover, Employees and Assets give an estimate of the wealth generated to society through ASO. Thus, from our study ASO created between year 1999 to 2010 with more than 3 years of operations generated 24.1 million EUR turnover, employed 509 people and had total assets of 55.5 million EUR at Y3 (Figs. 2, 3, 6).

If we focus only on companies which have data on Y6 and Y3 and calculate growth, these companies have grown from 15.1 to 34.7 million EUR in turnover, from 35.4 to 71.5 million EUR in assets and from 269 to 310 employees. However, key point is that aggregated profits although improved remain negative from -4.7 to -2.1 million EUR.

Turnover is the most common indicator for company performance. Sales increase is commonly used to size the company and is a measure of product/service success. The more is sold the more human and utilities are needed, that is more employment and more assets.

In order to achieve a sustainable growth, this increase in sales should end in significant improvements at the bottom line, through a better asset management and productivity increase.

We can appreciate from Table II and Figs. 2-6, that this route not always stand: performance results at the university level show that ASO from UPC have more companies, with more turnover in Y3 and Y6, companies in Y6 presented more productivity than Y3, and roughly the same level of investment. This surprising employment drop could have an explanation on the necessity to cut costs to improve the profit and loss statement. This reduction in the number of employees can bring as a consequence losing valuable knowledge that could difficult future growth. However, profits are profoundly negative in Y3 and Y6. Accumulated negative results lead to a significant loss Equity Value.

UB and UAB have better balanced figures (Figs. 2-6) and both of them presented aggregated positive results in Y6. The effect those results have in Equity value is impressive in the case of UB. Nine ASO companies from UB more than double Equity value of 17 ASO from UPC. Thus we can appreciate the key role profits play when it is time to assess ASO performance.

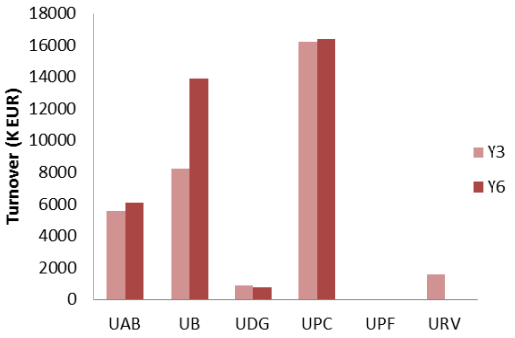

Fig. 2 Aggregated ASO Turnover by university

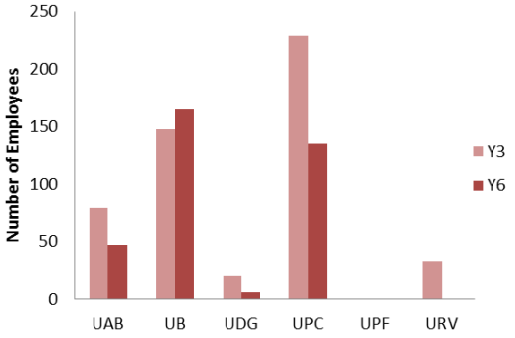

Fig. 3 Number of ASO employees by university

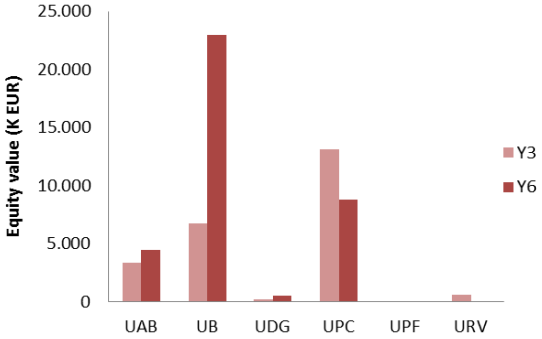

Fig. 4 Aggregate ASO Equity Value by university

Taking average company measures Fig. 12 data show that UPC creates bigger companies in term of Assets at year 3 and have better initial performance in terms of sales on Y3 (Fig. 7) but that grow slower in the following years, not accomplishing sustainable returns neither at Y3, nor at Y6 (Fig. 11).

