A PROPOSED PILOT STUDY INTO ATTITUDINAL, SITUATIONAL AND PERSONAL CHARACTERISTICS AS PREDICTORS OF FUTURE ENTREPRENEURS IN AUSTRALIAN PUBLIC RESEARCH ORGANISATIONS.

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ABSTRACT

The purpose of this study is to develop a model that predicts whether technologists at Public Research Organisations (PROs) will become entrepreneurs. This would enhance the ability of institutions and governments in setting policies that enhance their technology commercialisation activities.

Using inventors employed at SA-based PROs and spin-off entrepreneurs as samples, this paper investigates building a model based on individual inventors' attitudinal, situational and personal characteristics that is used to establish the likelihood that such inventors may become entrepreneurs. Inventors from these research institutions will be identified by the issuance of a patent, or pending patents for their work. Inventors that have previously left the laboratories to start-up their own companies will also be identified and both groups will be surveyed.

INTRODUCTION

Technological innovation is viewed as a driving force behind national economic growth, the globalization of markets, firm competitiveness and a nation's standard of living through its effect on increasing productivity.

There are a number of ways by which technologies invented in the research institutions may eventually reach the market. For example, inventions may be licensed to existing firms, they may be developed by joint ventures between the research institutions and existing firms, the research institutions could spin-off the researchers into their own company, or the inventors themselves could leave the labs to start their own companies.

Several studies have suggested that technology-based, high-growth companies are more innovative and effective at job and wealth creation than large companies in capitalist economies (Birch 1987; Flender 1977; Grasley 1979; Kirchhoff 1988; Rothwell 1988.) According to a study by Reynolds (1987: 231): "For public policy, the most significant implication is that a small percentage of new firms (30%) are providing the majority (60%-80%) of the jobs and sales."
Rothwell (1989) claims that small, technology-based firms are more efficient job and wealth creators because they are less bureaucratic, move more rapidly, and have lower costs for technology development, along the lines of the high flex Silicon Valley-type of firm (Teece 1996). While this distinction between new and more established firms is mostly stated than tested empirically (Chesbrough and Rosenbloom 2002; Zahra et al. 2006) there is an intuitive appeal to the notion that such firms can help reduce frictions in the marketplace and facilitate faster adaptation, or even the creation of new markets (Teece 1996; Yoffie and Cusumano, 1999), infect the culture of larger, more static corporations (Doz 1996) and invigorate product development pipelines of larger firms (Doz 1996; Powell 1998). In fact, it is a standard model in the pharmaceutical biotechnology industry that small research firms provide important input into the larger pharmaceutical firms’ pipeline (Fisken and Rutherford 2002; Glick 2008). The recent phenomena of YouTube and Google Maps also offer corroborating anecdotal evidence.

It should be emphasized that the technology-based, high-growth firm is a special segment of the small business community with above average prospects for job and wealth creation. Roberts (1991) has convincingly demonstrated the importance of technology-based, spin-off companies from MIT and other universities and laboratories in the Greater Boston area for the development of the first American technopolis. It is obvious that small high-technology firms are an important factor in the creation of wealth. Since Betz (1987) argues that the primary basis for high-growth new ventures is new technology, an argument can be made that technology-based, high-growth new ventures are a significant factor in economic development (Di Gregorio and Shane 2003). Thus the use of entrepreneurial spin-offs from public research organizations (PROs) merits serious consideration as a preferred mode of technology transfer. Indeed, the spin-off activity is likely to do more than commercialise a specific publicly-sponsored invention; it may create a technical entrepreneur who then commercialises additional public or private technology, or serve as role model for other academics and create a culture that is more favorably disposed to seeking commercial outcomes from research. According to Ronstadt (Ronstadt 2007; Ronstadt 1988), an entrepreneur is likely to initiate multiple ventures over their career.

If we are able to identify those inventors who are most likely to become entrepreneurs, we may also be able to improve the efficacy of programs developed by the research institutions designed to commercialise technological innovations (Di Gregorio and Shane 2003; Lerner 2004). Examples of these kinds of programs include

a) Programs to grant entrepreneurial leave to inventors who wish to create spin-off companies or

b) Funds granted to technologists by research institutions to mature technologies toward a commercial state if the associated scientists and engineers intend to start enterprises which will create local jobs or

c) Incubators created that support the creation of new businesses based on the technologies of the institution.

Other examples are also feasible.

