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construct

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The Entrepreneurial Motivation In Academia: A Multidimensional Construct

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Abstract

This paper analyses the motivations of academic entrepreneurs to create new firms based on their research results (academic spin-offs). We propose a model to analyse entrepreneurial motivation that comprises six major dimensions: personal, relating to the business opportunity, to scientific knowledge, to the availability of resources to create a new firm, to the organization of origin, and to the social environment. The model is tested based on information from a survey administered to 152 Spanish academic entrepreneurs. Our results show that entrepreneurial opportunity is not part of the entrepreneurial motivation, but is of the utmost importance to academic entrepreneurs. Also, we find the desire to develop scientific knowledge coupled with problems related to their transfer in the immediate environment is the main driver of entrepreneurial activity in the academia.

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1 Introduction

In recent years, interest in academic spin-offs has increased (Landry et al., 2006; Meyer, 2003). These companies, created by researchers to exploit the results of their research, are important because they contribute to the creation of employment and wealth, and local economic development (Carayannis *et al.*, 1998; Steffensen *et al.*, 2000; Shane, 2004) and also because they are key instruments for the transfer of knowledge developed in academia which is crucial for innovation. Academic spin-offs, therefore, are tangible evidence of the implementation of entrepreneurialism in universities (Chiesa and Piccaluga, 2000; O'Shea et al., 2004; Searle, 2006).

Although the earliest examples of academic spin-offs occurred in Europe, it is in the United States where this phenomenon has developed most widely and has consolidated to the point that the United States is recognized as the world leader in this successful technology transfer mechanism. In the European case, the development of spin-offs is incipient, although there is a strong interest in their promotion and development (Locket et al., 2005; Wright et al., 2007).

In the European context, promoting the establishment of academic spin-offs is a complex task. University researchers generally choose academic careers based on a vocation for research and teaching, and also the prospect of a stable and relatively well-paid job with certain benefits; this does not translate into a propensity to create enterprises (Etzkowitz, 1998). Also, academic incentive systems emphasise the publication (Levin and Stephan, 1991; Stephan, 1996), which does not encourage the transfer of knowledge through the creation of academic spin-offs (Franzoni and Lissoni, 2006). Added to this, cultural differences between the university and private sectors emphasise the lack of an entrepreneurial spirit within academia. So, why would we expect researchers to want to create spin-offs?

Although this issue is at the top of the scientist entrepreneurship research agenda (Audretsch and Kayalar-Erdem, 2004), studies on this topic are scarce and mostly focus on analysis of firms rather than on the decision of scientists and engineers to create companies (Audretsch and Kayalar-Erdem, 2004; Landry et al., 2006). Moreover, these works tend to focus on the analysis of specific cases, such as the US and Canada, where the phenomenon of academic spin-offs is fully consolidated (Doutriaux and Peterman,

1982, Louis et al., 1989; Samsom and Gurdon, 1990; Doutriaux, 1991; Doutriaux and Dew, 1992; Chrisman et al., 1995; Henrekson and Rosenberg, 2000; Shane and Khurana, 2003; Shane, 2004; Lehrer and Asakawa, 2004 ; Searle, 2006, Ding and Stuart, 2006; Zhang, 2006; Landry et al., 2006), while studies on Europe are less common (Jones-Evans, 1998; Klofsten et al., 2000; Henrekson and Rosenberg, 2000; Laukannen, 2003, Vohora et al., 2004; Mosey and Wright, 2007).

Our paper contributes to filling this gap in the literature, exploring the reasons why researchers create academic spin-offs. Our hypothesis is that the entrepreneurial motivation is a multidimensional construct. We propose a model that comprises several dimensions based on analysis of the literature. Our aim is to provide empirical evidence from analysis of a database of 152 Spanish academic entrepreneurs. Having tested the validity of the model, we will evaluate the contribution of each dimension to the decision to create an enterprise.

This article is structured as follows. In Section 2 we present a review of studies that analyse the motivations of researchers to create firms. Section 3 presents a model for the study of the entrepreneurial motivation. Section 4 describes the methodology used and Section 5 presents the results and a discussion. The paper ends with some conclusions.

2 Literature Review

As already mentioned, the literature on entrepreneurial motivation in academia is scarce and fragmented. The earliest study was by Doutriaux and Peterman (1982) who, based on interviews with 10 founders of Canadian spin-offs, found that the main reasons for their creating these spin-off ventures were boredom generated by the routine of their profession and the desire for more freedom and independence. Subsequently, Samsom and Gurdon (1990), in a study of 22 US and Canadian academic entrepreneurs, found that their main motivations for establishing firms were the advancement of science and its applications, the personal opportunity to become an entrepreneur and the opportunity to make money.

Autio and Kauranen (1994) in a study of 104 Finnish inventors found that their motivations (in descending order) were related to the market (market pull), the development of technology (technology push), personal satisfaction and the availability of the resources and infrastructure required to start a business. Doutriaux and Dew

(1992) examined in depth the motivations and the predisposition towards the creation of new businesses as a tool for technology transfer, in a set of 26 Canadian researchers, and found there were three types of academic entrepreneurs: genuine, casual and reluctant. The *genuine entrepreneur* favoured spin-off creation because it was the technology transfer mechanism that brought the greatest financial returns, the *casual entrepreneurs* had started their enterprises as a means to other goals, such as additional resources for research, and the *reluctant entrepreneurs* were rather averse to spin-off creation, but had been "forced" into this alternative because it was the only way to complete the development of a promising product.

