

The determinants of the creation of academic spin-off by Italian universities.

Ugo Rizzo^{1*}, Laura Ramaciotti¹

¹Department of Economics and Management, University of Ferrara, Ferrara, Italy

* ugo.rizzo@unife.it

Abstract

The aim of this work is to investigate the determinants of the creation of academic spin-off firms at university level in Italy, with particular attention to the relationship between university funding and propensity of universities to create spin-offs. More specifically we test the effect of public and third party funds on the propensity of universities to generate academic spin-off firms. We then estimate the effect of several variables referring to the characteristic of the university and the context. The results indicate that, contrary to expectations, third party income received by universities does not exert any effect on the propensity of that university to generate ASO firms. Similarly, the scientific productivity, the context innovativeness and the experience in patenting do not exert a positive and significant effect on the university propensity to generate spin-off, as literature would suggest. We find the phenomenon to be influenced by the amount of public income, the past experience in creating spin-off and the establishment of a technology transfer office. This work contributes towards comprehending in which ways the academic spin-off phenomenon in Italy is significantly different from the most widely studied phenomenon in Anglo Saxon countries. Important policy implications derive.

Keywords: Academic spin-off, University income

1. Introduction

While collaboration between industry and university represents an old tradition, the creation of formal academic spin-off is a rather new phenomenon. Academic spin-offs are firms whose business is the exploitation of research results developed within the academic environment. Such firms are considered important in fostering technological change and economic development (Vincett 2010), as they represent a direct bridge between university and market (Fontes 2005). As a consequence, economics and management literature has widely investigated the factors related to a higher propensity for universities to generate more academic spin-offs (Di Gregorio and Shane 2003, Powers and McDougall 2005, Gomez Gras et al 2008).

Several factors have therefore been identified as important and of worth to universities, such as the presence of policies (Di Gregorio and Shane 2003, Baldini 2010), the innovativeness of context (Friedman and Silverman 2003), university research excellence (Di Gregorio and Shane 2003, Powers and McDougall 2005, Baldini 2010), and the experience of the university or of the TTO in dealing with such phenomenon (Powers and McDougall 2005, Shane 2004, Gomez Gras et al 2008).

Although the majority of studies have been conducted in Anglo Saxon countries, several studies have also considered the European context (e.g. Wright et al 2007). From these studies it can be seen how variegated the phenomenon of academic spin-off across different countries is (Proton Europe 2010, Wright et al 2007). Moreover, while it seems widely acknowledged that collaborating with industry leads to a higher number of patents applications (Lawson 2013, Czarnitzki et al 2012), only few studies have investigated the relationship in respect to academic spin-off. These studies have been mostly referred to the American context (Powers and McDougall 2005, Di Gregorio and Shane 2003)

The aim of this work is to investigate the determinants of the creation of academic spin-off firms at university level in Italy, with particular attention to the relationship between university funding and propensity of universities to create spin-offs. Italy may be classified as a peripheral area, a country not abundantly endowed with all the factors correlated with an important high-tech entrepreneurial flourishing context (Benneworth and Charles 2005).

Italy is the fourth largest economy in Europe and a leading country in terms of scientific production by universities (cfr for example Scimago Journal and Country Rank,

www.scimagojr.com). Moreover academic spin-off in Italy seems to be quite different from the ASOs in the US and UK: in fact few Italian ASOs are generated on the shoulder of an academic patented invention (Netval 2011) leading the ASO phenomenon in Italy to be characterised by an high number of business service firms (Netval 2011), in which several ASOs are created by young scientists aiming at securing a job (Rizzo 2012), rather than by senior scientists who look for profit, prestige or challenges, which in Italy seem to be particularly risk adverse (Chiesa and Piccaluga 2000).

The contribution of this paper is twofold. First we contribute to the literature on the determinants of academic spin-off in a country significantly different from the Anglo Saxon contexts (Chiesa and Piccaluga 2000). Secondly we are able to disentangle the effects of both public and private university income on the probability of the university to create spin-offs.

The ASO phenomenon is rather new in the Italian contexts as in many continental European countries. As a consequence policies have been mostly endorsed on the knowledge of the issue derived from the investigation of the American context. This work seeks to contribute to grasp the features of the ASO phenomenon in a “peripheral” country (Benneworth and Charles 2005). The results of this paper contribute therefore to shedding light on the peculiarities of the phenomenon across different contexts and lead to important policy implications.

The paper is structured as follows: section 2 reviews the literature on the issue and puts forth our hypothesis; section 3 defines the data collection and the methodology of the study, then section 4 reports the empirical analysis and describe its findings and finally in section 5 some concluding thoughts and policy implications are put forth.