Equity values in Y3 (Fig. 9) are an indicator at this point of company life of the investor confidence and effort. We can see that is fairly variable in each university and around 0.4 million euro on average. At Y6 important loses or profits diminish or

increase this value so differences between universities enlarge at Y6 where all universities had losses except for UAB and specially UB that made a turnaround in results.

These positive results allow UB and UAB to reduce leverage, whereas UPC remains at around a 70% of debt probably close to their debt limit (Fig. 13).

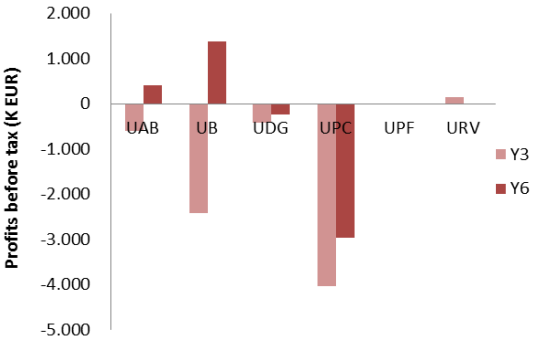

Fig. 5 Aggregate ASO Profits before Tax by university

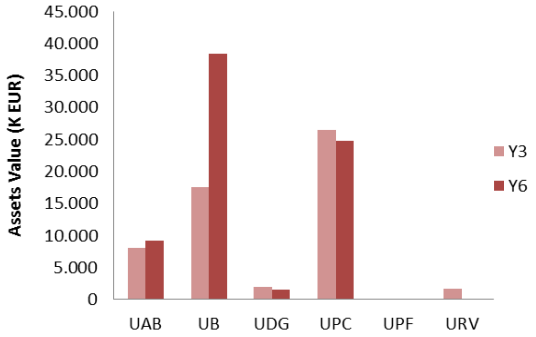

Fig. 6 Aggregate ASO Assets Value by university

B. High Growth ASO

Only 35 companies have data at year 6, and thirteen of these companies match all three criteria for being considered HGASO. Six of them in the biotechnology industry three in the computing engineering industry and the rest are in other engineering areas.

We compare average ASO variables with average HGASO data. Average turnover in ASO in Catalonia is around 0.5 million euro that multiplies by 2 on average at year 6 and by 3 on average for HGASO. On the other hand, employment on those companies roughly grew more than 50%.

At an individual level there are a small number of companies that explain the major part of the profits/losses account. UAB has 6 ASO with an average profit of 69.122 EUR, 5 ASO near breakeven and one winning 421.232 EUR at year 6. UB have 9 ASO at year 6, 5 of them with moderate losses, 1 with moderate benefits and 3 with strong profits records (> 500 K EUR) for its size. On the other hand UPC has a larger amount of 17 ASO, 14 of them with moderate profits/losses and 3 with high losses that turn the university average to loss.