In this paper, we report on a study that will address the question: a priori, using empirical data, is it possible to identify likely entrepreneurs from those employees at the research institutions that have produced inventions which (according to the patenting process used in the PROs) were thought to have some commercial potential? We will use situational variables, attitudes and personal characteristics to answer this question. The result is a proposed technique that can be used to determine the characteristics of inventors and innovators who are likely to become entrepreneurs. The significant resources being deployed to promote spin-off technology commercialisation could be focused upon individuals who have the characteristics that imply a high probability of becoming entrepreneurs as was proposed by Sarasvathy (2004.)

Alternatively, the results can be used for broader interventions, if certain widespread barriers to entrepreneurship are discovered (Sarasvathy 2004), then allowing the more entrepreneurially disposed researchers self-select for more specific programs.
CONCEPTUAL FRAMEWORK

The literature explains the entrepreneurial act through three major schools of thought: the first school proposes that traits or personal characteristics determine who becomes an entrepreneur. Although Gartner (1989a; 1989b) argues that the "traits" school of thought regarding entrepreneurship has been relatively unproductive, others have found such an approach to be useful when applied to a specific subset of entrepreneurs (such as PRO scientific and technical inventors) and their non-entrepreneurial counterparts. Autio and Kauranen (1994), for example, found that technical entrepreneurs differed from technical non-entrepreneurs in that they exhibited stronger internal personal motivations. In their study on innovation radicalness, Marvel and Lumpkin (2007) confirmed that characteristics and human capital embodied in technology entrepreneurs are related to outcomes. Trait-oriented studies have also been conducted to explore differences between subgroups of technical entrepreneurs. Schrage (1994) found no correlation between personal achievement motivation and degree of success of technical entrepreneurs. Perry (1982) argues that further refinement of the taxonomy of technical entrepreneurs may reveal different motives.

Mosey and Wright (2007) found that academics with previous entrepreneurial experience had better social and business networks, hence were better able to engage with businesspeople and potential investors, although some discipline-base differences occur. For example, the biological sciences appeared to have fewer opportunities for academic-industry interaction. Markman et al (2003) also propose that personal characteristics can be a contributing factor in entrepreneurial success.

The second school of thought maintains that the environment or situation where an individual works, has a major effect on the entrepreneurial act (Shane 2002; Di Gregorio and Shane 2003; Lerner 2004; O'Shea et al. 2005; O'Shea et al. 2007). For example, Goldhar and Lund (1982) describe the necessity of continued technical support from the technology source as well as the availability of resources from the local business community in their case study of a technology commercialised after transfer from a university. Donckels and Courtmans (1990) also note the extraordinary integration of the small firm into the local business environment and its dependence upon support from this environment, while West and Noel (2009) found that the state of development of the local community appears to affect how the CEO’s previous knowledge can be leveraged. Roberts (1991) identifies the existence of role models as an inducement for laboratory employees to become entrepreneurs. Hence, the perception of a significant incidence of entrepreneurship from the laboratory is one of the composite situational variables used in this study. Cooper (1986) argues for the importance of situational variables in the formation of new firms; his variables are similar to those used in this study. Martin (1984) provides a comprehensive descriptive model of the high-tech entrepreneurial act including the causal variable of perceived supportive environment. Several studies (Louis et al 1989; Shefsky 1994) of the technology-based entrepreneurial act from universities found that situational variables included herein were important in the stimulation of spin-off activity and Dew (2009) argues that a combination of situational influences can have an important bearing on entrepreneurial behaviour.

The third school of thought argues that the attitudes of individuals with respect to the act of entrepreneurship are most effective in differentiating entrepreneurs from non-entrepreneurs and can be used to predict which, upon performing suitable attitudinal testing, are most likely to become entrepreneurs Robinson et al (1991.) This school of thought is derived from a substantial body of literature in social psychology that addresses the relationship between attitudes and behaviors (Allport et al, 1935; Ajzen and Fishbein 1980; Baggozzi 1984; Baggozzi 1981; Breckler 1984.) Social psychologists' interest in the concept of attitude as a means of explaining social behavior dates from the turn of the 20th century. However, until Robinson et al (1991), few attitudinal scales were developed specifically to study entrepreneurial behavior. These authors also describe the difficulties inherent in the first two schools of thought and argue, "A viable alternative to personality and demographic approaches is the use of attitudes in predicting behavioral tendencies" (1991: 15.) In their paper, these authors used the generally accepted tripartite model of attitudes (that is attitudes are comprised of three components: affect, cognition and
conation) to develop the Entrepreneurial Attitude Orientation Scale as a predictive instrument. We have adopted this scale, along with the traits (and personal characteristics) and situational variables alluded to earlier in the construction of the model. Markman et al (2002) have found that self-efficacy and the type of regret are different between technological entrepreneurs and technological non-entrepreneurs.

