

# The effect of intrinsic and extrinsic motivations on academics' entrepreneurial intention

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**DRAFT**

## 1. Introduction

The identification of an entrepreneurial opportunity is an intentional behaviour. Entrepreneurial behaviour is largely predicted by entrepreneurial intention. Investigating entrepreneurial intention is therefore an important research task which help understand and predict entrepreneurship (Krueger et al. 2000, Kolvereid and Isaksen 2006). However, although intention is a very strong predictor of behaviour, it must be specified that the former may be identified long time before the actual behaviour is enacted, and the behaviour may also never take place.

Two main theoretical models of entrepreneurial intention have been proposed, the Theory of Planned Behaviour (Ajzen 1991) and the Model of Entrepreneurial Event (Shapiro 1982). The two models have been found to be both robust to empirical tests and basically to converge toward a similar interpretation of the determinants of the entrepreneurial intention (Krueger et al. 2000). These models identifies two main elements which are considered to be strong predictor of the intention of an individual to create a venture: perceived feasibility and perceived desirability. Perceived feasibility represents the confidence an individual have toward undertaking the entrepreneurial process. 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. Lee et al. 2011a). Perceived desirability conversely represents the attractiveness an individual have in respect to the starting of a new venture: it is often measured evaluating the desire an individual have in conducting some tasks.

These models also identify the influence of social norms, that represent the effect of the context in which the individual is embedded on the formation of the entrepreneurial intention. Social norms are sometimes considered part of perceived desirability (Krueger and Brazeal 1994), however are often found to explain less variance than perceived feasibility and desirability (Armitage and Conner 2001, Krueger et al. 2000).

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Nevertheless some authors claim that social norms have been poorly accounted both theoretically and empirically (Elfving et al. 2009). Recent studies in fact argue that environmental influences play a role in respect to the formation of entrepreneurial intention: in particular Liñán et al. (2011) find that positive entrepreneurial culture exerts an effect on increasing the entrepreneurial intention of Spanish university students. On the contrary Lee et al. (2011b) find that entrepreneurial intention of IT professionals in Singapore is positively affected by working contexts that are unfavourable to innovative behaviours. Moreover Engle et al. (2011) 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.

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, predictor of perceived feasibility, some studies also take into account past experience (Boyd and Vozikis 1994, Zhao et al. 2005), risk propensity (Chen et al. 1998, Zhao et al. 2005), the influence of environmental factors (Boyd and Vozikis 1994) and so on. Similarly the concept of perceived desirability has been addressed by empirical studies including various different items. For example Douglas and Shepherd (2002) argue that perceived desirability may be measured in respect to the individual attitude toward risk, work effort and other intrinsic rewards. Fitzsimmons and Douglas (2011, 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 (2013, 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 behaviour, however, given the evidence provide by the literature, it seems limitative to refer to perceived feasibility as only to individual motivations.

The presence of a link between intention and motivation has been widely recognized (Ryan and Deci 2000), and it has been argued that the relationship between motivations and intentions is not unidirectional (Carsrud and Brannback 2011). Elfving et al. (2009) proposes a revised model of entrepreneurial intention in which motivations, together with goals and opportunity evaluation, represent a main antecedent. Although Joordan (2014) investigates and finds the presence of a relationship between intrinsic motivations and entrepreneurial intention, our knowledge on this link remain rather scarce. The constructs of motivations has been widely related to entrepreneurial behaviour rather than to entrepreneurial intention.

The aim of this work is to contribute to fill this gap. By disentangling the construct 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. Intention has been considerably investigated in the entrepreneurship research, however few studies approached the issue at the level of academic entrepreneurship (exceptions are: Goethner et al. 2012, Mosey et al. 2012).

The issue of entrepreneurial intention in academic entrepreneurship is poorly investigated, contrarily to the determinants of entrepreneurial behaviour, as it will be highlighted in the next session; moreover, differently from general entrepreneurship, it has been found that there is a significant share of entrepreneurially intentioned academics which do not finally move to entrepreneurial behaviour (Mosey et al. 2012). Given the considerable amount of investigations regarding motivations that spur academic scientists to create a venture, 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 behaviour. Showing that motivations that determine intention are rather different for scientists from motivations that determine behaviour, our results point to the presence of such a discrepancy. Moreover we also provide evidence of how contextual factors exert a different role to different types of academic scientists in respect to entrepreneurial intention.