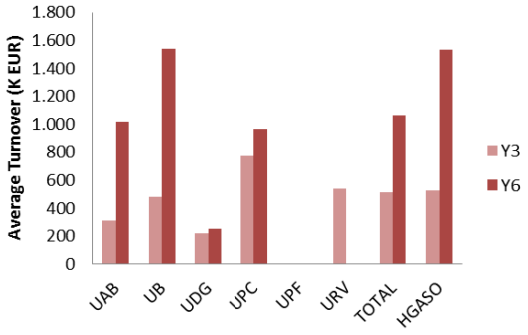

Fig. 7 Average ASO and HGASO Turnover by university

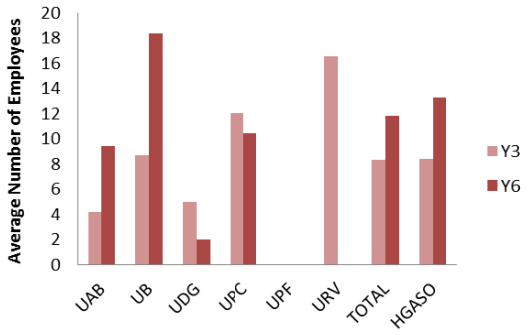

Fig. 8 Average ASO and HGASO Employees by university

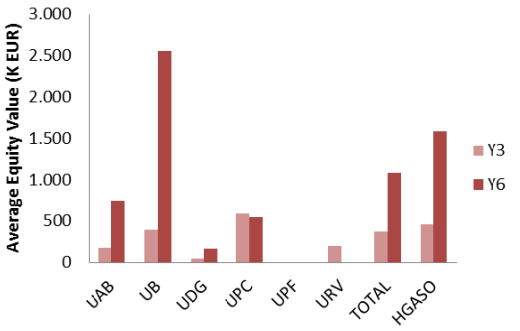

Fig. 9 Average ASO and HGASO Equity Value by university

The positive evolution of HGASO through time can be stated in Fig. 11, with an impressive improvement in results that allow companies to have access to further financial resources to invest, increase total assets and maintain or even reduce its leverage level. Total average profits are negative in Y3 (-113 KEUR) and in Y6 (-42 KEUR), with substantial differences between universities, whereas HGASO show average loses in Y3 (-124 KEUR) but an impressive turnaround to positive returns in Y6 (193 KEUR)

V. Conclusions

A. ASO Creation in Catalonia

According to previous studies in Spain, bigger Universities (UB, UAB, UPC), with more resources in TT infrastructure and R+D expenditure account for more ASO created [36] and for more HGASO.

