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The Effect of Intrinsic and Extrinsic Motivations on Academics' Entrepreneurial Intention

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Abstract: This work investigates entrepreneurial intentions among academic scientists. Drawing from the literature on entrepreneurial behavior, it contributes to delineate the differences in motivations that are correlated with entrepreneurial intention to those that are considered to be linked to entrepreneurial behaviors. By disentangling the concept of motivations in its ultimately basic constructs of intrinsic and extrinsic motivations, we investigate how these two different types of motivations are related to the formation of entrepreneurial intention at the level of academic scientists. Through a survey conducted at the University of Ferrara—one of the leading universities in Italy in terms of technology transfer and scientific production—findings reveal that while academic entrepreneurial intention seems to be mostly driven by intrinsic motivations, the effect of extrinsic motivations, which are regarded as a main antecedent of entrepreneurial behavior among scientists, are largely mediated by academic positions, work environment and different combinations of these two factors. This work therefore highlights the importance of social norms in the investigation of entrepreneurial intention in academia.

Keywords: intrinsic motivations; extrinsic motivation; entrepreneurial intention; academic entrepreneurship

1. Introduction

Considerable efforts have been made in stimulating an entrepreneurial culture among academic scientists. Policies have emerged in all western countries in order to push scientists to exploit their research results commercially. The number of new ventures created by academic staff therefore increased considerably in the last decades, and several studies arose aimed at identifying who are the scientist-entrepreneurs (e.g., [1,2]). Among these studies, increasing attention has been devoted to the investigation of the motivation pushing scientist to create their own venture.

Studies revealed that scientists tend to be motivated to undertake entrepreneurial careers by a wide variety of factors, such as peer recognition [3], self-determination [4,5], research-related purposes [1,6], and monetary rewards [2,5]. Researches on academic scientists' motivations to act entrepreneurially also reveal that contextual elements may play a fundamental role in shaping academic propensity to undertake entrepreneurial behavior [7,8].

While studies on academics' entrepreneurial behavior are numerous, less investigated are the factors affecting entrepreneurial intention among scientists. The identification of an entrepreneurial

opportunity is an intentional behavior and this is largely predicted by entrepreneurial intention [9]. Investigating entrepreneurial intention is therefore an important research task which helps to understand and predict entrepreneurship [10,11], because it allows us to shed light on the transition processes of entrepreneurship [12,13]. Although works on academic scientists' intention are in their infancy, some argue that only few of the academics who are entrepreneurially intentioned seem to finally move to entrepreneurial behavior [14]. For these reasons, this work focuses on entrepreneurial intention among scientists, and drawing from the literature on entrepreneurial behavior, it seeks to contribute to delineating the differences in motivations that are correlated with entrepreneurial intentions to those that are considered to be linked to entrepreneurial behaviors. Our findings reveal that motivations related to having an entrepreneurial intention are largely mediated by the contextual and situational factors of the researchers. We then interpret our findings on the factors affecting entrepreneurial intention in relation to the factors acknowledged to affect entrepreneurial behavior: this work sheds lights on the misalignment between entrepreneurial intention and behavior among scientists.

The paper is structured as follows. In Section 2, we summarize the theoretical foundation of the construct of entrepreneurial intention. Section 3 revises the literature on academic scientists' motivations to venture creation. Section 4 puts forth the empirical analysis, Section 5 highlights the results and finally Section 6 concludes.

2. The Construct of Entrepreneurial Intention

Two main theoretical models of entrepreneurial intention have been proposed: the Theory of Planned Behavior [15] and the Model of Entrepreneurial Event [16]. The two models have been found to be both robust to empirical tests and to basically converge toward a similar interpretation of the determinants of the entrepreneurial intention [10]. These models identify two main elements which are considered to be strong predictors of the intention of an individual to create a venture: perceived feasibility and perceived desirability. Perceived feasibility represents the confidence an individual has toward undertaking the entrepreneurial processes. The construct of self-efficacy is considered the main predictor of perceived feasibility and is often measured asking respondents their perceived capability in conducting some specific tasks (e.g., [17]). Perceived desirability conversely represents the attractiveness an individual has in respect to the starting of a new venture: it is often measured by evaluating the desire an individual has in conducting some tasks.

These models also identify the presence of social norms that represent the effect of the context in which the individual is embedded in the formation of the entrepreneurial intention. Social norms are sometimes considered part of perceived desirability [18], however they are often found to explain less variance than perceived feasibility and desirability [10,19]. Nevertheless, some authors claim that social norms have been poorly accounted for, both theoretically and empirically [20]. Recent studies, in fact, argue that environmental influences play a role in respect to the formation of entrepreneurial intention: in particular, Liñán et al. [21] find that a positive entrepreneurial culture exerts an effect on increasing the entrepreneurial intention of Spanish university students. On the contrary, Lee et al. [17] find that entrepreneurial intention of IT professionals in Singapore is positively affected by working contexts that are unfavorable to innovative behaviors. Moreover, Engle et al. [22] reveal that informal institutions, which regard social and cognitive contextual aspects, play a stronger role toward the formation of entrepreneurial intention, compared to more formal institutions, such as regulations and written norms [17].

Empirical studies on entrepreneurial intention tend to proxy these concepts of perceived feasibility and desirability, and also social norms, in various and different ways, relying on the evaluation of a variety of different items. Moreover, across different studies, often similar items are considered to be predictors of both perceived feasibility and perceived desirability. For example, within the concept of self-efficacy, a predictor of perceived feasibility, some studies also take into account past experience [23,24], risk propensity [24,25], the influence of environmental factors [23] and so on.

Similarly, the concept of perceived desirability has been addressed by empirical studies including various items. For example, Douglas and Shepherd [26] argue that perceived desirability may be measured in respect to the individual's attitude toward risk, work effort and other intrinsic rewards. Fitzsimmons and Douglas [27] (p. 434) argue that risk attitude may be considered "a sufficient proxy for perceived desirability of the entrepreneurial action". Another important element related to the concept of perceived feasibility is motivations. Douglas [28] (p. 637), in extreme synthesis, refers to the construct of perceived feasibility as to "the motivation to exploit". Although motivations are a crucial factor, able to influence both entrepreneurial intention and behavior, given the evidence provided by the literature, it seems limitative to refer to perceived feasibility as only individual motivations.