2. Literature review and hypothesis

Several articles have investigated the determinants of the creation of ASO firms, at different levels of analysis, from individual to geographical. In this work we concentrate on the university level, or, according to O’Shea et al (2008), the organisational level. University level of analysis is important for two main reasons. First universities are themselves pushed

more and more to contribute to economic development (Etzkowitz 2002) and to undertake action in order to favour technology transfer activities, this therefore reflects on the main level of policy and actions implementation (Nosella and Grimaldi 2008, Chiesa and Piccaluga 2000). Secondly the decreasing public funding to universities places them in competition from various perspectives; undertaking a higher level of technology transfer activities can on the one hand provide resources for the university, but also, and more importantly, provide prestige to universities.

Among the wide variety of factors addressed by literature, we identified five main elements regarded as particularly important (Di Gregorio and Shane 2003, Powers and McDougal 2005). These factors are: research funding, university policies, university experience, scientific productivity and contextual characteristics. Let us explore each of these factors separately.

Research funding

In recent times we have observed increased attention paid towards the effects of industry funding on the propensity of undertaking technology transfer activities. Such literature has mostly concentrated on the effect of this type of research funding on the propensity of the individual researchers to apply for patents (e.g. Lawson 2013, Lissoni et al 2013). Few studies have investigated the relationship in respect to the academic spin-off mechanism of technology transfer (e.g. Di Gregorio and Shane 2003, Powers and McDougal 2005).

According to Roberts and Malone (1996) within contexts in which collaboration between industry and university is high, the number of ASO firms the university may generate is higher compared to other contexts. However, they do not find clear cut evidence on this. Similarly Di Gregorio and Shane (2003) argue that the higher the commercial orientation of a university is, the higher the propensity of a university to generate ASO firms should be, but their empirical study only provides limited support.

Other studies, in contrast find a significant and positive relationship: Powers and McDougall (2005) find that receiving R&D funding from industry leads US universities to spur more ASO firms. The authors argue that collaborating with industry contributes to building the networking relationship and capabilities needed to stimulate scientists to create an ASO firm (Colyvas et al 2002, Wright et al 2004, O'Shea et al 2005). Similar reasoning has been put

forth by Krabel and Muller (2009) on a study conducted at individual level: they argue that scientists who collaborate with industry are more prone to founding an ASO.

Moreover, studies have pointed to the fact that undertaking technology transfer activities of any nature, or having experience in collaborating with industries, should exert a positive effect on a researcher or university to spur more ASO firms because the university becomes more entrepreneurial (Lockett and Wright 2005a, Powers and McDougall 2005). However, while the influence of industry funding seems to exert a positive effect on the propensity of university to create ASO firms, very few studies investigate the effect of public funding (an exception is O'Shea et al 2005).

In respect to this issue Blumenthal et al (1996) affirms that faculty members who collaborate with industry tend to be more productive commercially compared to their counterparts who base their research activity on government funds. However, in a study on ASO firms, O'Shea et al (2005) finds that the higher the public funding a university receive in scientific disciplines is, the higher the number of ASO firms that university generate will be

On the evidence indicated here we put forth the following hypothesis:

H1a: The higher the funding the university receives from commercial activity is, the higher the number of ASO firms generated will be;

H1b: The higher the public funding the university receives, the higher the number of ASO firms generated will be.

University policies

Literature has pointed to the influence of policies on the propensity of a university to conduct technology transfer activities (Friedman and Silverman 2003), on patent applications (Baldini et al 2006) and on the generation of ASO firms (Di Gregorio and Shane 2003, Nosella and Grimaldi 2008).

Among the main tools by which policies foster technology transfer activities in general and the formation of ASOs in particular, the establishment of a technology transfer office represents the main and most diffuse instrument (Siegel et al 2003). Literature argues that TTOs are important vehicles for enhancing technology transfer activities of a university, especially when such offices involve many personnel, are managed by competent staff with

and when they acquired experience in dealing with technology transfer activities (Powers and McDougall 2005, Siegel et al 2003, Muscio 2010).

With regard to the specific Italian context, Nosella and Grimaldi (2008) study in depth the interdependence among different kinds of university policies relating to the effects on the university propensity to generate ASO firms. Although they do not find that the establishment of a TTO is directly related to the generation of an higher number of ASO firms, they find that several variables related to its implementation do. Similar results are found by Muscio (2010). The author explains that the TTO may be an important mechanism that fosters the generation of university industry collaboration when managed by skilled and entrepreneurially oriented and experienced staff, and when integrated in the institutional contextual setting.