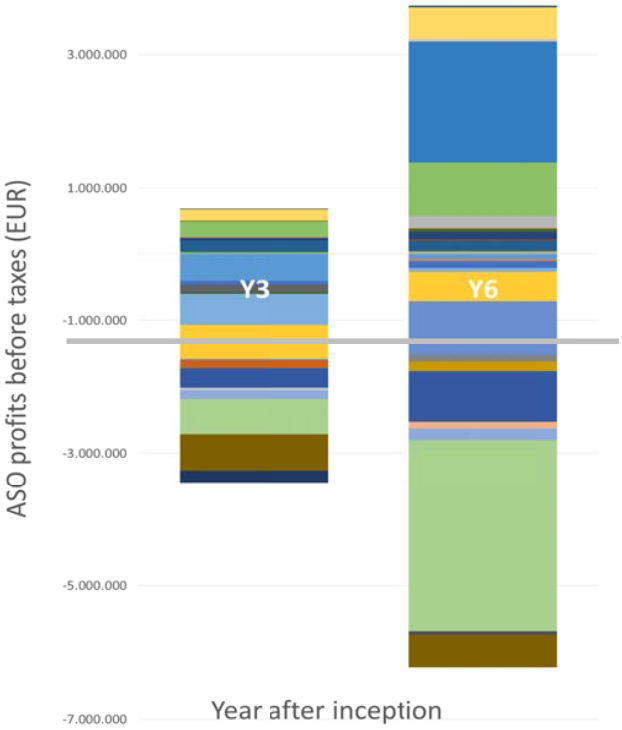

Fig. 10 Individual ASO Profits before Tax in Y3 and Y6

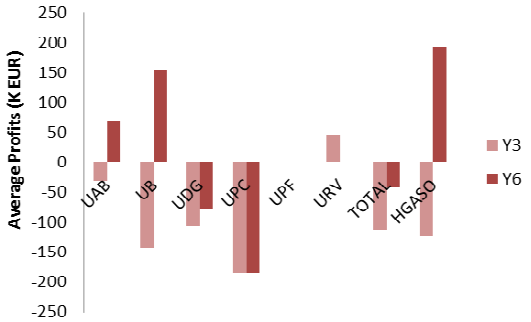

Fig. 11 Average ASO and HGASO Profits before Tax by university

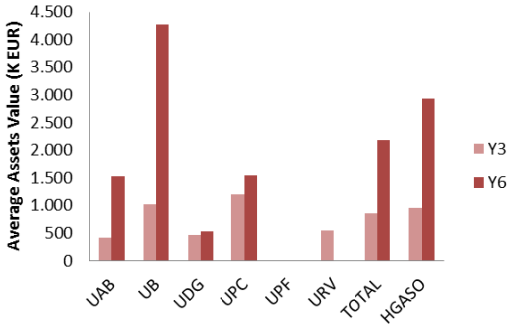

Fig. 12 Average ASO and HGASO Assets Value by university

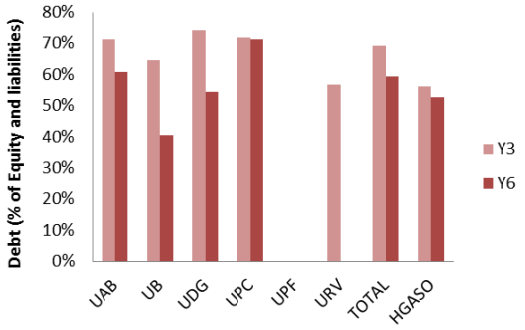

Fig. 13 Average ASO and HGASO percentage of debt on Total Equity and Liabilities by university

B. ASO Performance in Catalonia

Figs. 2-6 show the aggregated turnover, employees, equity, profits and assets value of the Catalonian ASO. The purpose of the study is not to compare the weight of these figures with Catalonian GDP, total employment and other macro statistics, but to observe the evolution of these indicators over time.

After 3 years of performance, ASO's face critical junctures, and depending on the industry and the company's resources and abilities, companies should already trying to overcome the threshold of credibility and enter in the sustainability stage, generating enough returns to convince stakeholders of its long –term viability.

If we compare Y6 with Y3, we can observe substantial average turnover and employee increases which are the measures commonly used to measure performance and company growth. Equity value also increases reflecting that although profits remain negative, in general terms, investors keep investment in those companies. Assets value also increase almost in the same proportion as Equity.

However, our results indicate that performance of ASO in Catalonia in terms of profits is poor in Y3 and in Y6, with average loses on both exercises. And profits are precisely what validate Vohora's sustainability stage [52] in the long run, it gives cash-flow to pay debt, it gives resources to increase investment, it gives stability and good perspectives to employee salaries and because it validates the company in front of investors accomplishing their ROE objective and increasing company value.

From the investor point of view, the attractiveness of a business with heavy losses during at least six years is very difficult to justify. Business plans with six years losses are extremely unusual.

So we can conclude that ASO companies in most cases take at least three years to achieve sustainable returns and the majority of companies do not achieve them at year 6. The question here is if those companies will ever achieve this milestone or it is simply a matter of time. As we already stated, losses during a six year period is a difficult situation to downturn.

Differences between universities are significant. Whereas UPC has the greater number of ASO created and the heavier average investment (Fig. 12) the average company show low performance in terms of growth sales and employment.

Average profits show heavy losses at Y6.

This situation is obviously detrimental for the company, but also for the university and the TTO, since there is no "success story" to show to future entrepreneurs, workers and managers will probably have high short term pressure for results. Risk of failure will make financing conditions get tougher, and the company is less attractive for new investors and to recruit new talent.

So, according to these results in general terms there is a certain base to subscribe some affirmations of those who are critical with the way UE is deployed with TTO's structures with low selectivity and support [21] and [23], especially in the long term, and ASO created with poor performance and growth orientation [54]-[57].

C. HGASO

Good news is that there is a small group of companies that exhibit superior performance (Figs. 7-9, 11). HGASO are companies that not only growth a compound average of 43% on sales during 3 years, but also show employment growth in 16%, increasing productivity and that have made a turnaround from losses to significant profits of 13% on sales in Y6.

So this selected group exhibits a sound evolution in their main indicators, and it has arrived on average at the desired stage of sustainable returns. When we study the individual companies some of them show spectacular figures (Fig. 10). The impact of just one high-growth company can represent a turnaround on the university-TTO performance results. So these results cannot be taken into account to judge the task of the TTO, but definitely they should cause a consideration about the productivity of TTO's, their objectives and where to focus their efforts.