Weatherston (1995), in assessing the motivations and perceptions of risk in a group of 26 academic entrepreneurs from the United Kingdom, found that they were motivated by both "pull" and "push" forces. The pulls included a desire for independence, lack of confidence in others to commercialize their product, need to control their invention and desire for wealth. The push motivations were mainly related to dissatisfaction in their jobs. Chiesa and Piccaluga (2000), in a study of 48 Italian spin-offs, found a wide range of motivations, which they also classified under "pull" or "push" motivations. Among the pull motivations they uncovered reasons such as market opportunities and the need to apply knowledge for practical uses, and among the push motivations they found that the need for a change in the working environment was one of the most important.

Shane (2004), in his study of academic entrepreneurs from the Massachusetts Institute of Technology (MIT), presents qualitative evidence on a diverse range of motivations for creating spin-off, which reveals a more complete picture. Shane brings together the motivations for creating an academic startup within two categories of reasons: psychological and career-oriented. Among the psychological motivations are: a) the desire for put technology into practice, b) desire for wealth and c) desire for independence. Among the career-oriented reasons of scientist are: a) stage in the academic life cycle, b) status within the university, c) being a "star scientist" and d) prior experience in business creation.

In most of these studies, the entrepreneurial motivation is analysed in a tangential way, taking account of only a handful of possible reasons for creating an enterprise. Also, the sample sizes in the quantitative studies are small and are focused primarily on the study of US and Canadian cases, and/or those countries of Europe where the phenomenon of spin-offs is better developed (the UK and Finland). Here, we try to present a fuller

picture of entrepreneurial motivation in academia through analysis of a broad set of motivations and by exploring the creation of academic spin-offs in a country where the phenomenon is just emerging.

3 A model for the study of entrepreneurial motivation in academia

The results of studies concerning the entrepreneurial motivation in non-academic settings suggest that entrepreneurs have a variety of reasons for deciding to create a company (Shane et al., 1991; Birley and Westhead, 1994, Dubini, 1988, Carter et al., 2003; Shane et al., 2003; Segal et al., 2005), and academic entrepreneurs are no exception. The analysis of qualitative and quantitative works related to academic entrepreneurs and their motivations allows us to identify several issues relating to the decision to found a spin-off. Our hypothesis is that the entrepreneurial motivation is a construct which is comprised of six major groups or motivational dimensions: personal, related to scientific knowledge, to the entrepreneurial opportunity, to the availability of resources to create business, to the “incubator organization” and to the social environment. These dimensions, in turn, are shaped by 13 subdimensions, as depicted in Figure 1.