The presence of a link between intention and motivation has been widely recognized [29], and it has been argued that the relationship between motivations and intentions is not unidirectional [30]. Elfving et al. [20] proposes a revised model of entrepreneurial intentions in which motivations, together with goals and opportunity evaluation, represent a main antecedent. Although Jordaan [31] investigates and finds the presence of a (causal) relationship between intrinsic motivations and entrepreneurial intention, our knowledge on this link remains scarce. The constructs of motivations has been widely studied in relation to entrepreneurial behavior rather than to entrepreneurial intention.

This work contributes to fill this gap. By disentangling the concept of motivations in its ultimately basic constructs of intrinsic and extrinsic motivations, we investigate how these two different types of motivations are related to the formation of entrepreneurial intention at the level of academic scientists. The issue of entrepreneurial intention in academic entrepreneurship is poorly investigated, contrarily to the determinants of entrepreneurial behavior. Given the considerable amount of investigations regarding motivations that spur academic scientists to create a venture, and considering the fact that only few scientists who intend to create a venture ultimately do create a venture [14], it emerges as relevant to investigate the motivational antecedents of entrepreneurial intention in order to see if there is a discrepancy between motivation toward intention and motivation toward behavior. In order to examine this potential discrepancy, we are able to highlight how contextual and situational factors exert a fundamental role in shaping academic scientists' entrepreneurial intention.

3. Entrepreneurial Motivations and Academic Entrepreneurship

Economics literature ultimately recognizes two forms in which motivations to undertake a task can be classified: intrinsic and extrinsic motivations [29,32]. These also apply to the case of entrepreneurial motivations [30], however poorly explored. Intrinsic motivations regard the personal sphere and comprehend those intangible incentives which endogenously foster an individual to undertake some task. Among intrinsic motivations several elements can be recognized: interest, reciprocity, self-determination, need for achievement and so on. On the contrary, extrinsic motivations refer to external factors affecting the individual's behavior, and regarding the incentives produced by the desire to obtain an outcome. Within the category of extrinsic motivations, scholars identify monetary payoff, recognition, external control, and so on.

Intrinsic and extrinsic motivations have been often found to work in opposite directions to the incentives to undertake some task [33]. However, some authors also identified situations in which the two types of incentives may be complementary and reinforce each other [34]. Amabile [35] argues that entrepreneurial creativity can be enhanced by the synergy between intrinsic and extrinsic motivations, although intrinsic motivations tend to play the stronger role. On the contrary, the creation of academic spin-off, which we broadly define as a start-up founded by an academic staff, and which may be considered to enter the category of entrepreneurial creativity adopted by Amabile [35], seems to be mostly driven by extrinsic motivations, rather than by intrinsic ones (e.g., [2]).

Works about what motivate scientists to engage with industry, and also specifically to create academic spin-offs, highlighted how non-monetary payoffs may represent the higher-level motivation. Monetary payoffs represent the higher order of extrinsic motivation, while within the broad category of non-monetary payoffs identified by the literature, we find both intrinsic and extrinsic motivations.

Among these non-monetary factor we can find the search for independence [4,5], the search for prestige and peers recognition [3], the need for research funding [1,6], individual willingness to bring some research onto the market [5,6,36] and necessity reasons [8].

It has been shown that academics may be particularly keen to engage with industry when they receive feedback for their research, and less interested in the more commercial issues related with its transfer, such as the creation of a start-up [37,38]. The picture that emerges is somehow contradictory: some authors claim that academic engagement with industry is mostly driven by monetary extrinsic motivations, and others find that other reasons, rather than monetary incentives, play the lion share of the incentives. Along this line of investigation, D'Este and Perkmann [2] explore different reasons for different technology transfer channels. They find that, on the one hand academics engage with industry with, above all, research-related motivations, therefore claiming that direct rewards are not such an important type of incentive. Secondly, they find that monetary rewards are the only driving factor when scientists are to create an academic spin-off. In other words, while academics engage with industry for both intrinsic and extrinsic motivations, when they create a venture they are only driven by extrinsic motivation.

Intrinsic and extrinsic motivations are also affected by the context in which the individuals are inserted. Social norms, although poorly explaining entrepreneurial intention, are found to either hinder or enhance the intrinsic or extrinsic motivations of an individual in undertaking a task, and this reasoning also applies to entrepreneurial motivations [20]. In the realm of academia, contextual factors have been recognized as particularly important in respect to the conduction of research activity exploitation [7,8,39]. Bercoviz and Feldman [7] explore in detail the contextual factors affecting the propensity of academics to engage in technology transfer activities. They find that individuals are more likely to engage in technology transfer activities if trained and inserted in a context that positively see these new types of activities. On the contrary, they find that individuals who are embedded in a context that does not favor technology transfer activities, are less likely to undertake themselves these types of activity.

Another important element that is found to play a role in respect to the propensity of scientists to undertake entrepreneurial actions is their academic positions. In particular, some studies note that scientists tend to engage in commercial activities in later stages of their career [2,7]. These studies, however, tend to focus only on permanent position staff, and as Gurmu et al. [40] note, academic laboratories are mostly populated by PhD students and post-doctoral fellows. These authors [40], investigating the patent production determinant of US universities, find that the number of patent applications by universities is significantly and positively influenced by temporary researchers. Similar results are also find in respect to the formation of ventures by academic scientists in Italy: Rizzo [8] argues that young scientists may be motivated by necessity driven reasons, while Horta et al. [41] find that there is a positive correlation between high skill unemployed and the formation of academic spin-off. We may therefore conclude that in Italy young researchers are more prone to undertaking the creation of a venture from university research results.

