Entrepreneurial Team Evolution in Technology-based Firms: The case of IST Spin-off Community

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Abstract

This article investigates how the composition of entrepreneurial teams evolves over the various phases of development of a university-based start-up firm. With the objective of creating synergies and active links between new ventures and the university, IST – Technical University of Lisbon has created a community of spinoff firms through its TTO. This allowed us to focus on a very specific and already well identified population for the present study. A pair of questionnaires was built, one to collect the company's general information and another to collect personal information on the entrepreneurs that were involved in these new ventures. Therefore our research question is: How do entrepreneurial teams evolve along the different phases of a spin-out process? The contribution of our research will not only lie in the fact that we will take a dynamic team perspective, allowing for the identification of the team heterogeneity evolution, but also on its analysis under the different research conditions were these companies developed their R&D. In line with the literature's findings (Vanaelst et al., 2006), our findings suggest that teams are not immutable entities, as they evolve along the various phases of development, changing in composition. Our analysis suggests that the team's heterogeneity changes as it evolves throughout the various phases of development, increasing particularly when the firm is officially created.

Keywords: Academic Entrepreneurship, Entrepreneurial Teams; Team Heterogeneity

1. Introduction

The purpose of this research is to study, understand and analyze the process of team composition on academic start-up firms, with a special focus on firms created within the scope of the Technical University of Lisbon (TUL), in particular in one of its faculties, Instituto Superior Técnico (IST). The choice for IST relates, on one hand with the fact entrepreneurial activities engaged in an engineering school have a very strong technological basis (for example Di Gregorio and Shane, 2003, find that approximately 12% of university-assigned inventions are transferred to the market through the creation of new organizations/firms); on the other hand, the existence of a "Spin-off Community" composed of start-ups whose previous founders are IST alumni acted as a strong motivation for bringing new knowledge on team homogeneity and heterogeneity regarding founders academic backgrounds and labor market experience.

Entrepreneurship has re-emerged as a vital factor in modern economies (Audretsch, 2003), mainly due to the reduction of the extent of scale economies in manufacturing and the increasing importance of innovation, reducing the relative

importance of large-scale production (Brock and Evans, 1989). Furthermore, the re-emergence of entrepreneurship has also been explained with increasing globalization, which has contributed significantly to the emergence of comparative advantage in knowledge-based activities (Audretsch and Thurik, 2001; Audretsch, 1995).

Recently, national governments have begun to restructure their policies regarding science funding in order to encourage universities to commercialize their research results, as academic science is increasingly being defined by national policy makers as a highly contributing factor to international competitiveness (Johansson et al., 2005).

The decision to create an academic start-up firm challenges the researchers since they have to enter a business community that is different from the scientific community in which they had been active so far (Vanaelst et al., 2006). There are different resources needed for a successful launch of the venture, such as technology resources (which are usually in place) and of course the financial and human resources, which often seem to be the most critical (Vanaelst et al., 2006).

Previous research shows in fact that these two resources (human and financial) are closely interrelated, as early-stage venture capital funds use the "business experience" of the entrepreneurial team as well as the question of a well-balanced team as a main criterion to allocate investment (Vanaelst et al., 2006; Clarysse and Moray, 2004). Consequently many high technology start-ups do not receive the needed funding because they lack of an experienced manager within the entrepreneurial team (Clarysse and Moray, 2004).

2. Entrepreneurial Teams

In order to define the concept of an "Entrepreneurial Team" there has been a considerable debate of what this concept exactly means (Vanaelst et al., 2006).

There is a most frequently used definition which states that an entrepreneurial team is composed of two or more individuals who jointly establish a business in which they have equal financial interest (Kamm et al., 1990), as these individuals are present from the pre-start-up phase of the venture, before it has even begun to build goods or services commercially available in the market.

However, according to Cooney (2005), two substantive elements of the previous definition are subject to disagreement, as the inclusion of the term "equal" financial interest and the focus on "pre-start-up".