O'Shea et al. (2007) provide a multivariate explanation of why MIT has been so successful in its commercialisation activities. They found four broad areas to be relevant:
1. personal characteristics of the academics
2. environmental forces acting upon the academics
3. organisational culture that can influence commercialisation activity
4. environmental conditions outside the institution.

In summary, the relative effectiveness of the three schools of thought in separately predicting the entrepreneurial act is not the subject of this paper. Empirical research continues based upon each of these schools and their relative effectiveness will be debated for some time. It is our intent to combine these three streams of research to produce an instrument that will optimize our chances of identifying potential entrepreneurs, or generally assessing the likelihood of entrepreneurial outcomes from the research domain.

THE STUDY

A questionnaire that queries respondents for demographic information, personal characteristics, situational perceptions and attitudes will be administered to a sample from two populations. Both populations were inventors at PROs. Inventors are defined by their act of applying for and receiving patents, or generally being named on a patent. The two distinct populations are: 1) non-entrepreneur inventors (NEI) who at the time of the study elected to remain employees of the laboratories and 2) entrepreneur inventors (EI) who in the last five years had left the laboratory in order to commercialise their technology. While different inventions obviously have different commercial value and thereby represent varying degrees of entrepreneurial opportunity, invention disclosures are reviewed for commercial potential. The expense of patent prosecution is incurred only if the invention is judged to have such potential.

For this pilot we intend surveying SA-based inventors, expanding across Australia in the next round.

The questionnaire consists of three parts: in part I, standard questions are asked regarding the inventors’ demographic profile such as age, sex, education and years of experience. The second portion of part I (personal characteristics) deals with the respondents’ involvement in the pursuit of entrepreneurial activities such as spin-offs, consulting, receipt of royalties and other business activities.

Part II of the survey instrument consists of 49 questions designed to capture data about seven classes of situational variables. Situational questions are derived from three sources: 1) the authors' experiences with PRO spin-offs over the last two decades, 2) a pilot study involving six spin-off entrepreneurs, and 3) a survey of the literature that discusses situational variables used in contexts similar to that of this study, that is, scientists and engineers leaving technology sources to commercialise their inventions. The seven factors are defined by factor analysis using principal components with varimax rotation and are extracted from the 49 questions. The factors are: 1) the degree of support from laboratory management for entrepreneurial spin-offs; 2) self-reported inclination to be an entrepreneur; 3) the extent of local business support for new businesses; 4) personal resources available to become an entrepreneur; 5) the desire to be involved in supporting the laboratory mission of technology commercialisation; 6) the incidence of laboratory spin-offs or entrepreneurial activity; and 7) the seriousness of constraints to the entrepreneurial act.

The Entrepreneurial Attitude Orientation Scale which was available in the published literature was used as Part III of the survey instrument. Twelve composite attitudinal variables, derived from 75 survey questions, are to be investigated using a Likert-type ten-point scale. The survey developed by Robinson et al (1991) was selected because of its empirical validity and availability in the published literature.
Cronbach’s alpha will be calculated to ensure the reliability of the personal characteristic section. Nunally (1978) indicates that a reliability measure of 0.70 or higher is acceptable indicating the reliability of the survey instrument.

The Model used to Predict Entrepreneurs from PRO Inventors

The purpose of this study is to create a model that will predict future entrepreneurial acts on the part of inventors who have not previously so behaved. Responses to the questionnaire provided data for a discriminant analysis that sought to find a model that effectively predicts future entrepreneurs from a set of technical laboratory inventors.

In this study, we will have respondents from two populations that differ in the consummation of the entrepreneurial act. We will use various Fisher discriminant functions to assign each respondent in the sample to one of the two groups that better reflects their personal characteristics, situational perceptions and attitudes: the EIs or NEIs. The classification of NEIs as EIs is our method of predicting the inventors who will become entrepreneurs because they have the characteristics, the environment (the situational component) and the attitude to become entrepreneurs. Johnson and Wichern (1992) describe the Fisher method of separating a sample made of two populations into two separate groups using Fisher's linear discriminant functions. For example, the discriminant analysis to be run with the situational variables will use the seven variables (inclination to be entrepreneur, lab support, business support, incidence of entrepreneurship, personal resources, desire to support commercialisation and constraints) to define a formula that assigns each respondent to a group depending on the respondent's score on each one of the variables. The discriminant analysis is therefore a classification scheme that utilizes several statistical techniques to determine ways in which the scores on each one of the variables can be used to differentiate between the different groups and then assigns each respondent to a group based on their scores so that they are defined by their scores rather than by their actual group.