On the basis of the literature surveyed, we put forward the following set of research questions that we seek to answer with the empirical application, where the focus group of potential entrepreneurs are academics: (i) Are the intentions to exploit the research outcomes on the market, via venture creation related to intrinsic and extrinsic motivations? (ii) Are the relations between entrepreneurial intention and motivations influenced by the work environment? (iii) Does the relation between entrepreneurial intention and motivations change with the academic position? (iv) Do the two types of motivation reinforce each other, that is, are they complements? Responding to these questions, our findings recognize that motivations toward intentions are importantly moderated by the working environment and academic position of the scientists.

4. Empirical Analysis

4.1. Data

Survey data has been collected by submitting a structured electronic questionnaire to all the staff population of the University of Ferrara [42]. The University of Ferrara is a medium university in the North of Italy and it represents a leading Italian university in terms of both technology transfer performances [43] and scientific production [44].

The population we refer to is composed of 1817 individuals on 31 December 2012 (This information has been collected at the Human Resources of the university). The questionnaire has been submitted through a web application, and we collected 358 completed answers, corresponding to 28% of the total population. Given the purpose of this work, to investigate the entrepreneurial intention of academic scientists we excluded non-research staff from the analysis, i.e., administrative workers and adjunct professors without a research position, remaining with a sample of 261 individuals, of a total population of 1260 researchers, which corresponds to almost 21% of the population. The sample is well distributed across academic position with just a slight underrepresentation of full professors and PhD students (See Tables 1 and 2 below). Among scientific areas, we note that Social Sciences and Medicines are slightly underrepresented, while Technological Sciences are overrepresented. The Cochran Q test, giving an error equal to 0.54 (The general rule of thumb here is to accept values up to 0.5), supports our sample choice. Finally, we note that 35% of our sample is less than 35 years old, the 50% between 36 and 55 and the remaining 15% more than 55 years old.

Table 1. Respondents distribution (shares).

	Full Professor	Associate Professor	Assistant Professor	PostDoc Researchers	PhD	Total	Total (Count)
Sciences	4.49	10.11	8.24	7.49	8.24	38.58	103
Humanities	0.75	1.50	0.75	1.50	1.87	6.37	17
Economics/Law	1.87	1.50	1.87	2.25	1.50	8.99	24
Medical Science	1.50	2.62	5.99	7.12	6.74	23.97	64
Technological Sciences	1.87	2.25	5.99	7.12	4.87	22.10	59
Total	10.49	17.98	22.85	25.47	23.22		
Total (count)	28	48	61	68	62		267

Table 2. Total staff on the 31 December 2010 (share).

	Full Professor	Associate Professor	Assistant Professor	PostDoc Researchers	PhD	Total	Total (Count)
Sciences	3.91	5.30	6.60	4.73	13.28	33.82	415
Humanities	1.55	2.12	1.14	0.65	1.96	7.42	91
Economics/Law	2.69	2.36	2.28	1.14	5.46	13.94	171
Medical Science	3.99	4.56	6.76	7.66	5.30	28.28	347
Technological Sciences	2.20	2.28	3.18	4.07	4.81	16.54	203
Total	14.34	16.63	19.97	18.26	30.81		
Total (count)	176	204	245	224	378		1227

4.1.1. Dependent Variable

Two dependent variables are used in the analysis. The first one we may refer to as “firm intention” (Firm_Int) and represents the intention of commercialize the research outcome through the creation of a firm, independently of also having the intention to exploit research results through other channels, such as selling patents, or to do nothing. In this case, the variable takes the value of 1 whenever the respondent answers Yes to the first question of Table 3, whatever the answers to the other questions, and 0 otherwise. The second dependent variable may be referred to as “strict firm intention” (ST_Firm_Int) and captures the willingness of exploiting research results only by means of setting up a firm: we assign 1 only in the cases in which the respondents select items 1 but not the other

items in Table 3, and 0 otherwise. In so doing, we isolate the idea of setting up a business venture due to the research outcome, from other mechanisms of technology transfer. In our sample, about 57% of academics, 150 out of 261, express the intention of also creating a business venture (Firm_Int) if their research results could provide this possibility. When we focus on the idea of only creating a firm (ST_Firm_Int), this subsample of academics reduces to 77 individuals, corresponding to 29% of the sample.

Table 3. Question used to construct the dependent variables.

If the Results of Your Research or the Use of Your Abilities Led to a Commercialization, under which Forms Would You Consider It?	Yes	No
1. The creation of a firm		
2. Patent registration and development by the use of licenses		
3. Sell patents to firms which have interest in them		
4. You will let others deal with the commercialization of your research results		

4.1.2. Independent Variable

The main independent variables of our investigation represent proxies of intrinsic and extrinsic motivations. The questionnaire proposed that individuals evaluate the personal reasons for which they would have created a firm to exploit their research results, and the personal reasons for which they are not thinking of creating a firm. Among these items to evaluate, various motivations such as “increase the wellbeing of others”, “increase your own prestige”, “create relations within your workplace”, “make money” and so on are found. For each of these questions, the respondents were asked to evaluate the importance of these elements from 0 to 100. We conducted a principal component analysis on all these items which resulted in two components that can be referred to as *intrinsic* and *extrinsic motivations*, as explained below (methodology section) in details.

These represent our two main variables of interest. However, we included in the empirical exercise a series of other variables as identified by the literature to be antecedents of entrepreneurial intention. In particular, we control for the perceived feasibility and desirability of the individuals: following the literature on the topic, we included experience in having already created a firm, risk propensity, the perception by the individual of possessing the entrepreneurial and social capability to conduct a business, and the experience in having participated to other technology transfer projects of any kind. Moreover, we also included a variable that approximates the so called social norms in the academic environment [7], i.e., the working context of the individual, which refers to the perception by the individual of the attitude of the research group/department in which the individual works, toward technology transfer activities. More specifically, the questionnaire asked respondents to evaluate from 0 to 100 the following questions: “Do you feel encouraged by your lab to pursue the economic promotion of your research activities?” Finally, we controlled for the scientific sector, age and academic position of the individual. The variables used in the analysis are described in the tables below (Tables 4 and 5).