The issue tackled in this work is relevant and the value added of this investigation is twofold: first it shed light on the relationship between motivations and intention in the study of entrepreneurship; and secondly it contributes to enhance our comprehension of the phenomenon of entrepreneurial intention among academic scientists, and ultimately the process of academic spin-off creation.

The paper is structure as follows. Sections two revise the literature on motivations especially concerned to the literature of academic spin-off creation. Section three put forth the empirical analysis, section four highlight the results of the analysis and finally section 5 concludes.

## **2. Entrepreneurial motivations and academic entrepreneurship**

Economics literature ultimately recognises two forms in which motivations to undertake a task can be classified: intrinsic and extrinsic motivations (Deci and Ryan 1985, Ryan and Deci 2000). These also applies to the case of entrepreneurial motivations (Carsrud and Brannback 2011), however poorly explored. Intrinsic motivations regards the personal sphere and comprehend those intangible incentives which endogenously foster an individual to undertake some task. Among intrinsic motivations can be recognised interest, reciprocity, self-determination, need for achievement and so on. On the contrary extrinsic motivations refer to external factors affecting the individual behaviour, and regard the incentives produced

by the desire to obtain an outcome. Within the category of extrinsic motivation scholars identify monetary payoff, recognition, external control, and so on.

Intrinsic and extrinsic motivations have been often found to work in opposite direction toward the incentives to undertake some task (Bénabou and Tirole 2003). However some authors also identified situations in which the two types of incentives may be complementary and reinforce each other (Bowles and Polania-Reyes 2012). Amabile (1997) 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 entering the category of entrepreneurial creativity adopted by Amabile (1997), seem to be mostly driven by extrinsic motivations, rather than by intrinsic ones (e.g. D'Este and Perkmann 2011).

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 payoff 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 (Birley and Westhead 1994; Shane 2004), the search for prestige and peers recognition (Stuart and Ding 2006), the need for research funding (Hayter 2010; Fini et al. 2009), individual willingness to bring some research onto the market (Minshall and Wicksteed 2007; Shane 2004; Fini et al. 2009) and necessity reasons (Rizzo 2015).

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 (Lee 1996, 2000). The picture that emerge 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. Aiming at clarifying the matter, D'Este and Perkmann (2011) investigates different reasons for different technology transfer channels. They find that on the one hand academics engage with industry above all with research-related motivations, therefore claiming that direct rewards are not such an important type of incentive. Secondly they argue that monetary rewards play a central role only when scientists are to file a patent and 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 are found to poorly explain entrepreneurial intention, they are found to both hinder

or enhance the intrinsic or extrinsic motivations of an individual in undertaking a task, and this reasoning also applies to entrepreneurial motivations (Elfving et al 2009, Carsrud et al 2007). In the realm of academia contextual factors has been recognised as particularly important in respect to the conduction of research activity exploitation (Rizzo 2015, Ramaciotti and Rizzo 2014). Bercoviz and Feldman (2008) 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 do not favour 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 (Bercoviz and Feldman 2008, D'Este and Perkmann 2011). These studies however tend to focus only on permanent positions staffs, and as Gurmu et al. (2010) note, academic laboratories are mostly populated by PhD students and post-doctoral fellows. These authors (Gurmu et al. 2010), investigating patent production determinant of US universities, find that the number of patents application 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 (2015) argues that young scientists may be motivated by necessity driven reasons, while Horta et al. (2015) find that there is a positive correlation between high skill unemployed and the formation of academic spin-off, concluding that young researchers are more prone to undertake an the creation of a venture from university research results.