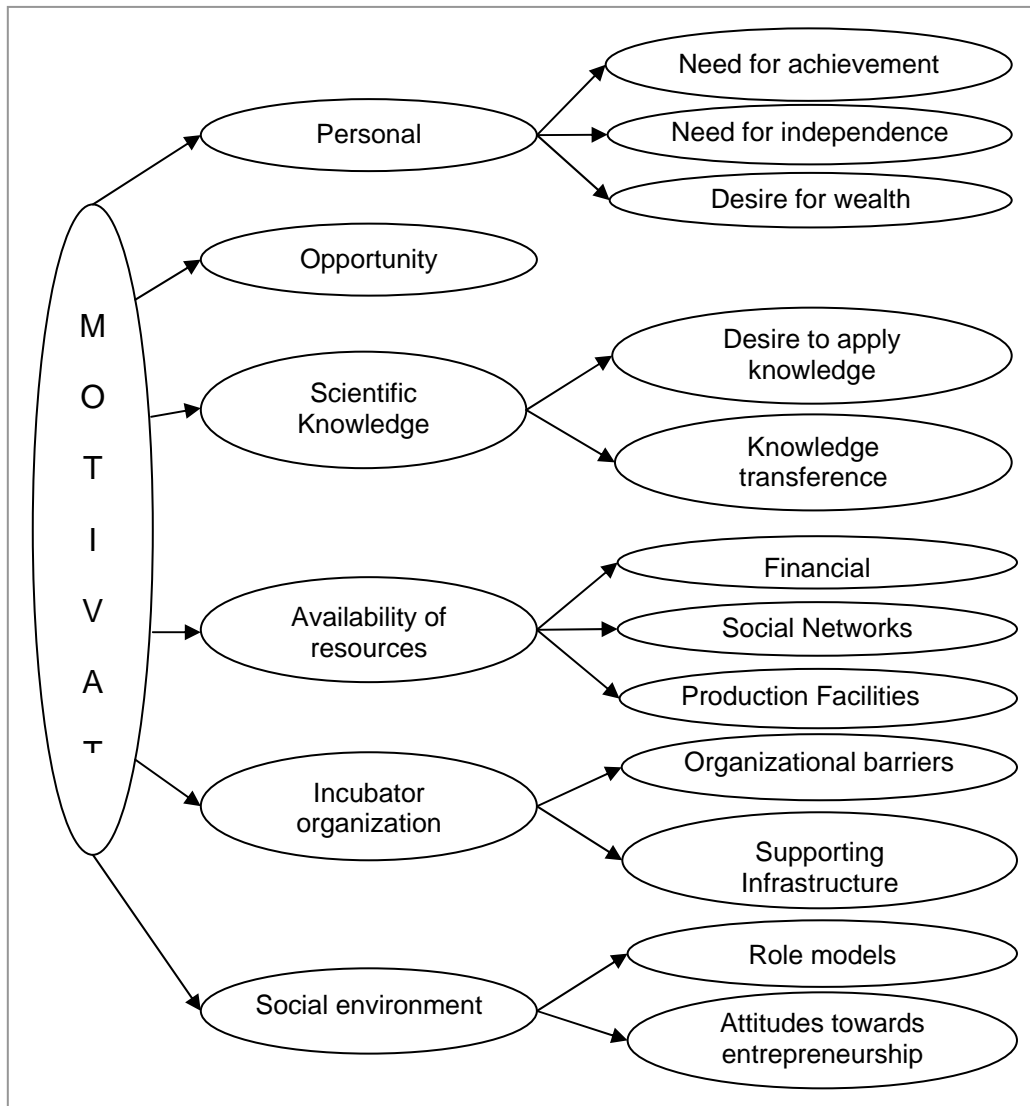


Figure 1. Model for the study of entrepreneurial motivation

Personal motivations

The personal motivations group is the first dimension in our analytical model. This group is related to the researcher’s expectations and objectives in creating a company and are often discussed in academic works on entrepreneurship. In this group we include three motives: *the need for achievement, the need for independence and desire for wealth.*

The *need for achievement* refers to the desire to perform difficult and challenging tasks (McClelland, 1961). There is some evidence that this is a major reason for an academic to create a business. Doutriaux and Peterman (1982) found that boredom with the routine of academic life was one of the main reasons for start-up activity and Chiesa

and Piccaluga (2000), in their study of the Italian spin-offs, indicated that personal success was an important reason for 18% of the participating entrepreneurs.

The *need for independence* is a feature of the personalities of entrepreneurs and refers to the desire of the individual to be able to plan his or her own work and make his or her own decisions (Gartner, 1988; Shane et al., 2003; Cassar, 2007). Weatherston (1995), Doutriaux and Peterman (1982), Chiesa and Piccaluga (2000) and Shane (2004) provide quantitative and qualitative evidence that suggests that the desire for independence is an important motivation for academic entrepreneurs to set up businesses despite the high degree of autonomy and the relative freedom they have in their university jobs.

Finally, the *desire for wealth* is one of the goals traditionally associated with entrepreneurs (Birley and Westhead, 1994, Shane, 2004, Cassar, 2007). In the case of academic entrepreneurs, academic life cycle models show that scientists tend to found companies at the end of their careers in order to get some financial return for their accumulated tacit knowledge (Levin and Stephan, 1991; Stephan, 1996). Shane (2004) presents qualitative evidence to support this. However, other studies provide qualitative and quantitative evidence that suggest that this type of incentive is important only for a small group of researchers (Doutriaux and Peterman, 1982; Doutriaux and Dew, 1992; Weatherston, 1995; Chiesa and Piccaluga, 2000).

Motivations related to scientific knowledge

The development of scientific knowledge is one of the main motivations of researchers during their career development (Etzkowitz, 1998). In this sense, the creation of a spin-off may be an attractive alternative if it constitutes a tool that allows the academic to advance further in his or her area of research. Some studies suggest that knowledge is an important motivation for academic entrepreneurs. Samsom and Gurdon (1990: 443) found that the most important motivation for creating a spin-off was the "progress of science and its applications", and Chiesa and Piccaluga (2000) found that the need to apply knowledge in practical uses was one of the most important motivations for 23% of the Italian academic entrepreneurs interviewed. Likewise, there is evidence that the difficulties involved in the transfer of technology to industry are another important element in the decision to create an enterprise (Doutriaux and Dew, 1992; Weatherston,

1995). Given the prominence of these issues, this dimension of the model considers as subdimensions: the desire to apply scientific knowledge, and knowledge transfer.

Motivations related to entrepreneurial opportunity

Entrepreneurial opportunity is a key element in the process of firm creation (Shane and Venkataraman, 2000). The identification of an entrepreneurial opportunity can be the event that triggers the decision to create a company and there is empirical evidence supporting this. For these reasons we consider it necessary to include entrepreneurial opportunity as a dimension of entrepreneurial motivation. Chiesa and Piccaluga (2000) and Autio and Kauranen (1994) found that identifying a market opportunity was the main reason for the creation of spin-offs by Italian and Finnish academic entrepreneurs respectively.

Motivations related to availability of resources

Establishing a company involves the investment of various kinds of resources, so their availability is an essential element in the decision and influences perception of the viability of developing the project (Gartner, 1988; Radosevich, 1995). If a would be entrepreneur perceives an entrepreneurial opportunity, but does not have the resources to exploit it and there are no potential sources of supply in the environment, such as venture capital firms, then the project will be difficult to realize. Academic spin-off creation requires certain assets including knowledge, finance, organizational, social capital, and intellectual property (Landry et al., 2006). The (un)availability of any of these resources can become a key element in the decision to establish a firm; thus, we believe that resource availability is a key dimension in entrepreneurial motivation. Consequently, the establishment of a business incubator or technology park, access to venture capital, and introductions to investors, potential partners or individuals with managerial skills useful for the new firm, are aspects that can be decisive for potential entrepreneurs (Radosevich, 1995; Carayannis et al., 1998). Thus, our analysis includes aspects relating to the availability of resources to create the firm, represented by three subdimensions: *financial resources*, *social networks* and *production facilities*.

