Start-ups success using public funds: university versus industry sponsorship

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Abstract

Innovation and entrepreneurship are pillars of the knowledge-intensive economies. As such, most countries develop public support programs through Economic Development Agencies (EDA) to foster their development and growth. These public programs consider the idea of smart money that means not only providing financial resources, but also technical-administrative advice to the entrepreneurs. In this research, we are interested in comparing if the results of triple helix alliances (public funds, entrepreneurs and university incubators), outperform non triple helix partnerships (public funds, entrepreneurs and private consulting firms). We analyze the performance of a sample of start ups subsidized by the Seed Capital Program (SCP) of CORFO, the main EDA in Chile, using data mining methods. The results describe clusters with better performance measures in sales, jobs creation, patenting, and fund raising for those new companies partnering university incubators than the non-triple helix cases of business developments.

Subtheme: Good practice, bad practice: learning from evaluations of government-funded innovation programs in support of innovation, technology transfer and entrepreneurship

Keywords: Start-up, Economic development agency, University sponsored innovation, Private sponsored innovation, Impact evaluation of public programs

Introduction and Theoretical Framework

It is generally agreed that economic growth and socioeconomic development are strongly influenced by innovation and entrepreneurship (Bercovitz and Feldman, 2006; Cooke, 2006; Etzkowitz and Kolfsten, 2005). Some countries have adopted the triple helix model to foster innovation through the institutionalization of the concept and the creation of policies and entities that bring together universities, industry and the government (Etzkowitz and Leydesdorf, 2000, O'Shea et al., 2005; Schutte, 1999), whereas other countries innovate under a traditional linear innovation basis for the creation of new businesses and economic value (Godin, 2006). Whether the basis for innovation is the triple helix or the linear model, in both types one can find Economic Development Agencies (EDA) with a number of specific programs oriented to foster innovation and entrepreneurship. Unlike the science parks, technology transfer offices, and venture capital firms described by Etzkowitz (2006) as mechanisms of innovation and knowledge transfer, EDAs aim to foster entrepreneurship no matter if it starts up as a research spinoff, or as an individual business entrepreneurship idea of any given citizen, not necessarily related to academia or research. These two branches – innovation and entrepreneurship – are usually complemented in programs that support innovative entrepreneurship and provide financial and technical platforms for high impact start ups that offer new products and services. Especially in the last cases, it is interesting to assess if the triple helix model combined with the mechanisms provided by EDAs produce better results than the traditional public funding for start ups.

Top-down implementations of the triple helix model are often expressed in policies to protect intellectual property, subsidies to high tech companies' development, creation of specialized entities to support technology transfer and interactions among the relevant actors (Chukumba and Jensen, 2005, Leydesdorff, 2006). In the top-down implementations EDAs typically have specific programs to foster innovative business ideas based on high-tech products or knowledge intensive services. A series of academic studies have researched the impact and effectiveness of top –down approaches. For example, Bill, Johannisson and Olaison (2009) argue that different European studies for countries like Belgium, Holland, Ireland and Sweden have failed to identify a positive correlation between public support programs and entrepreneurial growth and development (Norrman and Bager-Sjogren, 2006; Lambrecht and Pirnay, 2005; Faoite, Henry, Johnston and Sijde, 2004). The main explanation for this result is that these programs generate a self-selection of mediocre projects (Greene and Storey, 2004) as the entrepreneurs most likely to participate in these support programs are not, necessarily, those who develop businesses with a greater expectation of growth, but rather at times only want to capture funding to overcome cash flow problems in the short term. On the other hand, there are several studies showing that there is a positive correlation between support programs and some measure of entrepreneurial growth. Breschia, Cassi, Malerbaa and Vonortas (2009) studied the Information Society Research, Technological Development and Demonstration Program (IST-RTD), which forms part of the largest Project of the Sixth Research Framework Programme (FP6) of the European Union. It aims to develop research and development through networks and knowledge diffusion. The results of the study show that IST-RTD plays an important role in generating and diffusing knowledge because it helps to administrate key players in the industry and create interesting networks of connectivity. In an evaluation of Spain, Diaz-Puente, Cazorla and De los Ríos (2009) studied a program for the creation of Technological Diffusion Centres (TDCs). These centers aim to become intermediaries in the development of a culture of innovation among SMEs in Madrid. The results of the program indicate that there are positive impacts sectorially, especially in urban and industrial areas. The programs are also effectual in peripheral or rural areas provided they also support other local enterprises.