Table 4. Variable description for the main covariates of the econometric analysis.

Variable Name	Description	Mean	St. Dev.	Min.	Max
Firm_Int	The individual had the intention also to create a firm to exploit his research results (binary)	0.559	0.497	0	1
ST_Firm_Int	The individual had the intention of exploiting his research results only by creating a firm (binary)	0.295	0.457	0	1
<i>Controls</i>					
Sc_Area	Scientific area each individual belongs to: six dummies for Humanities, Economics/Law, Medical Science, Technological Sciences, Mathematic/Physics/Astronomy, Life Sciences (binary)	/	/	0	1
Acad_Pos	Academic position of each individual: three dummies for PhD and PostDoc researchers, Assistant Professor, Associate and Full Professor (binary)	/	/	0	1
Age	Age class (categorical)	3.946	2.663	1	10
Ability_index	Index of perceived entrepreneurial and social capabilities	74.825	13.613	33.333	100
Tec_Transf	Experience in technology transfer activities	43.134	30.121	0	100
Risk	Index of risk propensity (categorical)	1.556	0.640	1	4
Context	Degree of lab support to technology transfer activities	48.517	31.796	0	100
SO_Exp	Experience as member of an academic spin-off (binary)	0.165	0.372	0	1
<i>Motivations</i>					
Int_Mot	Component: synthesis of variables capturing intrinsic motivation	−0.047	0.977	−3.123	2.624
Ext_Mot	Component: synthesis of variables capturing extrinsic motivation	0.059	1.024	−2.382	2.349

Table 5. Correlation matrix for the main covariates of the econometric analysis.

Correlations	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Ability_index (1)	1							
SO_Exp (2)	0.1196	1						
Risk (3)	0.1945	0.1797	1					
Tec_Transf (4)	0.1438	0.076	0.0959	1				
Age (5)	0.0038	0.0906	0.0785	-0.0439	1			
Context (6)	0.1717	0.2154	0.0405	0.2696	-0.1067	1		
Int_Mot (7)	0.2223	0.1019	0.1564	0.1939	-0.0817	0.3072	1	
Ext_Mot (8)	0.0295	-0.1239	0.0041	0.0181	-0.1242	-0.0992	-0.0887	1

4.2. Methodology

First of all, in order to shrink the information on motivations, we run a Principal Component Analysis (PCA) on the variables of interest. In so doing, we are able to reduce the dimension of the covariates vector, preserving the original variance of the variables included in the PCA as much as possible. Seven variables that capture motivations were included in the PCA, as reported in Table 6 below. These seven elements, grouped in two components, explain the 53% of total original variance (The full PCA results are available upon request from the authors). The choice of the two components has been made on the basis of the eigenvalues' magnitude: we retained the components with eigenvalues larger than 1.

Table 6. Rotated matrix of components*.

	Component	
	1 Intrinsic Motivations	2 Extrinsic Motivations
Wellbeing of Others	0.703	
Relation R&D	0.691	
Improve CV	0.724	
Unwanted Breaks		0.843
Make Money		0.500
Lessen Abilities		0.743
Preoccupation Issues		0.504
Eigenvalues	1.935	1.779
Cumulative variance explained		53.049%

Note: * Varimax rotation with Kaiser normalization.

The two factors can be interpreted as representing the *intrinsic* and *extrinsic* motivations of the individual toward the potential creation of a firm. The questionnaire asked to respondents to evaluate from 0 to 100 the elements presented in Table 6, under this heading: "If you were to create your own firm, this would personally ...". Within the component of intrinsic motivations the following elements as stated in the questionnaire are grouped: "... give you the feeling of doing more for the wellbeing of others", "... allow you to create relations with the structures of research development of your workplace" and "... enable you to improve considerably your curriculum vitae". We can appreciate that these elements refer mostly to the willingness of creating a venture in order to obtain intrinsic rather than extrinsic advantages, such as reciprocity and self-determination. On the contrary, under the component of extrinsic motivations we find the following elements: "... lessen the abilities you have in your own professional field because the firm would keep you away from it", "... allow you to make money", "... make you take the risk of an unwanted break in a promising career", and "... lead you to be preoccupied by technical, commercial or other issues linked to your firms, during your free time". We can note that some of these elements (preoccupation issues and unwanted breaks) can be associated with "control", that is, they create impositions typically associated with extrinsic incentives; moreover, we have the 'make money' elements which is another typical extrinsic incentive.

Their distribution of the components can be used in order to meaningfully observe the scores in their lower and upper quartile. Scoring in the highest quartile (75p) means that the individual is driven by a high degree of intrinsic (extrinsic) motivations with respect to the potential firm creation. The opposite for the lowest (25p). Considering that we can argue that an individual with a score of the motivation factor in the highest quartile has a high motivation, the opposite is true if the score is in the lowest quartile.

The empirical exercise proposes a probit model taking the following specifications:

$$\Pr (Y = 1|X)_i = \Phi (Controls_i, Intrinsic Motivations_i, Extrinsic Motivations_i) \quad (1)$$

$$\begin{aligned} \Pr (Y = 1|X)_i \\ = \Phi(Controls_i; Intrinsic Motivations_i, Extrinsic Motivations_i | WorkingContext \geq Median) \end{aligned} \quad (1a)$$

$$\begin{aligned} \Pr (Y = 1|X)_i \\ = \Phi (Controls_i; Intrinsic Motivations_i, Extrinsic Motivations_i | AcademicPosition = J) \end{aligned} \quad (1b)$$

where $J = PhDPostDocorAssFullProf^1$

$$\Pr (Y = 1|X)_i = \Phi (Controls_i, Complementarities_i) \quad (2)$$

where Y is alternatively $Firm_Int$ or ST_Firm_Int as described above. Controls include the main determinants of entrepreneurial intention, i.e., usual antecedents (experience, risk, abilities), social norms (academic environment), and the standard controls (sector, academic position). Intrinsic and Extrinsic motivations are variables constructed through the PCA (as explained above) of various questions available in the questionnaire. Exploiting the specification (1), it is possible to test for a relation between venture intention and intrinsic and extrinsic motivations, in order to answer to the first two research questions. We are also interested in evaluating the motivations role when the workplace of the academics supports (or not supports) the technological transfer (specification 1a). We address this issue by evaluating the intention probability in two cases: the first one when the workplace environment (variable *Context*) has a value above the median and the second one when it has a value below the median. In addition, we answer the third research question by interacting the two motivation factors with academic positions (specification 1b). In doing so, we are able to capture both the role played by the age of individuals (the young are usually in the lowest steps of the academic career) and by the tenure (young researchers have usually short term positions) when related to the specific kinds of motivations.