Motivations related to incubator organization

An incubator is the organization where the entrepreneur was employed before starting his/her new venture (Cooper, 1985). This incubator organization appears to influence the process of founding, and the nature of the new firm, in different ways. For example, there is empirical evidence that entrepreneurs tend to create companies in the same

industry as their incubator organizations and that the loss of work can be a trigger for the decision to create their own enterprise (Cooper, 1985; Roberts, 1991; Cooper and Gimeno-Gascon, 1992).

In the case of spin-offs, incubator organizations play a more decisive role, especially if spin-off creation is a key element in their missions, as is the case with the entrepreneurial university (O'Shea et al, 2004; Landry et al., 2006). Cross-university variation in spin-off activity can be explained by differences in university policies, venture capital availability, the possibility of leaves of absence for business creation, the opportunity to use university facilities in the early stages of the company, and staff attitudes towards entrepreneurial activities, among others (Kassicieh et al., 1997; Di Gregorio and Shane, 2003; Shane, 2004; Landry et al., 2006; Searle, 2006; O'Shea et al., 2004).

We would argue, therefore, that incubator organization constitutes a main dimension of entrepreneurial motivation. This is shaped by two subdimensions: *organizational barriers* and *supporting infrastructure*. The first subdimension refers to push motivations, such as promotion policies (based on scientific publications), the bureaucratic barriers to the development of entrepreneurial activities, employment instability, and so on. The second subdimension includes pull motivations, for example, the establishment of adequate organizational policies for the promotion of an entrepreneurial culture, establishing support programmes, the existence of a spin-off tradition in the incubator organization, and so on. Chiesa and Piccaluga (2000) examined these aspects and found that aversion for bureaucracy and the low risk orientation of the research environment were the most important reasons for creating spin offs.

Motivations related to social networks

In this dimension we include possible motivational elements in the entrepreneur's social environment, which are shaped by two subdimensions: *role models* and *attitudes toward entrepreneurship*. The existence of successful entrepreneurs both in the family environment and in the region of residence of the individual, and the attitudes of society towards the creation of new businesses, are aspects that affect perceptions of the feasibility and desirability of creating a company (Shapero, 1984). However, the evidence on these aspects is scarce and contradictory. Autio and Kauranen (1994) in

their study of Finnish academic entrepreneurs found that such motives were not important in the decision to create a firm, while Ding and Stuart (2006), in a study that explored the social backgrounds of 917 US researchers, found that the existence of role models in the social networks of the inventor can positively influence the likelihood of creating a company.

4 Methodology and data collection

The population of our study is made up of researchers from all Spanish universities and public research organizations (PROs),² who have created or are in the process of creating an academic spin-off. We identified 541 academic entrepreneurs associated with 459 spin-offs and 11 new firm projects in May 2007. The spin-offs were tied to 37 public universities and two PROs in Spain.

The information on motivations was collected via an email questionnaire. This process, which was conducted between March and September 2007, eliminated 41 of the original sample because they reported either that they had not founded a firm or had been students when they had created their firms, so they were not based on research results. This reduced our population to 500 researchers. We received 163 completed questionnaires, representing a response rate of 33%. Of these, eight could not be considered because the founders of the companies had been undergraduate students at the time and four were discarded because the respondents had not been founding members of companies. Thus our final sample included 152 academic entrepreneurs.

Measurement of motivations

To assess our model we used an adaptation of the scale used by Autio and Kauranen (1994) to analyse a triggering event in a group of 104 high-tech entrepreneurs in Finland. We estimated the applicability of items in the original scale to the Spanish context, reformulating and/or eliminating some, and including some new items to suit

² In Spain, technology transfer activities in universities emerged in the 19^{90s} making academic spin-offs an incipient phenomenon. Before 2000, there were only 17 spin-offs, since then there has been a significant increase in the number of academic spin-offs established, e.g. by 2006 there was a total of 530 spin-offs in Spain (RedOTRI, 2007).

the dimensions in our model. Our scale includes 36 items or variables covering the six dimensions of the entrepreneurial motivation proposed.

The data were analysed using first, second and third order confirmatory factor analysis. Using this technique, the measurement model describes the relationship between: a) the number of latent variables or factors; and b) the manifest indicator variables that measure those latent variables. The model investigated in this study includes 18 latent variables for the dimensions and subdimensions of the entrepreneurial motivation. In our analysis we follow Bentler's (1989) convention of identifying latent variables by the letter "F" (for Factor), and labelling manifest variables "V" (for Variable).

The dimension of *personal motivations* (F14) includes three subdimensions. First is the *need for achievement* (F1), which is measured by three items: V1-Desire to prove own ability to establish a new firm; V2-Personal achievement motivation; V3-Desire to develop one's own ideas. Second is *the need for independence* (F2) measured by: V4-Attempt to achieve a better working atmosphere, V5-Lack of work prospects, and V6-Desire to be more independent. Third is the *desire for wealth* (F3), measured by V7-The desire for wealth (million euros).