Most bottom-up approaches to implement triple helix practices tend to be informal and non-institutionalized, being the initiatives mostly the efforts of small groups or individuals from the academic and industrial domains to collaborate with each other, or isolated coordination instances between actors of innovation (Sutz, 2000). The bottom-up approach is typically found in developing economies, like Latinamerican, Middle east, or African countries. In developing countries, EDAs tend to focus more on entrepreneurship than innovation, being the key difference that entrepreneurship plans and programs aim to foster the creation of new businesses, without the focus of opportunity-driven entrepreneurship (related to innovative business ideas), but on a necessity-driven entrepreneurship, which has proven to show lower performance (Autio, 2007). As the triple helix literature describing cases of developing countries tends to show bottom-up types of experiences, it is interesting to explore and explain the types of interactions with higher impact and likelihood of success, because such knowledge can drive the institutionalization of best practices and formulation of policies that seek efficacy in the national innovation process (Lopez-Acevedo and Tan, 2010; Sorensen, 2007). The innovation literature indicates that EDAs and their programs' success is based on the types of entrepreneurship fostered (Acs and Amoros, 2008). In the context of Latin America, in recent years, several countries have begun to make systematic evaluations of their programs furthering the development of SMEs. For example, Alvarez and Crespi (2000) analyze the impact of a Chilean export promotion program called PROCHILE in the 90's using a database of 360 enterprises. They found a positive effect on the technological innovation of exported products, in particular on the number of agreements reached by enterprises that made use of the program. However, the program did not seem to have significant results in increasing, quantitatively, the types of products exported. On the other hand, Benavente and Crespi (2003) studied the impact on companies that participated in the PROFO program in Chile, which intermediate strategic associations for small businesses. The results indicate that the program has a positive impact on intermediate results (planning, marketing strategies, and training) and a minor impact on the net effect of the total productivity of factors. In Mexico, Tan and Lopez-Acevedo (2005) analyzed the impact of the CIMO program run by the Mexican Ministry of Labor in relation to training and improvement of workers in different SMEs. The results show a positive impact in the first cohort (1991-1993) regarding the intermediate results in comparison to the control group, with investment allocated to training and the adoption of quality control processes in enterprises that received the treatment. The results were mixed in the second cohort (1993-1995). Chudnovsky, Lopez, Rossi and Ubfal (2006) also analyzed a simple of 414 Argentine companies and studied the impact of the Argentine Technological Fund Program (FONTAR) on the results of enterprises. This fund helps finance innovation projects through different vehicles that compete in a public contest for the award. The results indicate a positive impact on the intensity of innovation, but no impact on the sales of innovative products or on worker productivity.

Given the wide and varied spectrum of results for the study of impact and effectiveness of EDA programs, we are interested in exploring, describing, and analyzing the performance of the CORFO SCP in Chile initiated in 2001. The SCP aims to foster innovative start ups meeting four conditions: a) Products in a pre-development or pre-adaptation phase, b) Significant differentiation of current products/services, c) Never implemented before in the nation, and d) High expectations for commercial, profits and growth opportunities. CORFO's SCP is a financial subsidy for enterprises that works like a contest fund. It aims to strengthen different ambits of management, the entry to new markets and consolidation of actual markets that present business opportunities to smaller businesses. This program provides financing and forces entrepreneurs to receive a certain level of training to access public funding. The program is therefore more than just economic aid. Fortunately, CORFO's PCS is assimilated more to a combination of training and technical assistance programs with a strong component of what entrepreneurial literature calls smart money (Sorensen, 2007), i.e. support from persons trained in entrepreneurial strategy for small businesses, in addition to financial aid. CORFO delivers financial resources up to US$ 90.000 to private entrepreneurs that start new companies. The subsidy is canalized through sponsors, responsible for controlling the capital expenditures, and training, supervising and assisting the entrepreneurs so that increased rates of success are expected for the start-up. The sponsors that work with CORFO and the entrepreneurs are of two types: a) business incubators, belonging to universities; and b) Consulting firms, private in nature. According with the features of the CORFO SCP, we are interested in discovering whether star-ups success as a form of innovation and entrepreneurship are more successful when the three actors identified in the triple helix model interact to integrate a business idea, with public funding and knowledge transfer from academia, or if they perform better with private and public actors playing typical roles of business idea and public subsidies.