Finally, with specification (2) we test the complementarity (substitutability) and the effect of the joint contribution of intrinsic and extrinsic factors to the intention to create a firm or, more generally, exploiting the research outcomes on the market. This allows us to answer the last research question.

In order to test for complementarities, we decided to dichotomise the two main components of Intrinsic and Extrinsic motivation: the result is a set of dichotomous variables (*Complementarities* in specification 2). The dichotomisation is functional to test the existence of complementarities in two specific regions of the components distribution (Intrinsic Motivations and Extrinsic Motivations): when the score of each component is in the first quartile (25q) and in the last quartile (75q). We obtain two sets of states of the world: one for the first quartile and the other for the last quartile (Table 7).

¹ With the distinction between *PhDPostDoc* and *AssFullProf* we aim to single out potential differences in the propensity to set up a venture between early career and late career researchers.

Table 7. States of the world for the two ‘extremes’ of the distribution of Intrinsic Motivations and Extrinsic Motivations indexes.

Definition	Intrinsic Motivations	Extrinsic Motivations	Solution Sets
	first quartile (25q) (IM_25p)	last quartile (75q) (EM_25p)	State of the World
Value 1 if <i>Intrinsic Motivation component</i> score is in the first quartile (25p); 0 otherwise;	0	0	(0,0)25p
Value 1 if <i>Extrinsic Motivation component</i> score is in the first quartile (25p); 0 otherwise	1	0	(1,0)25p
			(0,1)25p
			(1,1)25p
	first quartile (25q) (IM_75p)	last quartile (75q) (EM_75p)	State of the World
Value 1 if <i>Intrinsic Motivation component</i> score is in the last quartile (75p); 0 otherwise;	0	0	(0,0)75p
Value 1 if <i>Extrinsic Motivation component</i> score is in the last quartile (75p); 0 otherwise	1	0	(1,0)75p
			(0,1)75p
			(1,1)75p

The way to test complementarities is based on theories and properties of supermodular functions (see for example [45,46] for empirical applications). In the present case, and following [47], we can say that two variables, x and y in a lattice Z , are complements if a real-valued function $F(x,y)$ on the lattice Z is supermodular in its arguments. That is, if and only if:

$$F(x \vee y) + F(x \wedge y) \geq F(x) + F(y) \quad \forall x, y \in Z. \tag{3}$$

Or, written in a different way:

$$F(x \vee y) - F(x) \geq F(y) - F(x \wedge y) \quad \forall x, y \in Z, \tag{4}$$

that is, the change in F from x (or y) to the maximum ($x \vee y$) is greater than the change in F from the minimum ($x \wedge y$) to y (or x): raising one of the variables raises the value of increases in F of the second variable.

In our case, we consider the probability to have the intention of exploiting the research outcomes as a dependent variable, so our objective function is measured in terms of probability. As specified above, we have two sets of quadruplets that we use to substitute the two indexes of Intrinsic and Extrinsic motivations. Focusing on the first set of states of the world, as in Table 6, we have shown that: the individual has low intrinsic motivation and low extrinsic motivation, his/her scores in both components are within the first quartile (1,1)25p, his/her scores are one in the first quartile and the other above the first quartile (1,0)25p or (0,1)25p, and both the scores above the first quartile (0,0)25p. The same holds for the second set of states of the world, which focuses on individuals having values of the Intrinsic and Extrinsic motivation indexes in the last quartile.

Using our notation, we can state that complementarity exists if the following inequality is satisfied:

$$Y_j(11, \Omega_j) - Y_j(00, \Omega_j) > [Y_j(10, \Omega_j) - Y_j(00, \Omega_j)] + [Y_j(01, \Omega_j) - Y_j(00, \Omega_j)] \tag{5}$$

where Ω_j is a vector of variables potentially influencing the venture intention Y . The inequality shows that changes in the probability of having the idea of a venture when the motivations are increased are higher than the changes resulting from the sum of the separate increases of the two motivations. In our empirical application, we follow Hottenrott et al., (2012) and we specify our regressions to test for complementarities as:

$$\Pr(Y = 1|X)_i = \Phi([Controls_i, (1,1) 25p_i, (1,0) 25p_i, (0,1) 25p_i]) \tag{6}$$

$$\Pr(Y = 1|X)_i = \Phi([Controls_i, (1,1) 75p_i, (1,0) 75p_i, (0,1) 75p_i]) \tag{7}$$

The set of the four states of the world in each specifications (6) and (7) represents a lattice $Z = \{\{00\}, \{01\}, \{10\}, \{11\}\}$ and the Y function is supermodular in the motivation couples, that is, motivations are complements, if the Inequality (5) is satisfied.

The operationalization of the procedure to test for the complementarities among motivations is quite straightforward. After having estimated the two Equations (6) and (7), we simply run tests on parameters restrictions. The parameters of interest are those associated to the states of the world variables: b_1 for the state of the world (1,1); b_2 for (1,0) and b_3 for (0,1). The tests are Wald tests. The test is distributed as Chi2 statistic with one degree of freedom in the numerator, since we are testing a single linear restriction at a time, so we can apply the appropriate procedure for the p -value adjustment in testing inequalities. For an appropriate reference see [48], which, with an appropriate correction of the p -value, allows us to test the following null hypothesis (as a one-sided t -test): $H_0: b_2 + b_3 \geq b_1$. A result of the test against this H_0 leads us to conclude that we cannot reject the hypothesis of complementarities among our variables of interest. Hence, we can state whether we are in the presence of complementarity ($b_1 - b_2 - b_3 \geq 0$) between the couple of two motivations measured in the first and last quartile or, instead, if we are in presence of substitutability ($b_1 - b_2 - b_3 \leq 0$).