A more open interpretation of financial interest is required, as well as the fact that an individual can become part of the entrepreneurial team at any stage of the maturation of the firm (Cooney, 2005). Summarizing, we shall follow the lines of Cooney (2005), defining entrepreneurial teams as "two or more individuals who have significant financial interest and participate actively in the development of the enterprise".

The relationship between teams and firm overall performance has been examined in the literature on the "upper echelon perspective" (Hambrick and Mason, 1984), stating that general organizational outcomes (performance levels and strategic choices) are partially predicted by the managerial background characteristics of the firm's top management team.

Nevertheless, there is a key difference between the large firms and spinoffs being that the former are already established firms in the market, whereas spinoffs are emerging new ventures passing through various stages before becoming an established organization in the market (Vanaelst et al., 2006).

As referenced by Rothaermel et al. (2007), current issues on founder teams revolve around issues concerning team composition and its effect on new firm performance, being team composition observed in relation to the founder´s affiliation, business experience and education profile.

This research has so far fruitfully informed us about the importance of team heterogeneity (Ensley and Hmieleski, 2005), inviting future researchers to further identify how university spin-outs can more effectively develop a founding team that will conduct to a superior firm performance (Rothaermel et al., 2007).

2.1 Phases of Development

Furthermore, in order to investigate the entrepreneurial events of the spinout process, the

dynamic composition and changes in spin-out teams will be addressed.

Drawing on the work of Vohora et al., 2004, spinoffs are bound to encounter “critical junctures” that must be overcome in order to make an evolutionary transition from one phase of development to another. These phases of development or growth are identified as the (1) research, (2) opportunity framing, (3) pre-organization, (4) re-orientation stage, and last but not the least, the (5) sustainable returns phase (Vohora et al., 2004).

At the interstices between these phases Vohora et al. (2004) identified four critical junctures that spin-out companies have to overcome if they are to be successful, which are opportunity recognition, entrepreneurial commitment, threshold of credibility, and finally the threshold of sustainability.

The first phase is composed upon scientific research (1) that has to take place within the university academic departments over a number of years, as during the second phase (2) the transition between a recognized opportunity and the formative steps to creating a new venture mainly focuses on the academic and the TTO.

In this phase, either independently or together, the academic and the TTO work together towards examining if the opportunity has sufficient overall value to warrant further effort in pursuing its commercialization.

In the third phase, which is pre-organization (3), the management of the new venture will start to implement strategic plans, involving decision-making for the present moment and the future regarding the resources and capabilities to develop, the resources and knowledge to acquire as well as were and when to access them. In the re-orientation phase (4), the new ventures attempt to generate returns by offering their product(s) or service(s) of value to potential customers.

As a consequence of these attempts, entrepreneurial teams face the challenges of continuously identifying, acquiring and integrating different resources, and reconfiguring them. The last phase in this framework is the sustainable returns phase (5), were new ventures are characterized by attaining the capability to have sustainable returns.

Reaching such a phase is the fundamental objective of entrepreneurial teams, as these have to access and reconfigure their resources to assemble the capabilities enabling the firm to reach sustainable returns.

Clarysse and Moray (2004) described a similar classification of the development phases, having identified a research phase (during which the project is prepared to undergo incorporation into a spinout) and a phase of external capitalization.

Vanaelst et al. (2006) modified the delineation of the different stages of development by taking the research phase and opportunity framing phase together as the first phase in the spinout process, simultaneously using a comparable delineation for the other development phases.

In summary, the development phases considered by Vanaelst et al. (2006) were the (1) research commercialization and opportunity screening, (2) organization in gestation, (3) proof of viability of the newly established venture and (4) the maturity phase.

3. Methodology

The locus of our analysis is the dynamics and evolution of entrepreneurial teams as they climb through the different stages (milestones) considered for a spin-out process. The contribution of our research will lie in the fact that we will take a dynamic team perspective, allowing for the identification of team heterogeneity along the spin-out process. The team’s heterogeneities will also be analyzed under the Research Unit were their R&D was conducted to analyze the implications that this factor may have on team’s heterogeneity.

First of all, and after an extensive description of team evolution throughout the phases of development considered by Vanaelst et al. (2006) we will clarify how we will take on this aspect in our work by defining our own phases of development.