The main hypothesis to test in the present study is that the relationship Public Funding (Government), Entrepreneurs (Privates) and Business incubators (Universities) outperform in the measures typically studied in the innovation and entrepreneurship literature, such as: sales, number of employees and fund raising, compared with the cases in which public funds subsidize privates that are sponsored by private consulting firms. This is interesting because allows us to test the effectiveness of triple helix and public-private modes of financing start-ups and establishing high growth companies. In order to find empirical evidence and discern the best way to fund high growth start-ups, we use the method of knowledge discovery in databases (KDD).

The method selected (KDD) consists of a series of rigorous steps to identify new, unknown, valid, and useful patterns in the data and is used here to characterize successful and high-impact start-ups. The process of knowledge discovery starts with the selection of variables to build constructs and classification models. As a second step, we control for missing values and outliers in the data. The third step in KDD is to categorize the selected variables, either transforming or normalizing the original values, resulting in a 'clean' and numerical dataset used to model and test the effects of triple helix versus public-private support for start-ups. The classification models built allow us to define key variables and relationships in high growth entrepreneurship. The last step with the data is the qualitative and quantitative interpretation of results. Such results provide the empirical evidence to compare top-down and bottom-up approaches for the establishment of the triple helix model for innovation. The construction of models is based on mathematical programming, which by solving and optimizing the models, finds the best way to classify and describe the start-ups in the sample. Finally, KDD will assist us in providing quantitative and qualitative interpretations of the empirical data to support or reject our hypothesis.

Methods and Materials

CORFO provided contact information about a universe of 160 new companies that applied and obtained the SCP funding from CORFO between March 2001 and December 2007. A survey to describe the level of sales, employment, funds raised, perception of the quality of the partners, benefits, entrepreneurs' profile, and product features, among the most relevant topics was sent to the 160 contacts provided. From the surveyed start ups, 25% of the new companies provided complete data. In a preliminary description of the data, we identified that from the subsidized companies, 62% presented an average sales income of US$ 80.000 in the first year of operations. 25% of the newly established companies obtained additional funding from private actors, indicating that CORFO acceptance and success are important milestones in the lifecycle of start-ups in Chile. Another interesting result is that only 38% of the subsidized companies closed after the first 3 years of operations (usually known as the valley of death), compared to the 2 out of 3 closings reported in the international literature. According to our preliminary and descriptive results of the data, the entrepreneurs participating in the SCP funding program seem to be successful thanks to the smart capital approach of funding defined by CORFO to subsidize entrepreneurship and innovation; however, we also aim to discover if smart capital under a triple helix approach (public funding for private entrepreneurs with guidance of a university incubator) can be more effective than a traditional public subsidy to private entrepreneurs, and if a triple helix approach would produce more successful, or high-impact start-ups.

The method we use to describe and classify the start ups treated by the SCP is the technique known as Knowledge Discovery in Databases (Fayyad et al., 1996). This is a non-trivial process to identify unknown, valid, new, and potentially useful and logic patterns in the data. By applying KDD we aim to identify the key distinguishing features among the clusters in the sample of start-ups analyzed. In order to apply KDD, a first selection stage is performed on the dataset to identify the variables in the database that can be used to build analytical models to be tested and to recognize patterns. The selection process combines theoretical and experts' knowledge with technical judgments based on statistical inference.

A first pre-processing stage is performed to identify missing values and outliers in the data. Anomalies in the database can be treated in several ways, for example, deleting the instances, using appropriate constants, or generating predictive models to populate missing values. As a result, a clean and consistent database will be obtained from this stage. With a database free of anomalies, the variables selected to build models are transformed to numbers or dummy variables, and new variables are also generated using the original ones. The result of pre-processing, cleaning and transforming data is a numerical database on which the theoretical models can be empirically tested and analyzed.