5. Results

The following table (Table 8) reports the results of the first step of our analysis, with baseline probit models. We propose six specification, the first three referred to our first dependent variable (firm intention) and the last three referred to our second dependent variable (strict firm intention). While specifications 1 and 4 are conducted on the full sample, we then divided our sample in two sets: one in which scientists argue to be embedded in a laboratory that positively supported technology transfer (specifications 2 and 5) and one in which scientists are not supported in these activities (specifications 3 and 6). (We divided the sample according to the median. Given the fact that the median value was the same for numerous individuals, we selected the supportive context as those scientists who indicated a value higher than the median value).

Table 8. Probit results (Marginal effects reported).

	Firm_Int			ST_Firm_Int		
	(1)	(2)	(3)	(4)	(5)	(6)
	Full Sample	Positive Working Context	Negative Working Context	Full Sample	Positive Working Context	Negative Working Context
Sc_Area	Yes	Yes	Yes	Yes	Yes	Yes
Acad_Pos	Yes	Yes	Yes	Yes	Yes	Yes
Ability_Index	-0.000 (0.003)	-0.002 (0.006)	0.000 (0.004)	-0.008 ** (0.003)	-0.020 *** (0.007)	-0.002 (0.004)
SO_Exp	0.923 *** (0.281)	1.200 *** (0.377)	0.401 (0.395)	0.725 *** (0.235)	0.819 ** (0.320)	0.540 (0.393)
Risk	0.240 * (0.141)	0.236 (0.206)	0.329 (0.210)	0.028 (0.150)	0.040 (0.252)	0.095 (0.209)
Tec_Transf	-0.001 (0.003)	0.002 (0.005)	-0.002 (0.004)	-0.003 (0.003)	-0.002 (0.006)	-0.004 (0.005)
Age	-0.010 (0.047)	-0.026 (0.064)	0.010 (0.067)	0.075 (0.046)	0.089 (0.069)	0.106 * (0.063)
Context	-0.001 (0.003)	0.002 (0.010)	0.002 (0.007)	-0.002 (0.003)	0.006 (0.011)	0.002 (0.007)
Int_Mot	0.440 *** (0.099)	0.415 ** (0.171)	0.512 *** (0.136)	0.187 ** (0.095)	0.126 (0.176)	0.220 * (0.132)
Ext_Mot	-0.180 ** (0.090)	-0.170 (0.156)	-0.204 * (0.118)	-0.088 (0.092)	-0.134 (0.147)	-0.113 (0.123)
N	261	117	144	261	117	144
r2_p	0.205	0.192	0.205	0.224	0.337	0.211
chi2	60.085	24.935	35.938	66.578	41.843	37.065
df_m	15.000	14.000	15.000	15.000	15.000	15.000
P	0.000	0.035	0.002	0.000	0.000	0.001

Notes: Marginal effects; Standard errors in parentheses; * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Regarding results first of all, several controls are related to the two types of intentions: both the academic position and the scientific area of each academic are factors influencing the intention to bring research outcomes to the market. A specific control, the past experience in having founded a spin-off (SO_Exp), seems to play an important role as an element that positively influences the probability to grow the intention of doing a venture.

When we look at our main variables of interest, we can see that the two motivations are differently related to the intention of exploiting the research results on the market or setting up a firm in order to exploit the research outcomes. In the first case (specification 1), intrinsic motivations seem to play a crucial and positive role in influencing the intention to exploit their research results via venture creation, while, quite unexpected, extrinsic motivations are negatively related to the probability of having such an intention. This means that scientists with high extrinsic motivations prefer to exploit their research results by means of other technology transfer channels or do not exploit them, rather than creating a venture. Looking at specification 4, which has the 'strict' intention to set up a firm as a dependent variable, we can appreciate that intrinsic motivations still maintain an important role, while extrinsic motivations do not play a role at all.

When we focus on specification 2 for Firm_Int and 5 for ST_Firm_Int, we can see what happens to the intention/motivations relation in the case that the workplace environment supports the technological transfer (working context is above the median). The role of intrinsic motivations decreases for both the dependent variables, and in the case of ST_Firm_Int, it statistically 'disappears'. For extrinsic motivations, the negative marginal effect registered in specification 1 is no longer significant. Specifications 3 and 6 show what happens when the workplace environment does not strongly sustain the technological transfer (context variable below the median): the results turn out to be as those in specifications 1 and 4. Hence, we can conclude that the environment in which the academic conducts her/his research influences the intention/motivations relation.

This first set of results allows us to answer the first two research questions. We can say that intrinsic and extrinsic motivations both play a role in the probability to intend to bring to the market the research outcomes of academics. The relations, however, are not trivial. If intrinsic motivations play a positive role, the extrinsic ones are negatively related to the dependent variables. These relations are both mediated by the degree of support that the workplace environment, in which the academic works, provides to the technological transfer.

A second set of results shows how the motivation/intention relation changes when we focus on two specific categories of academics (Tables 9 and 10): early career researchers (*PhDPostDoc*), PhD students and post-doc researchers, and late career researchers (*AssFullProf*), associate and full professors. These two categories of academics are interacted with the motivations. In so doing, we jointly account for the age of the individual, with the *PhDPostDoc* category being composed of younger individuals than the *AssFullProf* category, and for the role of tenure in influencing the motivations.

From Tables 9 and 10, we have some interesting results. First of all, also in this case, the first specifications, 1a and 1b in both the tables, comprise all the academics of our sample, while the second and third ones (2a, 3a and 2b, 3b) focus on the subsamples of academics that work in an environment that support or does not support technological transfer.