The dimension of *entrepreneurial opportunity* (F4) was measured by three items: V8-Analysis of business opportunity developed by the OTT, V9-A new idea for a product/service; V10-Perceived customer's needs or deficiencies in existing products.

For the dimension in motivations related to *scientific knowledge* (F15) five items are involved. Two are related to *the desire to apply knowledge* (F5): V11-Cutting edge technological knowledge; V12-Desire to apply knowledge in practical use; and three are related to *knowledge transfer* (F6): V13-High value-added knowledge, which is the base of the new firm; V14-Difficulties in transferring the knowledge to the immediate environment; V15-Exclusivity of the knowledge available (there is no similar knowledge in other research and development (R&D) environments).

The dimension related to *resources availability* (F16) includes three subdimensions. The first measures the availability of *financial resources* (F7) based on three items: V16-Available finance (grants, bank loans, family, friends, etc.), V17-Available personal assets to invest, and V18-Available public support (loans). The subdimension related to *social networks* (F8) contains three items: V19-Availability of person suitable to be manager of the firm; V20-Good contacts for establishing the company (e.g.,

knowledge about potential partners); and V21-Good contacts in the potential market. The subdimension of *production facilities* (F9) is measured by three items: V22-Existence of a scientific or technological park in the city/region; V23-Existence of a business incubator in the area; V24-Availability of production facilities.

The motivations related to *incubator organization* (F17) are measured by six items. Four of them refer to *organizational barriers* (F10): V25-The difficulty of promoting professionally within the incubator organization; V26-High level of bureaucracy in the incubator organization; V27-Low risk orientation of the research environment; and V28-Existence of specific legislation for the creation of spin-offs in the incubator organization. The other two items which refer to the *supporting infrastructure* (F11) are: V29-The existence of a tradition of spin-off generation in the incubator organization and V30-Attitude towards new business creation within the incubator organization.

Finally, the *social environment* (F18) dimension comprises two subdimensions. The first is *role models* (F12), which includes: V31-Relatives or family members act as entrepreneurs; V32-Advice received from friends and V33-Examples of successful companies. The second subdimension, *attitudes towards entrepreneurship* (F13), also includes three items: V34-Advice received from external organizations; V35-Campaigns aimed at encouraging entrepreneurship and V36-Society's attitudes towards entrepreneurship.

The 36 items considered were evaluated through responses to the question: "How important was each of the following aspects in your decision to set up a firm?". Following the methodology in Autio and Kaurannen (1994), responses were assessed on a Likert scale ranging from 0 to 3, with the higher score indicating higher perceived importance of the motivational item.

5 Results and discussion

5.1 Assessing the multidimensional nature of entrepreneurial motivation

The process of assessing the multidimensional nature of the entrepreneurial motivation consists of two steps: assessment and adjustment of the measure model, and verification of the multidimensionality of the concept.

First, we assessed and adjusted the measurement model proposed for analysis of the entrepreneurial motivation. The model was evaluated by first and second order confirmatory factor analysis, estimated using the Maximum Likelihood (ML) method. We used EQS 6.1 software for this process. The pattern of large normalized residual (over 0.258), parameter significance tests, and Lagrange multiplier tests showed that it was necessary to re-estimate the model. The re-estimation process led to elimination of the variables V8, V17, V25, V28 and V32 and elimination of the subdimensions *desire for wealth* (F3) and *supporting infrastructure* (F11). This resulted in a model with an acceptable adjustment where the chi-square value for the model was statistically significant $\chi^2_{(282, n = 152)} = 440.94$, and small, the non-normed-fit index (NNFI = 0.920), the comparative fit index (CFI = 0.931), and the goodness of fit index (GFI = 0.812) took values close to 0.9, and the standardized Root Mean-Square Residual (RMSR=0.08) took a value between 0.05 and 0.08, indicative of an acceptable fit (Bentler and Bonett, 1980; Bentler, 1989; Hair et al., 1999).

Having achieved our adjusted model, we verified its reliability and validity. Reliability of the entrepreneurial motivation scale is determined by computation of Cronbach's alpha. The standardized alpha for the 28 item scale was 0.80, indicating an acceptable degree of internal consistency (Nunnally and Bernstein, 1994; Hair et al., 1999). Validity of the entrepreneurial motivation scale was measured in two ways: content validity and construct validity.³

³ The assessment scales process recommends assessing nomological validity. Scales show nomological validity of the constructs if the construct being measured is capable of demonstrating relationships with other constructs which, conceptually or theoretically, should exist (Vila et al., 2000). Accordingly, to assess this kind of validity it is necessary to have scales for several constructs, which is not the case here.