The construction of analytical models for empirical testing (data mining) allows the researcher to learn from the data and discover patterns hidden in it. In our study, the analytical model will allow us to identify patterns that describe and characterize start-ups. Finally, the quantitative and qualitative interpretation of results can confirm or reject the hypotheses or theoretical patterns, and with that knowledge, assess the effectiveness of current policies to foster innovation and entrepreneurship in the Chilean context, and propose policy guidelines.

Fuzzy c-Means data mining

One key aspect of the fuzzy cluster theory is the possibility for objects in a database to belong to more than one cluster (Xu y Wunsch, 2008). Therefore, the fuzzy cluster theory defines for each object a degree of membership to each cluster. The numerical values of such degree usually fall in the continuous interval (0, 1) (Zadeh, 1965). Our study uses a cluster algorithm named Fuzzy c-Means (Bezdek, 1981). The algorithm assigns a set of objects, in our research start-up companies, to a pre defined number of clusters. The output of the algorithm is a matrix with the degree of membership of each new company and the identification and definition of centroids for each cluster.

To explain how the algorithm works, let's assume that our task is to classify ***m*** companies that can be described using ***n*** numeric variables. The total set of start-ups is fully characterized by the ***X mxn*** dimension matrix of data, where the company ***i*** is associated to the row vector Xi. It is defined as the degree of membership of company ***i*** to the cluster ***k***, considering a total of K clusters. Also, we define the matrix W, of Kxm dimension, containing the degrees of membership of each start-up. Below we describe the stages of the Fuzzy c-Means algorithm.

<u>Step 1:</u> *Initialization*

In this stage, the components μ_{ki} of the W matrix are initiated with random values and using one restriction:

$$\sum_{k=1}^{K} \mu_{ki} = 1 \ \forall \ i = 1, \dots, m.$$

<u>Step 2:</u> *Determination of centroids*

Considering the values obtained for the degree of membership μ_{ki}, the cluster centroid *vk* is defined using the following expression:

$$v_k = \frac{\sum_{i=1}^{m} (\mu_{ki})^c x_i}{\sum_{i=1}^{m} (\mu_{ki})^C} \ \forall \ k = 1, .., K.$$

The ***c*** parameter is called fuzzifier, which determines the fuzziness degree for the classes found. The parameter takes values between 1 and ∞^+. A ***c*** value closet o 1 implies a slightly fuzzy classification, meaning that the solution tends to show a value for μ_{ki} equal to 1 for one cluster and

0 for all other clusters. If ***c*** tends to ∞^+, the solutions for the μ_{ki} value tend to 1/K, which is interpreted like the same degree of membership to all clusters.

Step 3: Updating the degrees of membership

Once the centroid values ***vk*** are obtained, we update the values for the degree of membership of each object using the following expression:

$$\mu_{ki} = \left[\sum_{k'=1}^{K} \left(\frac{d_{ik}}{d_{ik'}}\right)^{\frac{2}{c-1}} \right]^{-1} \quad \forall\, i = 1, \dots, m.;\, k = 1, \dots, K,$$

Where the parameter ***dik*** is the Euclidean distance between object ***i*** and centroid ***k*** (**vk**).

Step 4: Condition to stop the algorithm execution

The steps 2 and 3 iterate until the following stop condition is reached:

$$||W^{t+1} - W^{t}|| \leq \varepsilon$$

Where W^t corresponds to the degree of membership's matrix in the iteration t, and ε is the stop threshold defined by the user. The result of the algorithm defines the matrix W* containing the optimal degree of membership for each object in the sample.

Experimental Results

The data for the subset of the 40 companies under analysis had no missing values or outliers. To characterize the start-ups and associate them into clusters, we worked with 11 variables widely used in the innovation and entrepreneurship literature, which are described in Table 1. The variables helped us to cluster companies by the profile and experience of the entrepreneur, as well as by sales, fund raising, and new jobs generated, all measures used to assess effectiveness and impact of new business ideas put to practice (Jarmin, 1999; Martí, Salas & Barthel, 2008; Global Insight, 2009). Additionally, from the innovation literature we incorporated elements to describe property rights (patenting) and sponsor organization (university or industry partners).