In order to further simplify these phases of development we will take the organization in gestation and the proof of viability phases together, ending up with three final phases as basis for our analysis. These phases will be (1) Research & Opportunity Screening (pre-startup), (2) Proof of Viability (post-startup) and (3) Maturity Phase (post-startup).

We will consider that the formal creation of the new venture will occur between the first and second phases of development. Following the work of Vanaelst et al. (2006) we will take the inspiration of Vohora et al. (2004), considering that each new venture must pass through the previous phase in order to climb the several development stages, involving each phase an iterative and nonlinear process of development.

3.1 Data Collection

In order to collect the necessary data we took on the method of the questionnaire, using a particular population of university spinoffs. As was often stated before, with the objective of creating synergies and active contact between new ventures and the university, the faculty IST of the Technical University of Lisbon has created a community of spinoff firms through its TTO.

All the companies belonging to the community were contacted. Of the total of 37 companies officially composing the IST's Spinoff Community, we managed to collect reliable information for 23 companies, representing a 62,16% success rate. Additionally, we collected information on two other companies that don't belong to the community yet (as they are very recent), but were created in the same environment and by entrepreneurs from IST. These companies operate in various areas of activity, ranging from Aerospace Technology to Biotechnology, being Software the most common area of activity found.

We scheduled an interview with the founder or CEO of each company involved in the study and conjointly filled out the answers in the more complete and rigorous way possible. By doing this we increased the response rate, guaranteeing good and reliable information. The first option to collect the data was through personal interviews with one of the founders of these companies, having been conducted by telephone when a personal meeting was not possible. When accepted, the conversations were recorded for future analysis.

Two distinct questionnaires were built, one to obtain general information about the company itself (e.g. history, evolution, area of activity, dates involved) and the evolution of the team (entry and exit of members, dates involved), and another to collect basic personal information of each member of the entrepreneurial team, such as background information, education and past experience. Following Vanaelst et al. (2006) we also collected the personal basic information of past members of the entrepreneurial team, allowing us to evaluate the experimental diversity of the team at different stages of the spin-out process.

3.2 Team Heterogeneity

As an indicative of a broad range of human capital within a team, Heterogeneity facilitates the gathering of information from a variety of sources, inducing alternative interpretations and perspectives (Ucbasaran et al., 2003).

To measure the heterogeneity of categorical variables: (H) = - $\sum P_i (\ln P_i)$, we followed Ucbasaran et al. (2003) using the Teachman's (1980) scale. This measure takes into account how team members are distributed among the different categories of a variable, being the total number of categories of a variable equal to n. The parcel P_i is the fraction of team members falling into each category.

Four different heterogeneity categories were considered for analysis and computation, scientific area heterogeneity, course heterogeneity, experience heterogeneity and entrepreneurial experience heterogeneity. In accordance to the literature, we computed experience heterogeneity and entrepreneurial experience heterogeneity (Vanaelst et al., 2006; Ucbasaran et al., 2003). Additionally, we followed the same method (Ucbasaran et al., 2003) to compute scientific area heterogeneity and the course heterogeneity.

These four heterogeneity categories were calculated for each company in each development stage considered (Research and Opportunity Screening; Proof of Viability; Maturity), giving us a dynamic perspective of heterogeneity.

3.2.1 Scientific Area Heterogeneity

The scientific area heterogeneity allows us to observe the evolution of a team's heterogeneity throughout the various phases of development concerning the scientific area of studies of its members. To collect information on this topic 5 different and broad areas of studies were considered, beginning with (1) Engineering, (2) Economics, (3) Human and Social Sciences, (4) Arts and (5) Other (e.g. law).

3.2.2 Course Heterogeneity

As was concluded before, most entrepreneurs took their courses in the scientific area of engineering. This fact points out to low mean values of scientific area heterogeneity. This is the reason contributing mostly to the decision to calculate the course heterogeneity, as many courses within engineering are very different, implicating that the entrepreneurs have in fact different skills and knowledge. To compute the course heterogeneity the 17 different courses identified were taken into account.