All the items included in the scale have been analysed in the literature on entrepreneurial motivation in academia and for this reason we consider that content validity is ensured. Construct validity was verified by assessing the convergent validity and discriminant validity of the scale (Vila et al., 2000). Convergent validity is verified by analysing the factor loadings and their significance. Standardized loadings for the indicator variables are presented in Table 1. The t scores obtained for the coefficients in Table 1 range from 0.464 to 0.882, indicating that all factor loadings are significant ($p < 0.05$). This finding provides evidence to support the convergent validity of the indicators (Anderson and Gerbing, 1988). Discriminant validity was assessed by the confidence interval test. The confidence interval test to assess the discriminant validity between two factors involves calculating a confidence interval of plus or minus two standard errors around the correlation between the factors, and determining whether this interval includes 1.0. If it does not include 1.0, discriminant validity is demonstrated (Anderson and Gerbing, 1988). The results for each pair of dimensions in our scale are shown in Table 2. Discriminant validity for the entrepreneurial motivation scale is supported since no range includes the value 1.0.

Table 1. Convergent validity of entrepreneurial motivation scale

| Factor | Indicator | Standardized loading (t-value) |
|---|------------------|--|
| F1. Need for achievement | V1 | 0.619 (4.031) |
| | V2 | 0.664 (4.576) |
| | V3 | 0.483 (4.005) |
| F2. Need for independence | V4 | 0.714 (4.876) |
| | V5 | 0.531(4.513) |
| | V6 | 0.637 (4.875) |
| F5. Desire to apply knowledge | V11 | 0.561 (3.641) |
| | V12 | 0.724 (3.677) |
| F6. Knowledge transference | V13 | 0.621(4.756) |
| | V14 | 0.567 (4.536) |
| | V15 | 0.690 (4.759) |
| F7. Financial Resources | V16 | 0.607 (4.411) |
| | V18 | 0.626 (4.457) |
| F8. Social Networks | V19 | 0.464 (3.148) |
| | V20 | 0.543 (3.216) |
| | V21 | 0.478 (3.086) |
| F9. Production facilities | V22 | 0.882 (6.033) |
| | V23 | 0.644 (6.049) |
| | V24 | 0.54 (5.374) |
| F10. Organizational barriers | V26 | 0.638 (9.227) |
| | V27 | 0.971 (9.278) |
| F12. Role models | V32 | 0.548 (4.144) |
| | V33 | 0.746 (3.942) |
| F13. Attitudes towards entrepreneurship | V34 | 0.603 (6.074) |
| | V35 | 0.755 (6.11) |
| | V36 | 0.703 (5.989) |

Table 2. Discriminant validity of entrepreneurial motivation scale

| Factors | Confidence interval for correlation | Factors | Confidence interval for correlation | Factors | Confidence interval for correlation |
|---------|-------------------------------------|---------|-------------------------------------|---------|-------------------------------------|
| F1,F2 | (0.11; 0.37) | F2,F9 | (-0.08; 0.17) | F7,F10 | (-0.02; 0.12) |
| F1,F5 | (0.00; 0.14) | F2,F10 | (0.04; 0.21) | F7,F12 | (-0.02; 0.12) |
| F1,F6 | (-0.07; 0.06) | F2,F12 | (0.03; 0.21) | F7,F13 | (0.08; 0.32) |
| F1,F7 | (-0.03; 0.16) | F2,F13 | (0.00; 0.19) | F8,F9 | (0.06; 0.35) |
| F1,F8 | (-0.07; 0.10) | F5,F6 | (0.03; 0.14) | F8,F10 | (-0.08; 0.05) |
| F1,F9 | (0.00; 0.26) | F5,F7 | (-0.04; 0.08) | F8,F12 | (-0.02; 0.12) |
| F1,F10 | (0.05; 0.22) | F5,F8 | (0.19; 0.29) | F8,F13 | (0.04; 0.26) |
| F1,F12 | (0.05; 0.26) | F5,F9 | (-0.04; 0.13) | F9,F10 | (-0.01; 0.20) |
| F1,F13 | (0.00; 0.19) | F5,F10 | (-0.04; 0.05) | F9,F12 | (0.00; 0.21) |
| F2,F5 | (-0.06; 0.07) | F5,F12 | (-0.03; 0.06) | F9,F13 | (0.13; 0.41) |
| F2,F6 | (-0.15; -0.01) | F5,F13 | (0.00; 0.12) | F10,F12 | (0.01; 0.14) |
| F2,F7 | (-0.05; 0.14) | F7,F8 | (0.04; 0.30) | F10,F13 | (0.01; 0.16) |
| F2,F8 | (-0.04; 0.13) | F7,F9 | (0.08; 0.38) | F12,F13 | (-0.04; 0.16) |

The second step in the analysis was to verify the multidimensionality of the entrepreneurial motivation; thus we needed to verify whether the dimensions proposed converged in a single factor. We calculated a third-order confirmatory factor analysis for the motivations. The final model is depicted in Figure 2. The measures of goodness and adjustment show a satisfactory adjustment for this new model (BBNFI = 0.93, CFI = 0.93, SRMR = 0.08).

The findings show that, as hypothesized, entrepreneurial motivation is a multidimensional construct. However, this construct consists of only five of the six dimensions proposed in our initial model. Items related to the entrepreneurial opportunity behave differently from the other dimensions and the situation is similar for the indicators of the subdimension *desire for wealth* and *supporting infrastructure*, which were eliminated in our adjustment to the scale. We need to clarify that this

analysis technique is based on the behaviour of covariance matrices, which will tell us that for the data analysed, the variables and subdimensions that we eliminated behave differently from the other variables in the model and, for this reason, their elimination results in the model that best explains entrepreneurial motivation. This may be due to the type of items chosen to measure these dimensions and/or the size of the sample, which would require its extension in future research. Apart from technical aspects, it is necessary to reflect on the role of the dimensions and subdimensions that we eliminated, in the process of new business creation.