Any NEIs that are classified by the discriminant functions as EIs are the ones that we assume to be our predicted entrepreneurs.

To test for differences in demographic, personal characteristics, situational perceptions and attitudes, we should have three groups:
1) NEIs predicted to become entrepreneurs: those who are predicted to become entrepreneurs.
2) NEIs not predicted to become entrepreneurs: the remainder of the NEIs.
3) the EIs who already had spun off their entrepreneurial firms.

The hypotheses that we want to test could be stated as

\[ H_1: \] There are differences among the three groups in personal characteristics.
\[ H_2: \] There are differences among the three groups in demographic information.
\[ H_3: \] There are differences among the three groups in situational perceptions.
\[ H_4: \] There are differences among the three groups in attitudes.

First an ANOVA test will be run to test for differences among the three groups. Mean differences between each pair of groups will be tested using the Tukey-Kramer test of multiple comparisons. The Tukey-Kramer test is an adjustment to the Tukey HSD pair wise multiple comparison test that is usually exercised when the size of the samples is unequal (1990.) The Tukey-Kramer test controls for multiple comparison errors when more than two variables are used in the differences tests.
CONCLUSIONS AND FURTHER RESEARCH

In the light of increasing government interest in the transfer of technology from PROs to commercial markets, this study attempts to improve the efficacy of commercialisation efforts by developing a methodology with which it may be feasible to identify those inventors that are most likely to become entrepreneurs.

Once identified, these individuals can be invited to participate in special programs that facilitate their entrepreneurial activities. On a related dimension, there is an argument for ‘creating’ a category of professionals to take on the role of technology/commercialisation entrepreneurs, with solid science and commercialisation capabilities in their profile, but who do not wish to be ‘behind the bench’ all the their lives, who enjoy science communication and who wish to be at the cutting edge of business and wealth creation, rather than mainstream markets, as described in the literature on surrogate entrepreneurship (Radosevich 1995; Davidsson et al. 2001; Lockett et al. 2005).

Future repetitions of the survey to acquire intertemporal data will allow further testing of the discriminant analyses as a tool to predict the propensity of inventors in public-sector technology sources to become entrepreneurs involved in the commercialisation of their inventions. The authors intend to repeat the survey, hopefully expanding it across Australia, in the first instance, every three years in order to determine who among the NEI sample actually became EIs during the intervening period. Another, more likely, outcome of longitudinal surveys is to allow monitoring and analysis of how the innovation system is developing with respect to the propensity to create new ventures directly from the research world. This in turn can be used for policymaking purposes, to address any concerns that arose, but also to help direct the innovation system towards desired outcomes.

If the propensity to become entrepreneurs can indeed be identified and determined to be useful as a predictor, there are major policy implications for the use of public-sector technology in industry. For example, preference could be established for selecting as licensees those inventors identified with this propensity. In the US, some laboratories use the existence of a business plan prepared by the inventor as an indicator of potential commercialisation activities. Indeed, technical staff could be hired, promoted and selected for training based upon their predicted likelihood to become entrepreneurs. Several laboratories are now involved in expensive training programs designed to improve entrepreneurial knowledge and skills for technical staff members. The success of these training programs can be enhanced if participants can be selected based upon their propensity to become actual entrepreneurs. The effectiveness of such programs also could be assessed by noting the degree to which the training affects this propensity.

In recent years, the Australian government has introduced a Commercialisation Training Scheme for students taking a higher degree by research. This entails undertaking courses that lead to a Graduate Certificate in research commercialisation. Willingness to participate in such a program could be taken as a partial indicator of willingness to engage in the entrepreneurial act. By the same token, longitudinal surveys could provide support or otherwise for the use of such measures to enhance commercialisation outcomes.

In addition to furthering the efforts for public-sector technology commercialisation, the ability to predict future technical entrepreneurs could enhance research activities regarding the entrepreneurial act. Almost all of the studies done to date are strictly ex post the actual act. If accurate predictions could be made, a priori data would allow the examination of changes in attitudes, perceptions and personal characteristics which result from the entrepreneurial experience. Such studies could significantly enhance our understanding of technical entrepreneurship.
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