3.2.3 Experience Heterogeneity

Experience heterogeneity allows us to evaluate the evolution of a team's overall experience based on the entrepreneurs past professional experience. To collect information on experience heterogeneity the past professional lives of the entrepreneurs were grouped into several categories, beginning with (1) Management, (2) Marketing, (3) Engineering or Research and Development, (4) Finance, (5) Human Resources and (6) Other (e.g. legal).

3.2.4 Entrepreneurial Experience Heterogeneity

The entrepreneurial experience heterogeneity allows us to observe the evolution of a team's entrepreneurial experience based on the entrepreneurs past experience on this topic. To accomplish this, yes (1) and no (0) answers were used. Previous self-employment experience had a positive and significant impact on the probability of white male Americans entering self-employment (Parker, 2004), but in our study no conclusions could be made on this topic.

3.3 ANOVA One way factor analysis

When only one factor is at study (independent variable), the analysis of the variance is designated as "One Way ANOVA". In the analysis that is performed in this paper recurring to this method the factor will be the Research Unit factor, which is composed of three groups (k=3). The behavior of the dependent variable (e.g. experience heterogeneity) may be explained by the following model (Barnes, 1994; Marôco, 2010):

$$Y_{i,j} = \mu + \alpha_i + \varepsilon_{i,j}$$

Where i=1,…, dimension of the sample; j = 1,…,k , μ is the global mean, α_i is an effect of the treatment of the sample *i*, and $\varepsilon_{i,j}$ which is an error associated with the observation

In this method, the following hypotheses are considered:

$$H_0: \mu_1 = \mu_2 \ldots \mu_k \text{ vs. } H_1: \exists\, i, j : \mu_i \neq \mu_j$$

These hypotheses test if the factor in study (in our case, the Research Unit were each team conducted its R&D) has (or not) a significant effect on the dependent variable.

The hypothesis H_0 considers $\alpha_1 = \alpha_2 = \ldots = \alpha_k = 0$, while the hypothesis H_1 considers that at least one α_i is different from 0.

The ANOVA test statistics is given by *F*, which is the division between the variance of the factor in study and the variance of the errors (Marôco, 2010). The hypothesis H_0 is rejected if *F* is greater or equal (*F* ≥) than the critical value of the Snedecor distribution in the first percentile (for this study we considered $\alpha = 0.05$). The ANOVA *F* statistics has the *F*-Snedecor distribution when the dependent variable has a normal distribution in all the groups and the population variances are homogeneous. If the dependent variable has a normal distribution and the variances are heterogeneous the Welch (1951) statistical test is used.

The process by which the decision for the rejection or non rejection of the hypothesis H_0 begins with the Levene test of the homogeneity of the variances, verifying if the p-value is above (considered homogeneous) or below (considered not homogeneous) $\alpha = 0.05$. If this test is verified as homogeneous we proceed to the ANOVA analysis to obtain the level of significance. Otherwise (if it is considered as not homogeneous), we proceed to the Welch's robustness test to obtain the level of significance.

When the obtained significance value is above 0.05, we consider the non rejection of the hypothesis H_0, otherwise, this hypothesis is rejected. In this last case we can conclude that there are different behaviors between the groups for the issue being analyzed. On this stage, in order to identify which group or groups have a different behavior, the multiple comparisons Tukey test should be made.

4. Results

The entrepreneurial teams, the locus of our analysis, were composed of total of 86 entrepreneurs along the various phases of development. Of these, 82 are Portuguese, and only 4 are women, being this fact not surprising as females are a minority of the self-employed workforce in all developed countries, and in all ethnic groups, being this fact consistent with the literature (Parker, 2004).

The results for the mean heterogeneities throughout the three development phases considered can be observed in Table 1.