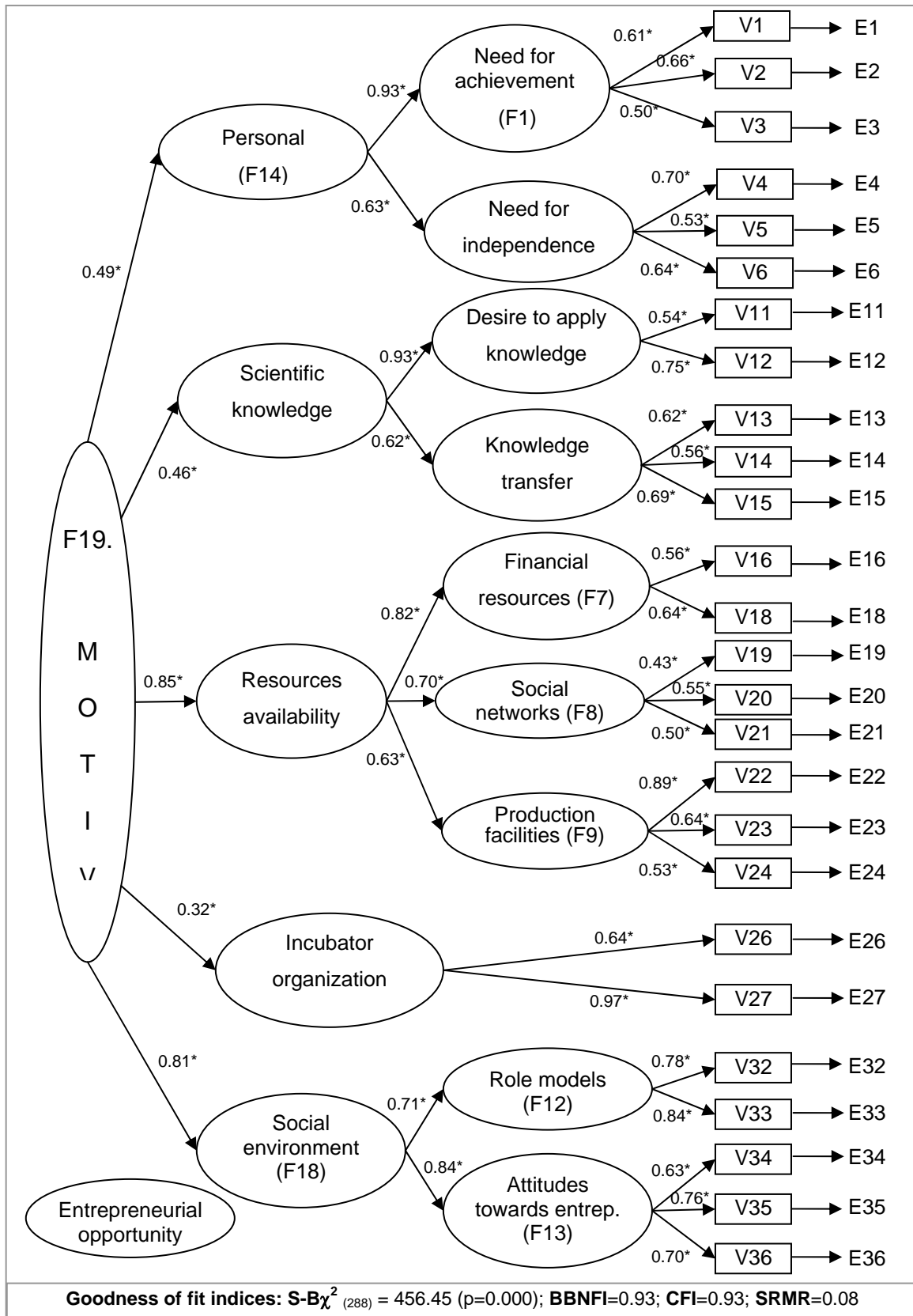
Entrepreneurial opportunity is not part of the entrepreneurial motivation and it seems to be an important independent construct in the entrepreneurial process. This result is consistent with the Shane and Venkataraman (2000), who suggest that the "discovery of entrepreneurial opportunities" and "the decision to exploit entrepreneurial opportunities" are two distinct stages in the entrepreneurship process. Also, according to Vohora et al. (2004), opportunities are identified by the researcher in the first phase of the process of creating an academic spin-off, where only those researchers that are able to relate the new knowledge to existing market needs will proceed to the later stages of the process. Accordingly, if an opportunity is detected far in advance of the formulation of the intention to create a spin-off, we can suppose that the researcher will assess other motivations when assessing the possibility of engaging in the creation of a new company. Regardless of when the entrepreneurial opportunity is detected, our results show that it is important for academic entrepreneurs (Average value of 2.3), which coincides with what was reported in other studies (Autio and Kaurannen, 1992; Chiesa and Piccaluga, 2000).

Moreover, the fact that the desire for wealth is not part of the entrepreneurial motivation for academics is logical because researchers generally do not seek material rewards and are usually only interested in recognition from the scientific community in the form of citations and awards for investigative work (Etzkowitz, 1998, Levin and Stephan, 1991).