Summing up the literature on academic technology transfer find that non-monetary rewards, among which only few elements may be classified as intrinsic motivations, play a very important role in pushing scientists to engage with industry, but when these activities regard the creation of a venture monetary payoffs, that is pure extrinsic motivations, become a central determinant. These conclusions are somehow in contrasts with the literature on entrepreneurial motivations, which share the vision that intrinsic motivations are the main driver of entrepreneurial behaviour. Given this discrepancy we investigate whether academics entrepreneurial intention is driven by the same motivation that is found to be determinant of academics entrepreneurial behaviour. More specifically, on the basis of the literature surveyed, we put forward the following set of research questions we seek to answer with the empirical application, where the focus group of potential entrepreneurs are academics: (i) Are the intentions to exploit on the market the research outcomes 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 and tenure status?

(iv) Does the two types of motivations reinforce each other, that is are they complements? Responding to these questions our findings point to recognise on the one hand that entrepreneurial intention and entrepreneurial behaviour are differently driven in respect to intrinsic and extrinsic motivations in the case of academic entrepreneurship and on the other hand that these motivations toward intentions are importantly moderated by the working environment and academic position of the scientists. In turn, we argue, these results rise important points of reflection for both researchers and policy makers.

### **3. Empirical analysis**

#### *3.1. Data*

Survey data has been collected by submitting a structured questionnaire to all staff population of the University of Ferrara (Bonnet et al. 2014). 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 (CIVR—Italian committee for research evaluation—2007) and scientific production (TIS 2011, ANVUR).

The population we refer to is composed by 1273 individuals on 31<sup>st</sup> December 2010 (Ministry of Education data). The questionnaire has been submitted through a web application, and we collected 358 completed answers, corresponding to the 28.1% of the total population. Given the purpose of this work, to investigate entrepreneurial intention of academic scientists we excluded from the analysis non-research staff, i.e. administratives and adjunct professor without a research position, remaining with a sample of 261 academics, on a total population of 859 academics, therefore corresponding to almost 25% of the population. The sample is well distributed across scientific areas and academic position with just a slight underrepresentation of full professors.

#### *3.2 Dependent variable*

Two dependent variables are used in the analysis. The first one we may refer as to “firm intention” (Firm\_Int) and represents the intention of commercialise the research outcome through the creation of a firm, independently of also having the intention to exploit research results through other channels such as filing and selling patents. In this case the variable take the value of 1 whenever the respondent answer Yes to the first question of Table 1, 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) 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 tab.1, and 0 otherwise. In so doing we isolate the idea of setting up a business venture out of the research outcome, from other mechanism of technology

transfer. In our sample, about the 42% of academics, 151 out of 261, express the intention of also creating a business venture (Firm\_Int) whether 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 29%.

Tab.1: Question used to construct the dependent variables

<b>If the results of your research or the use of your abilities led to a commercialisation, under which forms would you consider it?</b>	<b>Yes</b>	<b>No</b>
1. The creation of a firm		
2. Patent registration and development by the use of licences		
3. Sell patents to firms which have interest in them		
4. You will let others deal with the commercialisation of your research results		

### 3.3 Independent variables

The main independent variables of our investigation represent proxies of intrinsic and extrinsic motivations. The questionnaire proposed individuals to evaluate the personal reasons for which they would have created a firm to exploit their research results, also if they are not thinking of creating a firm. Among these items to evaluate are found various motivations such as ‘increase the wellbeing of others’, ‘increase your own prestige’, ‘create relations within your workplace’, ‘make money’ and so on. Each of these questions were asking to the respondents 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 component that can be named 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 included a series of variables in order to 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 approximate the so called social norms in the academic environment (Bercoviz and Feldman 2008), 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 to 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 scientific sector, age and academic position of the individual. The variables used in the analysis are described in the table below (Table 2).