Table 1- Heterogeneity Mean and Standard Deviation Values throughout the 3 Development Phases

Heterogeneity		Research and Opportunity Screening	Proof of Viability	Maturity
Scientific Area	Mean	0,02	0,07	0,05
	St. Dev.	0,08	0,12	0,11
Course	Mean	0,11	0,20	0,14
	St. Dev.	0,16	0,18	0,16
Experience	Mean	0,03	0,07	0,04
	St. Dev.	0,11	0,14	0,10
Entrepreneurial Experience	Mean	0,10	0,11	0,11
	St. Dev.	0,14	0,13	0,14

As we can observe from Table 1, the global average values for the heterogeneities are lower in the first phase of development with a global mean of 0,07, increasing 57% in the second phase of development to a global mean of 0,11. In the third stage of development the global mean value of the heterogeneity descended 27% to 0,08. By observing the heterogeneities evolution we can be inclined to conclude that the overall heterogeneity of the teams is low in the first phase of development, increasing in the Proof of Viability Phase, with a descending behavior in the Maturity phase, being nevertheless higher than in the first phase.

Scientific area heterogeneity is when compared to the other categories the lowest average heterogeneity (equally comparable to Experience Heterogeneity), particularly in the first phase of development, with a value of 0,02. In the first phase of development, we find that the teams scientific area of studies is highly concentrated in engineering. In fact, when the team actually pursues the creation of the firm (that takes place in the second phase of development), the scientific area heterogeneity goes up 0,05 points to a value of 0,07, representing a 250% increase in the teams heterogeneity.

This fact is supported the literature (Vanaelst et al.,2006), as a broader range of experience and knowledge is procured when the firm begins to take its first steps in the market (Proof of Viability phase). In the third phase of development the scientific area heterogeneity goes down 29% to a value of 0,05, becoming less heterogeneous than in the second phase. Nevertheless, in the last phase of development the companies teams have more heterogeneous scientific areas of studies when compared to the first phase (150% higher, from 0,02 to 0,05).

The course heterogeneity has the highest average values in comparison to the other types of heterogeneity, which is not surprising as 17 different courses were analyzed, differentiating people from the same scientific area of studies. Concerning its evolution, in the first phase it has an average value of 0,11, increasing in the second phase of development by 81% to a value of 0,20, following the trend presented by the other heterogeneity categories, as in the last phase it went down 30% to 0,14.

As for experience heterogeneity in the first phase of the spinout process they appear to be unbalanced in terms of their past professional experience, as the experience heterogeneity value is the lowest (0,03) in the phases analyzed. This fact is in accordance with Vanaelst et. al (2006), as their experience is highly concentrated in engineering and research and development, as it is the Research and Opportunity Screening phase that these companies are building the first steps of what in the future will be their commercial products and services. When the teams progress to the second phase of development, the average experience heterogeneity goes up to 0,07, representing a 133% increase in its average value, showing a broader range of experience in this

phase. In the third and last phase of development, this value goes down 43% to 0,04.

The entrepreneurial experience heterogeneity has in the first phase of development a value of 0,10, being the lowest in the phases analyzed. It would be expected that teams would attract entrepreneurial experienced people in the second phase of development, highly increasing the entrepreneurial experience heterogeneity value. However, the entrepreneurial experience value increased 10% from 0,10 to 0,11. Regarding entrepreneurial experience, Vanaelst et al. (2006) state that "teams in the first phase of the spinout process, (…), show a lack of entrepreneurial experience". Additionally, they find that "once the decision is taken to create a spinout, team members are attracted to the team that may have entrepreneurial experience".

In our study, the modest increase in entrepreneurial experience heterogeneity from the first to the second phase of development doesn't allow us to state that when these teams decided to create a new venture they actively pursued the attraction of entrepreneurial experienced people; therefore it remains inconclusive. In addition, we found a significant number of teams in our study that evolved through the various stages with absolutely no entrepreneurial experience, which apparently seems paradoxal but is supported by Vanaelst et al. (2006) conclusions, as they found the same behavior on this topic.

Regarding the period after the firm legal establishment (second and third phases), the average entrepreneurial experience heterogeneity doesn't change, as its value remains on 0,11 for both phases. This fact is in line with Vanaelst et al. (2006) findings as they state that "after the legal establishment of the firm, no clear finding on the nature of entrepreneurial experience was identified".