Elimination of the support infrastructure subdimension within the incubator organization dimension may be due to the incipient development of the spin-off phenomenon in Spanish universities, since the vast majority of these institutions still do not have an adequate infrastructure for the promotion of entrepreneurial activity,

although efforts are being made in this direction. It would be interesting to examine the role of incubator institutions in the entrepreneurial process more deeply.

Figure 2. Third order Confirmatory Factor Analysis Model for Entrepreneurial



motivation

*Statistically significant at the 95% level of confidence.

5.2 Importance of the dimensions of entrepreneurial motivation

An examination of the importance of each of the dimensions that constitute entrepreneurial motivation in academia was conducted. We calculated the average value of the variables that make up each dimension and applied a t-test for related samples. The results show that there are significant differences in the importance assigned to each dimension by the entrepreneur in the decision to create an enterprise (Table 3).

Table 3. T-test for related samples for the dimensions of the entrepreneurial motivation model

| Model dimensions | Importance Mean | Scientific Knowledge | Personal | Resources availability | Incubator organization | Social environment |
|------------------------|-----------------|----------------------|------------------|------------------------|------------------------|--------------------|
| Scientific Knowledge | 2.1 | X | | | | |
| Personal | 1.7 | 0.4 (-6.605)* | X | | | |
| Resources availability | 1.4 | 0.7 (11.580)* | 0.3 (4.593)* | X | | |
| Incubator organization | 1.3 | 0.8 (10.896)* | 0.4 (5.483)* | 0.1 (1.592) | X | |
| Social environment | 1.1 | 1.0 (18.027)* | 0.6 (10.690)* | 0.3 (6.186)* | 0.2 (6.186)* | X |

*Statistically significant at the 95% level of confidence.

Note: 0=not important, 3=very important

The results show that scientific knowledge is the most important dimension (2.1) for academic entrepreneurs in the decision to create a firm. The second most important factor is personal motivation (1.7), which includes the need for achievement and the need for independence. These results are consistent with those found for other countries such as Italy (Chiesa and Piccaluga, 2000) and the UK (Weatherston, 1995). The remaining three dimensions of entrepreneurial motivation were only of minor importance in the decision to create a business: F16-Resources availability (1.4), F17-Incubator organization (1.3) and F18-Social environment (1.1).

Our results suggest that academic entrepreneurs, unlike entrepreneurs from non-academic settings, are driven by the search for scientific knowledge and, thus, creating a company becomes a means to achieve their scientific goals. The higher accumulation of knowledge coupled with the desire to apply that knowledge and continue advancing in their development are the elements that "pull" the actions of these entrepreneurs, and possibly determine most of the decisions they make throughout their academic careers.

6 Conclusions

In this study we examined the motivations for creating a company among a group of 152 Spanish academic entrepreneurs. We proposed and evaluated a model for entrepreneurial motivation comprising six dimensions that represent different types of motivations: personal, related to scientific knowledge, to the entrepreneurial opportunity, to the availability of resources to create business, to the incubator organization and to the social environment.

Our results show that the dimension entrepreneurial opportunity is not part of the entrepreneurial motivation. Although this result is unexpected, it raises an interesting question about the role of Entrepreneurial opportunity in the decision to create a firm. Thus, rather than being the trigger, opportunity may have been perceived long before the idea to create a business emerges or perhaps after the decision to create a company.

The motivations related to scientific knowledge are important in the decision to create an academic spin-off. Desire to apply knowledge, and the problems related to knowledge transfer are aspects that are relevant in the entrepreneurial decision. That is, the creation of a spin-off is often driven by the search for and application of knowledge, the same driving forces of an academic career. However, we need to consider the effects of such motivations for the survival and growth of a firm, since one of the major weaknesses of technology-based companies is their tendency to focus on technical aspects at the expenses of good management. This finding also has implications for the design of policies and programmes to promote spin-offs and appropriate assessment mechanisms for the management capacities of these companies. Possible deficiencies on the management side might be offset by searching for and hiring trained personnel, or including in the business surrogate entrepreneurs or partners with managerial experience from the business environment.

Incubator organizations are shown not to be important motivating factors for the creation of academic spin-offs in Spain. When these organizations act as motivating factors, some negative features are driving the decision to create a company. In other words, high levels of bureaucracy and low risk orientation in the incubator organization push researchers to establish companies; spin-offs are a way of escaping from these constraints. This can affect future relationships between the new firms and the incubator organization, which could reduce the benefits from the creation of academic spin-offs for universities. There are some areas where the incubator organizations play a more positive role in the generation of these companies, for example, training in business management, reducing the academic loads of researchers engaged in creating spin-offs, and consultancy for various aspects of their business plans.

The results of this study point to interesting future research opportunities. For example, it would be interesting replicate this study in a non-academic setting in order to examine the role of the entrepreneurial opportunity in the decision to create enterprise. Also, it would be interesting to study the impact of spin-off creation on the academic researcher's career: if spin-offs are a new source of resources for research, their creation could have a positive impact in the scientific output of academic entrepreneurs. Also, studying the impact of the motivation dimensions for the survival and growth of academic spin-offs would make an interesting research topic.

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