Table 2: Variable description and correlation matrix 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)							
ST_Firm_Int	The individual had the intention of exploiting his research results only by creating a firm (binary)							
<u>Controls</u>								
Sc_Area	Scientific area each individual belongs to: 6 dummies for Humanities, Economics/Law, Medical Science, Technological Sciences, Mathematic/Physics/Astronomy, Life Sciences			0	1			
Acad_Pos	Academic position of each individual: PhD, PostDoc researcher, Assistant professor (short term position), Assistant professor (permanent position), Associate professor, Full Professor			0	1			
Age	Age class (categorical)			1	10			
Ability_index	Index of perceived entrepreneurial and social capabilities			0	100			
Tec_Transf	Experience in technology transfer activities			0	100			
Risk	Index of risk propensity (categorical)			0	4			
Context	Degree of lab support to technology transfer activities			0	100			
SO_Exp	Experience as member of an academic spin-off (binary)			0	1			
<u>Motivations</u>								
Int_Mot	Component: synthesis of variables capturing intrinsic motivation							
Ext_Mot	Component: synthesis of variables capturing extrinsic motivation							
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

### 3.2 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 as much as possible the original variance of the variables included in the PCA. Seven variables that capture motivations were included in the PCA, as reported in the table.3 below. These seven elements, grouped in two components, explain the 53% of total original variance<sup>2</sup>. 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.

<sup>2</sup> The full PCA results are available upon request from the authors.



Tab 3. Rotated\* matrix of components

Matrix of components		
	Component	
	1 Intrinsic Motivations	2 Extrinsic Motivations
WellBeing	0.703	
RelationRD	0.691	
ImproveCV	0.724	
UnwantedBreak		0.843
MakeMoney		0.500
LessenAbilities		0.743
PreoccupationIssues		0.504
Eigenvalues	1.935	1.779
Cumulative variance explained	53.049%	

\*Varimax rotation with Kaiser normalisation

The two factors can be interpreted as representing the *intrinsic* and *extrinsic* motivations of the individual toward the potential creation of a firm. Their distribution can be used in order to meaningfully observe the scores in their lower and upper quartile. Scoring in the highest quartile (75p) mean that the individual is driven by a high degree of intrinsic (extrinsic) motivations in respect to the potential firm creation. The opposite for the lowest (25p). In consideration of that we can argue that an individual who has a score of the motivation factor in the highest quartile has a high motivation, the opposite if the score is in the lowest quartile.

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

$$1) \Pr(Y = 1|X)_i = \Phi(\text{Controls}_i, \text{Intrinsic Motivations}_i, \text{Extrinsic Motivations}_i)$$

$$2) \Pr(Y = 1|X)_i = \Phi(\text{Controls}_i, \text{Complementarities}_i)$$

where Y is alternatively Firm\_Int or ST\_Firm\_Int as described above. Controls include the main determinants of entrepreneurial intention, ie usual antecedents (experience, risk, abilities), social norms (academic environment), and the usual 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 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. We address this issue evaluating the intention probability in two cases: the first one when the workplace environment (ENV) has a value above the median and the second

one when it has a value below the median. In addition, we answer to the third research question interacting the two motivation factors with academic positions. In doing so, we are able to capture both the role played by the age of individuals (young are usually in the lowest steps of the academic career) and by the tenure (young researchers have 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 allow 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 (tab.4).

Tab.4 – States of the world for the two ‘extremes’ of the distribution of Intrinsic Motivations and Extrinsic Motivations indexes

	IntrinsicMotivation_25p (IM_25p)	ExtrinsicMotivation_25p (EM_25p)	State of the world
Value 1 if <b>Intrinsic Motivation component</b> score is in the first quartile (25p); 0 otherwise; Value 1 if <b>Extrinsic Motivation component</b> score is in the first quartile (25p); 0 otherwise	0	0	(0,0)25p
	1	0	(1,0)25p
	0	1	(0,1)25p
	1	1	(1,1)25p
	IntrinsicMotivation_75p (IM_75p)	ExtrinsicMotivation_75p (EM_75p)	
Value 1 if <b>Intrinsic Motivation component</b> score is in the last quartile (75p); 0 otherwise; Value 1 if <b>Extrinsic Motivation component</b> score is in the last quartile (75p); 0 otherwise	0	0	(0,0)75p
	1	0	(1,0)75p
	0	1	(0,1)75p
	1	1	(1,1)75p

The way to test complementarities is based on theories and properties of supermodular functions (see for example Mohnen and Roller 2005; Antonioli et al, 2013; Hottenrott et al, 2012 for empirical applications). In the present case, and following Milgrom and Roberts (1995), 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:

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

Or, written in a different way:

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

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 variables, so our objective function is measured in terms of probability. As specified above we have two sets of quadruplets that we use substituting the two indexes of Intrinsic and Extrinsic motivations. Focusing on the first set of states of the world, as in tab.4 we have 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 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.