We find evidence that the teams overall scientific, entrepreneurial and professional experience skills, based on the four categories of heterogeneity considered in our analysis, have an increase when the decision to create a spinout is taken. In other words, the teams become one average more heterogeneous when the firm is officially created, finding the need for people with other skills and knowledge, as different activities from research and development are needed (e.g. management, marketing). This fact is in line with the literature's conclusions on this topic (Vanaelst et al.,2006).

On the other hand, we find no evidence that the teams continuously have their experience and knowledge more balanced and broadened the further they move along the spinout process, as in the Maturity phase all the heterogeneity values are lower than in the Proof of Viability phase. This fact may be due to the exit of team members in the last phase of development (which often sold their shares to the other partners), as in the maturity phase the companies already have a good number of employees, which now fulfill the needed experience and knowledge.

4.1 Research Unit Factor (Heterogeneity)

As initially proposed in this paper, data collected through personal interviews with the founders on each of the companies, makes it possible to explore the implications that Research Units might have on the teams heterogeneity and on firms' time to transition among the three life cycle phases.

In fact, considering all the data collected, we find it interesting to explore the implications that the Research Unit factor might have on the team's heterogeneity and on the time to transition.

These 25 companies have different research backgrounds, as 4 companies were developing their research in INESC and 12 in IST. Adding to these two Research Units (IST and INESC), we also have another group composed of 9 companies, which is the group of companies that did not develop its research in any Research Unit (we will name it NRU, standing for No Research Unit), totalizing 3 different groups (IST, INESC, NRU).

The first Research Unit, IST, is also the university where most entrepreneurs in our sample made their studies and where most companies in our population have done research, being in the locus of the discussion. The second Research Unit is INESC, which is an institution of public interest dedicated to advanced research and development in the domains of electronics, telecommunications and information technologies. INESC was founded in 2000, being IST one of its owners.

When there is only one factor being studied (independent variable), the analysis of the variance is called one way ANOVA. Given that the

factor being analyzed is the Research Unit, 3 groups are considered for this factor (k=3). Hypothesis H_0 will be "The Research Unit factor has no influence on Entrepreneurial Teams' Heterogeneity". For this analysis we will consider the experience heterogeneity, course heterogeneity and entrepreneurial experience heterogeneity. The results are exposed in Annex 1.

Concerning experience heterogeneity, we find that in the first and second phases of development the teams that were developing research have similar heterogeneities. In the third phase of development this fact changes, as INESC has notable higher experience heterogeneity when compared to IST.

The teams that weren't in any Research Unit have considerable higher experience heterogeneity in all phases of development, leading us to be inclined to consider that Start-ups not connected with any Research Unit (NRU) are likely to have higher experience heterogeneity levels. However, we conclude from this analysis that we do not reject H_0 on the non influence of the Research Unit factor on the three phases of development for experience heterogeneity, which means that, for each phase of the companies' life cycle, there are no evident statistical differences among Research Units.

The course heterogeneity in the first phase of development is higher among the teams that weren't doing research in a Research Unit. This may result from the evidence that teams doing research in IST or INESC are mostly or even entirely composed of students from IST or other engineering universities. Also, in the first phase of development, the teams that have done research in IST are more heterogeneous than the teams from INESC.

In the second phase of development the heterogeneity levels increase in all factors, being its values very close to each other. In the third phase of development, the trend is similar to the one in the first phase, being the heterogeneity values of the two research centers not as low as in the first phase. Although in the first and third phases of development the average means of each factor are quite different, we do not reject H_0 on the non influence of the Research Unit factor.

The entrepreneurial research heterogeneity is in the first phase of development higher in the teams that have done research in IST. In this same phase, the second higher value is of NRU teams, with INESC having the lowest value of entrepreneurial experience heterogeneity. In the Proof of Viability phase, the heterogeneity values are roughly the same, with no difference deserving attention.

On the Maturity phase, the relative positions and absolute values are similar to the ones in the first phase, with exception to INESC that has doubled its heterogeneity value, staying in the same relative position. In fact, we draw no conclusions or implications from these values as the expected results would be that NRU teams would have higher entrepreneurial experience heterogeneity as these teams are were not confined to the Research Unit's walls, being in the society sooner than their counterparts. Not surprisingly, we do not reject H_0 on non influence of the Research Unit factor on entrepreneurial experience heterogeneity.