D. University Ownership

University Entrepreneurship can give positive returns to universities through ASO ownership. In our study University presence in the company as shareholder is minimal. Either the TTO failed to identify the potential of the company or the University has a non-ownership policy. Both are detrimental for the university. As we have noticed in the study, a HGASO can multiply in three years its equity value. Besides due to profit generation, their future expected cash-flow can produce market value of the equity much higher than book's equity value. So it represents a missed investment opportunity for TTO and University, an opportunity to help finance entrepreneurship structures and to justify their task from an economic point of view.

So if aggregated impact in society in terms of turnover, employees or profits is being chased, it seems that quality is better than quantity, so we advocate to focus on high potential ASO because are the ones that will have high impact on long term performance, by increasing selectivity and consequently offering more support to selected companies.

When University enters in the company's equity, usually it takes around 10% ownership. The percentage normally obeys to a University policy rather than an objective valuation of the, knowledge and assets transferred to the ASO and or any financial estimation of the expected returns. We think that due to the non-economic goal of university little attention has been paid to the maximization of this possible income.

E. Venture Capital Ownership

We also try to establish a connection of VC ownership to ASO growth in our study. There is a consensus that VC help overcome financial barriers, provides credibility, bring new knowledge to the company and provide scouting and couching functions and access to networks [88], [90]. Consequently some authors found they tend to outperform compared to those without VC [91], although performance results on VC-backed companies are mixed. In our study, the percentage of companies with VC is very similar for HGASO and ASO, so their presence as shareholder does not seem to be a good predictor of HG.

F. Measures of Performance and Success

Another methodological conclusion is that it is time to quit the number of ASO created as a measure of success of a TTO's. Due to the huge differences between companies' figures, the number of ASO created does not have any relationship with total wealth created, number of jobs or investment. It also can have a perverse result on the TTO policies to low selectivity and low support; if the objective is just maximize the amount and not the quality of the companies created. We recommend some research on TTO's agency conflicts regarding this side-effect.

According to data it is wise to think that neither employment nor turnover at Y3 are good predictors of future performance of ASO. Looking at the individual results it appears clear that it is not until profits appear that one may think that company has a chance for growth in the long term.

Our point is that is not at least until Y6 we have a measure of real success of ASO. Until then, tracking the amount of ASO creation, employees… can be a measure of the amount of job done, but not of results in terms of increasing wealth for community. So University, TTO's should pose their eyes in profits. Profits guarantee sustainability, the generation of more resources for growth and are the last step in company development. Growth in investment, employment and turnover do not necessarily guarantee sustainability, but it is true that these variables can be used to anticipate profits because they happen before in the business process or product cycle. So chronologically one may think that after investment and employment, turnover arrives and after a period of time, profits. However, our study reveals that for ASO companies, a heavy investment or hiring does not always lead to enough turnover to generate profits, so that future growth and sustainability can be seriously compromised.

VI. Limitations and Implications for Further Research

Our study confirms some of the conclusions on previous studies on ASO in Europe about the poor performance of ASO and dig into the doubts about the way ASO and TTO success are measured.

When studied at the University level, differences in University's and TTO's policies lead to significant different results in the long term ASO performance.

Whereas there are a small group of companies with HG and sustainable and substantial returns on Y6, there are universities which companies made heavy investment and recruiting and present heavy losses at Y6 that we think can threaten not only their growth but their survival. It could be interesting to know if the downturn period is even longer than Y6 and if those companies have finally achieved sustainable returns.

So, longer studies are needed to complete the history of these problematic ASOs. Besides, with a longer time frame one could observe the previous records of other cases of HGASO. If it is a matter of small vegetative companies that make a big step or these bigger unprofitable companies made a downturn in their results.

We have found that employee and sales figures in early stages (near Y3) not always are good predictors of future company profitability and growth. So, early ASO measures should be interpreted with extreme caution. As a consequence more studies are needed about if there is really a good predictor for company success and if early employment or sales are measures good enough to guarantee success. We propose that a measure for a balanced growth should be studied to predict long term ASO sustainable growth.

Obviously this study has limitations and its conclusions cannot be generalized to other geographical areas. Besides, the youth of many companies lead to a lack of data of significant group of companies for Y6.

However it leaves interesting insights and questions on the appropriateness of how TTO and ASO success are measured and the different results universities can have on the companies they help to create.

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