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

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

Where  $\Omega_i$  is a vector of variables potentially influencing the venture intention  $Y$ . The inequality shows that changes in the probability to have the idea of a venture when the motivations are increased together 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:

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

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

The set of the four states of the world in each specification (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 innovations is quite straightforward. After having estimated the two equations (6) and (7) we simply run one sided 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*<sup>3</sup>, which with an appropriate correction of the p-value allow us to test the following null hypothesis:  $H_0: b_2 + b_3 \geq b_1$ . 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 presence of complementarity ( $b_1 - b_2 - b_3 \geq 0$ ) between the couple of two motivations measure in the first and last quartile or, instead, if we are in presence of substitutability ( $b_1 - b_2 - b_3 \leq 0$ ).

#### 4. Results

The following table (tab.5) reports the results of the first step of our analysis, with baseline probit models. 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 on 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 influence 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 on the market the research results or setting up a firm in order to exploit the research outcomes. In the first case (specification 1), intrinsic motivations seems to play a crucial and positive role in influencing the intention to 'go on the market', while, quite unexpected, extrinsic motivations are negatively related to the probability of having such intention. Looking at specification 4, which has the intention to set up a firm and nothing else as dependent variable we can appreciate that intrinsic motivations are less likely to influence such intention, while extrinsic motivations do not play a role at all.

When we focus on specifications 2 for Firm\_Int and 5 for ST\_Firm\_Int we can see what happens to the intention/motivations relation in case the workplace environment support the technological transfer (Context variable is above the median). The role of intrinsic motivations decrease for both the dependent variables, and in case of ST\_Firm\_Int it statistically 'disappear'. 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

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<sup>3</sup> 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 <http://www.stata.com/support/faqs/statistics/one-sided-tests-for-coefficients/>.

conclude that the environment in which the academic conduct her/his researches influence the relation intention/motivations.

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 on 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. This relations are both mediated by the degree of support the workplace environment, in which the academic works, provides to the technological transfer.

Tab.5-Probit results (Marginal effects reported)

	Firm_Int			ST_Firm_Int		
	(1) Full sample	(2) Positive working context	(3) Negative working context	(4) Full sample	(5) Positive working context	(6) 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

Marginal effects; Standard errors in parentheses; (d) for discrete change of dummy variable from 0 to 1

\*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

A second set of results shows how the relation motivation/intention changes when we focus on two specific categories of academics (tabb.6-7): those without a tenure (*PhDPostDoc*), PhD students and post-doc researchers comprising also the short-term contract assistant professors, and those with a tenure (*PermProf*), permanent assistant professors and both 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,

being the *PhDPostDoc* category composed by younger individuals than *PermProf* category, and for the role of tenure in influencing the motivations.

Tab.6-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

Marginal effects; Standard errors in parentheses; (d) for discrete change of dummy variable from 0 to 1

\*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

Tab.7-Probit results (Marginal effects reported): Motivations interacted with *PermProf*

	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 (0.064)	0.008 (0.063)	0.080* (0.045)	0.094 (0.071)	0.106* (0.062)

	(0.046)	(0.065)	(0.063)	(0.045)	(0.068)	(0.062)
Context	-0.001	0.002	0.002	-0.002	0.010	0.002
	(0.003)	(0.011)	(0.007)	(0.003)	(0.011)	(0.007)
Int_Mot	0.521***	0.317	0.656***	0.369**	0.463*	0.329
	(0.155)	(0.226)	(0.212)	(0.163)	(0.256)	(0.203)
Ext_Mot	-0.135	-0.141	-0.106	-0.112	-0.270	-0.025
	(0.106)	(0.173)	(0.147)	(0.108)	(0.174)	(0.149)
PermProf*Ext_Mot	-0.187	-0.255	-0.352	0.093	0.861**	-0.301
	(0.196)	(0.402)	(0.243)	(0.214)	(0.383)	(0.265)
PermProf *Int_Mot	-0.152	0.126	-0.303	-0.302	-0.466	-0.229
	(0.195)	(0.292)	(0.275)	(0.206)	(0.322)	(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

Marginal effects; Standard errors in parentheses; (d) for discrete change of dummy variable from 0 to 1

\*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

From tabb.6-7 we have some interesting results. First of all, also in this case the first specifications 1a and 1b in both the tables comprises all the academics of our sample, while the second and third once (2a, 3a and 2b, 3b) focus on the subsamples of academics that work in an environment that support (ENV above the median) or does not support technological transfer (ENV below the median).