Results show that motivations are more important for young researchers than for academics with tenure: both as positive 'determinants' (intrinsic motivations) and as negative 'determinants' (extrinsic motivations). The negative and significant role of extrinsic motivations fades out for tenured academics, while remains significant for young researchers. More specifically, results indicate that extrinsic motivations play a role for young researchers if they are embedded in a non-favorable context, while they play a negative role when the researcher is inserted in a favorable context. Conversely, senior researchers are positively motivated by extrinsic motivation when in a favorable context. The evidence leads us to positively answer the third research question: age and tenure, jointly captured

by the distinction of academics in two categories, influence the role that motivations play on the intention to bring to the market the research outcomes.

Table 9. Probit results (Marginal effects reported): Motivations interacted with *PhDPostDoc*.

	Firm_Int			ST_Firm_Int		
	1a	2a	3a	1b	2b	3b
	Full Sample	Positive Working Context	Negative Working Context	Full Sample	Positive Working Context	Negative Working Context
Sc_Area	Yes	Yes	Yes	Yes	Yes	Yes
Acad_Pos	Yes	Yes	Yes	Yes	Yes	Yes
Ability_Index	-0.001 (0.003)	-0.003 (0.006)	-0.000 (0.004)	-0.008 ** (0.004)	-0.019 ** (0.007)	-0.002 (0.004)
SO_Exp	0.890 *** (0.287)	1.214 *** (0.379)	0.205 (0.401)	0.686 *** (0.236)	0.810 ** (0.320)	0.386 (0.417)
Risk	0.213 (0.143)	0.209 (0.207)	0.321 (0.210)	0.030 (0.151)	0.104 (0.266)	0.093 (0.216)
Tec_Transf	-0.000 (0.003)	-0.001 (0.005)	0.000 (0.005)	-0.003 (0.003)	-0.001 (0.006)	-0.003 (0.005)
Age	-0.011 (0.046)	-0.029 (0.064)	0.015 (0.063)	0.079 * (0.045)	0.099 (0.071)	0.112 * (0.062)
Context	-0.001 (0.003)	0.002 (0.011)	0.002 (0.007)	-0.002 (0.003)	0.007 (0.011)	0.003 (0.007)
Int_Mot	0.530 *** (0.154)	0.311 (0.230)	0.687 *** (0.211)	0.359 ** (0.160)	0.504 * (0.275)	0.345 * (0.203)
Ext_Mot	-0.350 *** (0.130)	-0.374 (0.238)	-0.432 *** (0.161)	-0.074 (0.144)	0.383 * (0.226)	-0.291 * (0.169)
PhDPostDoc × Ext_Mot	0.294 (0.179)	0.275 (0.318)	0.470 ** (0.231)	-0.027 (0.187)	-0.710 ** (0.302)	0.393 (0.245)
PhDPostDoc × Int_Mot	-0.156 (0.194)	0.138 (0.295)	-0.338 (0.274)	-0.293 (0.203)	-0.523 (0.346)	-0.255 (0.275)
N	261	117	144	261	117	144
r2_p	0.214	0.197	0.229	0.230	0.362	0.227
chi2	62.889	26.534	40.453	65.825	43.778	45.413
df_m	17.000	16.000	17.000	17.000	17.000	17.000
P	0.000	0.047	0.001	0.000	0.000	0.000

Notes: Marginal effects; Standard errors in parentheses; * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 10. Probit results (Marginal effects reported): Motivations interacted with *AssFullProf*.

	Firm_Int			ST_Firm_Int		
	1a	2a	3a	1b	2b	3b
	Full Sample	Positive Working Context	Negative Working Context	Full Sample	Positive Working Context	Negative Working Context
Sc_Area	Yes	Yes	Yes	Yes	Yes	Yes
Acad_Pos	Yes	Yes	Yes	Yes	Yes	Yes
Ability_Index	-0.001 (0.003)	-0.003 (0.006)	-0.001 (0.004)	-0.008 ** (0.004)	-0.018 *** (0.007)	-0.003 (0.005)
SO_Exp	0.893 *** (0.287)	1.209 *** (0.381)	0.228 (0.399)	0.692 *** (0.237)	0.855 *** (0.327)	0.412 (0.408)
Risk	0.236 * (0.142)	0.224 (0.208)	0.357 * (0.206)	0.031 (0.151)	0.121 (0.254)	0.124 (0.208)
Tec_Transf	-0.000 (0.003)	0.002 (0.005)	-0.000 (0.004)	-0.003 (0.003)	-0.003 (0.006)	-0.003 (0.005)
Age	-0.011 (0.046)	-0.028 (0.065)	0.008 (0.063)	0.080 * (0.045)	0.094 (0.068)	0.106 * (0.062)
Context	-0.001 (0.003)	0.002 (0.011)	0.002 (0.007)	-0.002 (0.003)	0.010 (0.011)	0.002 (0.007)
Int_Mot	0.521 *** (0.155)	0.317 (0.226)	0.656 *** (0.212)	0.369 ** (0.163)	0.463 * (0.256)	0.329 (0.203)
Ext_Mot	-0.135 (0.106)	-0.141 (0.173)	-0.106 (0.147)	-0.112 (0.108)	-0.270 (0.174)	-0.025 (0.149)
AssFullProf × Ext_Mot	-0.187 (0.196)	-0.255 (0.402)	-0.352 (0.243)	0.093 (0.214)	0.861 ** (0.383)	-0.301 (0.265)
AssFullProf × Int_Mot	-0.152 (0.195)	0.126 (0.292)	-0.303 (0.275)	-0.302 (0.206)	-0.466 (0.322)	-0.229 (0.273)
N	261	109	144	261	117	144
r2_p	0.209	0.195	0.219	0.231	0.365	0.221
chi2	62.969	25.682	40.287	65.507	47.065	39.011
df_m	17.000	16.000	17.000	17.000	17.000	17.000
P	0.000	0.059	0.001	0.000	0.000	0.002

Notes: Marginal effects; Standard errors in parentheses; * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Finally, we test for the existence of complementarities as reported in Table 11. In this case, we are interested, as described above, in the methodological section, in disentangling the potential complementary role between the two types of motivations on the academic’s intention to go to the market.