4.2 Research Unit Factor (Development Phases Transition Time)

In addition to the study of the implications of the Research Unit factor on heterogeneity, we found it relevant to perform an additional analysis concerning the implications of this research factor with the time firms take to transition across different development phases, which is the amount of time taken by each company in each development phase. The results can also be seen in Annex 1. In the first phase of development we easily depict that the companies that have done research in INESC have had the highest average transition time, with 61,75 months, while the ones from IST have had an average duration of its transition time of 26,64 months.

The companies that weren't developing research in these Research Units have had an average duration on the first phase of development of 11,75 months (less than 1 year). In fact, although the teams from IST take less 35 months (on average) than the teams from INESC, they still take more than twice the time when compared to the NRU teams. The relative differences that seem to exist between these groups when concerning the duration time of the first phase of development have in fact implications.

The level of significance points out to the rejection of H_0 on the non influence of the Research Unit factor on the development phases duration time.

Therefore, to discover the underlying implications on this topic the Tukey test is made, concluding that there are significant differences between the factor IST and INESC, and between INESC and NRU. In the second phase of development, the average duration time is approximately the same for INESC and IST teams (45,00 and 47,14 months, respectively). Following the trend of the first phase of development, the NRU team's transition time is considerably inferior to IST and INESC, with an average duration of 32,00 months. Not surprisingly, we do not reject H_0 on non influence of the Research Unit factor on the Proof of Viability phase for the development phases transition time.

5. Discussion and Conclusions

Our study shows that not all the researchers and entrepreneurs involved in the original team are actively involved in the spinout at the time when our survey was conducted, as many original founders have left, particularly when the company reaches its Maturity phase. In fact, these teams change during the spinout process, with both new members joining the team as others abandon it, being these results in line with the Vanaelst et al. (2006) conclusions. We find no consistent evidence that members tend to leave before the formal creation of the spinout, as Vanaelst et al. (2006) suggests.

On the other hand, we find evidence that members tend to leave the spinout before it enters the Maturity phase for a possible variety of reasons, namely the amount of time the company is taking to reach sustainable earnings (Maturity phase), or even the discouragement posed by IST's policy which doesn't allow the combination of full academic tenure and a position in a venture.

After the venture is in the Maturity phase, most entrepreneurs stay in the company, while very few abandon the company. In other cases a surrogate entrepreneur is attracted to the team, even though the venture is already in Maturity. These facts are consistent with the previous findings (Vanaelst et al., 2006). With exclusion to Vanaelst et al. (2006) study, we provide an important extension to the previous research on entrepreneurial teams, as this subject is often viewed in a static framework (because traditionally different teams are analyzed at a certain moment in time), whereas we analyze the same teams in different moments in time, taking a dynamic perspective throughout the various phases of development.

The team's structure was analyzed at one point in time before the formal establishment (Research and Opportunity Screening) of the venture and at two points in time after this event (Proof of Viability and Maturity). In line with the literature and the overall expectations we found that new team members brought in different kinds of experience to the technology-based companies under study. We analyzed the team's heterogeneity in four different categories: Course, Scientific Area of Studies, Experience and Entrepreneurial Experience. Based on these categories, we find evidence that the teams overall scientific, entrepreneurial and professional experience skills suffer an increase when the decision to create a spinout is taken. In other words, the teams become on average more heterogeneous when the firm is officially created, finding the need for people with other skills and knowledge, as different activities from research and development are required (e.g. management, marketing). This fact is in line with the literature's conclusions on this topic (Vanaelst et al.,2006).

On the other hand, we find no evidence that the teams continuously have their experience and knowledge more balanced and broadened the further they move along the spinout process, because in the Maturity phase all the heterogeneity values are lower than in the Proof of Viability phase. This fact may be due the exit of team members in the last phase of development (which often sold their shares to the other partners), as in the Maturity phase the companies already have a good number of employees, which at that phase fulfill the needed experience and knowledge within the organization.