Variable	Description
Company age	Number of years of the company in the market
Geographic area	1= metropolitan area; 0 = other
Entrepreneur's studies	1= professional; 0 = Non professional
Entrepreneur's experience	Years of experience of the entrepreneur
Sales	1= Sales; 0= No sales
Average sales	Average sales in the last two years of operations
Employment	1= Created new jobs; 0= No jobs created
Capital Raising	1=Yes; 0 = No
Capital Raised	Amount of funds obtained after subsidy
Property rights	1= With patents; 0= Without patents
Sponsor	1= Private consulting firm; 0 = University incubator

Table 1: Variables used to cluster start-ups.

Identifying and clustering start-ups with fuzzy c-means

Using the cluster analysis technique (Xu and Wunsch, 2008), the researchers responsible for the study found that the number of clusters that best represents the companies in the sample are two, using a fuzziness coefficient c = 2. The two centroids defined by the two clusters after applying the *Fuzzy c-Means* algorithm can be described with the values for each variable described in Table 2.

Variable	Cluster A	Cluster B
Company age	5.9	6.3
Geographic area	0.76	0.87
Entrepreneur’s studies	0.92	0.87
Entrepreneur’s experience	16.14	20.31
Sales	1.0	0.5
Average sales	94,494,132	11,312,500
Employment	1.0	0.0
Capital Raising	0.76	0.37
Capital Raised	36,487,615	7,375,000
Property rights	0.92	0.000
Sponsor	0.23	0.75
Number of observations	14	26

Table 2. Centroids for clusters A and B

The centroids represent the typical company in each cluster. These results show how some variables clearly discriminate the two groups. Cluster A is characterized by companies with greater average sales, generate new jobs, and raise more funds than companies in cluster B. From Table 2 we see that company age, geographic location, entrepreneurs’ studies and experience do not allow differentiating the companies in our sample, given the close range of values observed for the centroids of both clusters. Results also describe important differences in patenting activity and sponsorship for cluster A; the interpretation of the cluster provide evidence to claim that companies sponsored by university incubators tend to be more successful in the traditional measures associated to high-impact start-ups than those companies sponsored by private consulting firms in the process of application and development of the business idea under the seed capital program of CORFO.

Conclusions

The study aims to find new ideas to further elaborate on public policy to foster innovation and entrepreneurship, and to provide new guidelines for impact evaluation of public funding programs. Particularly, our research tested the hypothesis that a triple helix type of organization can be more successful and effective in identifying and subsidizing high-impact start-ups than a traditional type of subsidy, even under a smart money approach.

The results of the application of clustering techniques to analyze a sample of 40 start ups support the statement that a triple helix approach to grant subsidies has had greater socioeconomic impacts in the Chilean case. In this way, entrepreneurs working with university incubators as partners to obtain and manage the funds coming from the CORFO SCP achieved greater sales, growth and jobs creation, additional funds raised, and patents than those entrepreneurs sponsored by private consulting firms in the same program. We perceive the smart capital way of funding as a great opportunity for universities to transfer knowledge as a form of entrepreneurial coaching with high economic impact. At the same time, the results indicate that for the sample analyzed, the best results were obtained consistently by partnerships of the three agents, where government provides seed capital, universities assist and manage resources, and privates exploit their innovative business ideas. The reasons of such findings are not explored in deep in this work, however, it seems like the triple helix model in supporting new business ideas, and which considers the knowledge transfer from universities to entrepreneurs is a key element to successfully start up. From our sample, the companies subsidized and which successfully partnered with university incubators were also closer to the high-impact start ups, than those firms partnering private consulting firms. The good results for the triple helix cluster may be linked with the reputation and visibility of incubators, based on reputational factors as well as marketing resources, networks, and systematic access to relevant experiences and cases of study. The last may imply that universities are perceived as better partners for the best projects, and therefore there could be a selection bias, but not necessarily that the university factor explains completely the better performance. The scope of our study and our sample size do not provide enough empirical data to predict that triple helix will always outperform the traditional subsidies to entrepreneurs, but at the exploratory level, it raises interesting questions like deeper studying the link between partnering with universities and performance of the start up, which can be universities attracting the best projects (selection bias) or universities affecting the process of starting up and growing (universities transferring knowledge).

Finally, we would like to say that the results of our studies must be considered preliminary as a longer time frame is required to develop a conclusive opinion. However, the initial light shed by our study may be taken into consideration by the public policy makers that seek effectiveness in the allocation of subsidies that promote entrepreneurial activities.

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