Table 11. Probit results (Marginal effects reported): Complementarity tests.

	Firm_Int		ST_Firm_Int	
	1a	2a	1b	2b
Sc_Area	Yes	Yes	Yes	Yes
Acad_Pos	Yes	Yes	Yes	Yes
Ability_Index	0.000 (0.001)	0.000 (0.001)	−0.002 ** (0.001)	−0.002 * (0.001)
SO_Exp	0.309 *** (0.084)	0.268 *** (0.082)	0.199 *** (0.059)	0.189 *** (0.059)
Risk	0.105 ** (0.043)	0.073 (0.045)	0.018 (0.040)	0.007 (0.040)
Tec_Transf	−0.000 (0.001)	0.000 (0.001)	−0.001 (0.001)	−0.001 (0.001)
Age	−0.004 (0.015)	−0.007 (0.015)	0.021 * (0.012)	0.019 (0.012)
Context	0.000 (0.001)	0.001 (0.001)	−0.000 (0.001)	−0.000 (0.001)
Int25Ext2511	−0.337 *** (0.086)		−0.149 * (0.084)	
Int25Ext2510	−0.224 * (0.133)		−0.148 (0.116)	
Int25Ext2501	−0.105 (0.078)		−0.066 (0.071)	
Int75Ext7511		0.274 * (0.151)		−0.050 (0.116)
Int75Ext7510		0.189 ** (0.073)		0.070 (0.062)
Int75Ext7501		−0.107 (0.067)		−0.024 (0.060)
N	261	261	261	261
r2_p	0.177	0.222	0.216	0.178
chi2	55.942	64.053	61.907	50.051
df_m	16.000	16.000	16.000	16.000
P	0.000	0.000	0.000	0.000
Test against H ₀ : coeff. 10 + 01 ≥ coeff.11	<i>p</i> -value 0.523	<i>p</i> -value 0.136	<i>p</i> -value 0.315	<i>p</i> -value 0.763

Notes: Marginal effects; Standard errors in parentheses; * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Looking at the complementarity test at the bottom of Table 11, we can note that the null hypothesis, which states that the sum of the coefficients (The tests on probit coefficients give the same results. The output is disposable from the authors upon request)—here the marginal effects—of the state of the world, when only one of the motivations is in the region of interest (first or last quartile alternatively), is higher or equal to the coefficient of the state of the world when both the motivations are in the region of interest, which implies the non-existence of complementarities, is never rejected. (Specifications 1a and 1b in Table 9 are used to test potential complementarities when we look at the lowest quartile of the motivation factors’ distributions, while specifications 2a and 2b are used to test complementarities in the highest quartile of the distributions). Hence, in our sample of academics, we do not find complementarities among intrinsic and extrinsic motivations, although, for Firm_Int, we are close to the rejection of the null hypothesis in the case in which both the motivations are high.

In synthesis, the whole spectrum of our results leads us to conclude that the scientists are moved by extrinsic motivations to exploit their research results via firm creation only in some specific situations. The exercise conducted here tells us that motivations are considerably moderated by the type of environment in which scientists are embedded, by their career stage, and by a combination of these two elements which are part of the social norm construct.

6. Conclusions

This work mostly contributes to the understanding of the entrepreneurial intention among academic scientists. We have studied the intention of a sample of academics from the University of Ferrara, one of the leading universities in Italy in terms of technology transfer and scientific production, in order to answer research questions that are often treated in the literature, but seldom focused on academics. The results of this work point to the fact that while academic entrepreneurial intention seems to be mostly driven by intrinsic motivations, the effect of extrinsic motivations, which are regarded as a main antecedent of entrepreneurial behavior among scientists, are largely mediated by academic positions, work environment and different combinations of these two factors. This work points therefore to the importance of social norms in the investigation of entrepreneurial intention in academia.

Misalignments between the intent to create a firm and the action of firm creation has been highlighted by other studies in the realm of academic scientists [14]. By investigating the antecedents of entrepreneurial intention in scientists and relating our analysis to the widely investigated results on the antecedents of academic entrepreneurial behavior, we contributed to the explanation of such highlighted discrepancies. In detail, we noted from the literature that extrinsic rewards, although not alone, play the predominant role in pushing scientists to create an academic spin-off. Conversely, we show that, on average, their entrepreneurial intention is not driven by extrinsic elements. On the contrary, intrinsic motivations alone are sufficient as antecedents of scientists' entrepreneurial intention. However, this effect is mediated by both the academic position of the scientists and the working context in which the scientists are embedded. More specifically, we find that, in line with the work of Lee et al. [8] and Rizzo [17], young researchers tend to be extrinsically motivated to pursue the intention of firm creation when inserted in an environment that unfavorably sees technology transfer activities. On the contrary, late career professors tend to be driven by extrinsic motivations when working in a research group that favorably sees the economic/monetary exploitation of research results. Finally, this work points to the absence of complementarity and of substitutability of intrinsic and extrinsic motivations toward entrepreneurial intention.

This work is, however, not without its limitations. Our theoretical framework draws from two rather distinct streams of research: entrepreneurial intention and motivations. We followed the insights proposed by Elfving et al. [20], although the robustness of this link and especially its causal direction need further exploration and tests. We also rely on a rather poor proxy of entrepreneurial intention, by capturing it with a dichotomous variable. Empirically, this work seeks to explore associations and does not claim any causality: the cross-sectional nature of the data does not, at this stage, allow further investigation of the presence of a direction of the relationship.

The study also points to the need of further investigations on why academics are mostly driven by intrinsic motivations in the entrepreneurial intention to create a spin-off, but subsequently undertake the entrepreneurial action only when also pushed by extrinsic rewards. Academics are a particular set of potential entrepreneurs as their habitual environment is rather different from that of the average potential entrepreneur. This issue requires further investigation, and this work represents a first step in highlighting the present gap in the comprehension of the link between academic entrepreneurial intention and academic entrepreneurial behavior.

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