Additionally, an analysis of these heterogeneities was also built concerning the Research Unit were each firm developed its R&D. Although no significant statistical evidence was found on this subject to prove that this factor has an actual influence on the various heterogeneities, the companies that weren't in any Research Unit (NRU) have considerable higher experience heterogeneity in all phases of development, suggesting that NRU may have a certain influence on experience heterogeneity. This fact could be because the companies doing research in IST and INESC are less open to newcomers from other

areas of experience. Nevertheless, this fact remained inconclusive.

Following another stream of research, we found it relevant to do one additional analysis concerning the implications of the Research Unit factor on the development phase's transition time. In the Research and Opportunity Screening phase the companies that have done research in INESC have had the highest average transition time, with 61,75 months, while the ones from IST have had an average duration of its transition time of 26,64 months. The companies that weren't developing research in these Research Units have had an average duration on the first phase of development of 11,75 months (less than 1 year). In fact, although the teams from IST take fewer 35 months (on average) than the teams from INESC, they still take more than twice the time when compared to the NRU teams.

Based on these facts conclusions were drawn (based on the Tukey test) stating that there are significant differences between the factor IST and INESC, and between INESC and NRU. This fact can have implications on future university policies, as the companies that have done research in INESC take significantly more time to make a transition into the next phase of development. This conclusion has limitations on a statistical point of view, due the small size of our sample.

5.1 Limitations and Future Research

In fact, there are some limitations in our study that should be carefully exposed. The population of companies analyzed is very stretched in time, as the time frame encompassing these firms creation spans from 1986 to 2011. This fact might have implications that we could not predict, as not only the social and economic conditions but also the policies surrounding entrepreneurship have significantly changed in these 25 years. Additionally, this fact arouse complications on the analysis of the team composition in the older firms, as for some entrepreneurs some occurrences were partially forgotten. Because of this fact not only a good degree of precision in the dates involved was harder to obtain as their past partners personal information was often hard to remember.

Additionally, our study focused only on the development of spinoffs in one geographical area, particularly in one university. Different institutional and geographical environments may due to various aspects have different impacts on the availability of potential incoming team members and university policies. These facts open the need for further research that examines the development of teams in different institutional contexts. The limited number of companies analyzed and with the focus on a limited set of issues, we were unable to analyze the relationships that could exist between the team size, heterogeneity and financial data. Although we analyzed the companies that were more formal spinoffs, as they were doing research in IST and INESC, and the companies that didn't develop formal research, our entire population is composed of academic new ventures.

Due to this fact, in terms of future research, there is a need for studies that compare the development of academic spinoffs and of similar nonacademic spinoffs, uncovering the differences that may exist not only on the team's heterogeneity but also on other issues (e.g. development phases duration time). Additionally, on future research on academic spinouts, not only a comparative study with spinoffs that originated from different Portuguese universities would be interesting as also a comparative study between Portuguese and foreign academic spinoffs.

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Annex 1 - Average Means for Experience Heterogeneity, Course Heterogeneity, Entrepreneurial Experience Heterogeneity and Development Phases Transition Time per Research Unit (ANOVA one-way factor analysis)

	Development Phase	IST	INESC	No Research Unit (NRU)	ANOVA Sig.	Welch
Experience Heterogeneity	Research and Opportunity Screening	0,023	0,028	0,068	0,712	-
	Proof of Viability	0,061	0,069	0,084	0,938	-
	Maturity	0,016	0,055	0,096	-	0,54
Course Heterogeneity	Research and Opportunity Screening	0,103	0,054	0,151	0,642	-
	Proof of Viability	0,199	0,224	0,202	0,973	-
	Maturity	0,121	0,109	0,155	0,871	-
Entrepreneurial Exp. Heterogeneity	Research and Opportunity Screening	0,118	0,054	0,082	0,703	-
	Proof of Viability	0,104	0,103	0,122	0,951	-
	Maturity	0,121	0,109	0,086	0,914	-
Dev. Phases Transition Time	Research and Opportunity Screening	26,64*	61,75*	11,75*	0,003	-
	Proof of Viability	47,14*	45,00*	32,00*		0,541

*Average Time in Months