Results show that motivations are more important for young researchers than for academics with a 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. The evidence leads us to positively answer to the third research questions: 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.

Finally, we test for the existence of complementarities as reported in tab.8. 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.

Tab.8-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	0.000	-0.002**	-0.002*
	(0.001)	(0.001)	(0.001)	(0.001)
SO_Exp	0.309***	0.268***	0.199***	0.189***
	(0.084)	(0.082)	(0.059)	(0.059)
Risk	0.105**	0.073	0.018	0.007
	(0.043)	(0.045)	(0.040)	(0.040)
Tec_Transf	-0.000	0.000	-0.001	-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)
<hr/>				
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 <sub>0</sub> : coeff. 10+01 >= coeff.11	<b>p-val. 0.523</b>	<b>p-val. 0.136</b>	<b>p-val. 0.315</b>	<b>p-val. 0.763</b>

Marginal effects; Standard errors in parentheses; (d) for discrete change of dummy variable from 0 to 1

\*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

Looking at the complementarity test at the bottom of tab.8 we can note that the null hypothesis stating that the sum of the coefficients<sup>4</sup>, here the marginal effects, of the state of the world when only one of the motivations is in the distribution 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 distribution region of interest, which implies the non-existence of complementarities, is never rejected<sup>5</sup>. 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 lead us to conclude that the scientists who are moved by extrinsic motivations do not intend to exploit their research results via firm creation, but probably by means of other technology transfer mechanisms. Moreover, the result could tell us that motivations are only poorly moderated by the type of environment in which scientists are embedded, although some degree of mediation is found, confirming literature findings on the weak role of social norms in explaining entrepreneurial intention. Finally, high levels of intrinsic motivations seem to represent a background that positively influence the intention of creating a firm or bring the research results on the market.

<sup>4</sup> The tests on probit coefficients give the same results. The output are disposable from the authors upon request.

<sup>5</sup> Specifications 1a and 1b in tab.8 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.



## 5. Conclusions

This work mostly contributes to the understanding of the phenomenon of academic spin-offs intention. We have studied the behaviour 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 often treated in the literature, but seldom focused on academics. This work provide evidence about how academic entrepreneurial intention is, at least partially, driven by different motives in respect to academic entrepreneurial behaviour. Divergences 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 (Mosey et al. 2012). By investigating the antecedents of entrepreneurial intention in scientists and relating our results to the widely investigated results on the antecedents of academic entrepreneurial behaviour this work contributed to disentangle such highlighted discrepancies.

In details, 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 in this work that, averagely, 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 is embedded. More specifically we find that, in line with the work of Lee et al. (2011) and Rizzo (2015), young researchers tend to be extrinsically motivated by pursuing the intention of firm creation when inserted in an environment that unfavourably sees technology transfer activities. On the contrary associate and full professor tend to be extrinsically driven by extrinsic motivations when working in a research group that favourably see the exploitation of research results economically. Finally this work point to the absence of complementarity and of substitutability of intrinsic and extrinsic motivations toward entrepreneurial intention.

The main results therefore point to the need of investigation regarding why academics are entrepreneurially intentioned to create an academic spin-off mostly because of intrinsic motivations, but subsequently undertake the entrepreneurial action only when pushed also by extrinsic rewards. Academics are a particular set of potential entrepreneurs as their habitual environment is rather different from the one of the average potential entrepreneur. This issue require further investigation, and this work represents a first step in highlighting the gap we have in the comprehension of the link between academic entrepreneurial intention and academic entrepreneurial behaviour.

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