However TTOs have been established in Italy quite recently, mostly after 2004, and were mostly directed towards the managing of intellectual property rights and to the generation of ASO firms (Netval 2008). The establishment of a TTO may also be considered as an indication of the university to undertake a more entrepreneurial orientation. Given these premises we may expect that in the Italian context, having established a TTO will bear a positive impact on the rate of ASO generated. We therefore put forward the following hypothesis:

H2: Establishing a TTO plays a positive effect on the number of ASO firms generated by universities

University experience

Another factor that could represent an important determinant of the university propensity to generate ASO firms is its past experience. Learning is an essential element to take into account in order to understand innovation activities. The experience in dealing with starting up a firm, has been highlighted as playing a positive role toward the propensity of a university of generating more ASO firms (O'Shea et al 2005). Such positive influence has been highlighted also in terms of routinisation of approach (Lockett and Wright 2005).

As a consequence, in line with innovation persistency (e.g. Peters 2009) and knowledge accumulation literature (Antonelli and Colombelli 2012), the stock of knowledge gained by a university in generating ASO firms must exert an important effect on the propensity of that university to generate ASOs. In this work we consider the fact that past experience of a

university in having spurred ASO firms can be related with the present capability of this university in the generation of more ASO firms.

The same argument is advanced also for individual researchers. Literature finds that researchers who have experience in creating start-up will be more prone to generating an ASO firm (Krabel and Muller 2009, Landry et al 2006). This argument also applies at patent level: researchers and universities who have experience in applying for patents will be more likely to apply for patents (Lawson 2013, Rizzo and Ramaciotti 2012). We therefore put forth the following hypothesis:

H3a: The higher the experience of a university in dealing with the ASO phenomenon is, the higher its propensity to create ASO firms will also be.

Another element related to the experience of the university concerns their overall technology transfer activity and specifically that related to patenting. In fact the process of ASO firm creation is often the result of a prior patenting activity by the university (Shane 2004). Evidence seems to point to a positive relationship between patenting and creating ASOs both in the Anglo Saxon countries (Roberts and Malone 1996, Shane 2001), and in the Italian scenario (Baldini 2010). We therefore put forth the following hypothesis:

H3b: the higher the number of patents a university applies for, the higher the number of ASO firms that university will spur.

Scientific productivity

A widely debated issue that has been investigated, regards the complementarity versus substitutive effect of technology transfer activities and traditional academic activities (Chang and Yang 2008), studies have mostly focused on patents versus scientific productivity, rather than on ASO firms (Lawson 2013). Although some counterfactual evidence has been produced (Hottenrott and Lawson 2012), most studies on the topic tend to converge on the complementarity between publishing and applying for patents (Agarwal and Henderson 2002, Fabrizio and Di Minin 2008).

The evidence which refers to ASO firms greatly resembles the patents versus scientific productivity scenario. In fact while Baldini (2010) finds no significant relationship between publication and the probability of ASO firm creation at the level of the single researcher in

Italy, studies in the US context find evidence that university with higher publication and citations productivity are more active in the generation of ASO firms (Di Gregorio and Shane 2003, Powers and McDougall 2005).

The number of publications and citations per researcher is very skewed to the right and mainly carried out by star scientists in some specific research fields. These star scientists are also the ones who are more active in the generation of start-ups (Zucher et al 1998). Studies in fact find a positive relationship at the level of the single researcher (Krael and Muller 2009). The main evidence seems therefore to lead us to expect a positive relationship. As a consequence the following hypothesis is put forth:

H4: The higher the scientific productivity performance of a university is, the higher the number of ASO firms that university will generate

Contextual characteristics

Innovation processes are localised and embedded in the context in which they emerge. Knowledge flows between the various organisations present in a context are crucial leverage to the technological change processes of a context (Zucker et al 1998a, Antonelli 2008). The literature on technology transfer from university to industry shows that universities that operate in contexts where innovation activities are flourishing tend to generate higher level of technology transfer activities (Friedman and Silverman 2003).

Given the presumed positive externalities of collaborating with industry by universities have on the probability of creating spin-offs, it may also be expected that being embedded in a context with a high level of innovation activities positively influences the university propensity to create ASO firms. We therefore derive the following hypothesis:

H5: The stronger the innovation performance of firms located in the regional context of the university is, the higher the number of ASO firms the university located in that region will generate.

3. Data and method

The empirical analysis consists of an econometric exercise in which our dependent variable is represented by the number of academic spin-offs generated by each university in each year from 2005 to 2011. The model proposed is the following:

$$ASO_{it} = \beta_0 + \beta_1 PUBINC_{it-2} + \beta_2 COMINC_{it-2} + \beta_3 TTO_{it} + \beta_4 ASOSTOCK_i + \beta_5 NOASO_i + \beta_6 PATUNI_{it-2} + \beta_7 SCIEPROD_{it-2} + \beta_8 PATREG_{it} + \beta_9 SIZE_{it} + \beta_{10} SOUTH_i + \delta_1 z_i + \gamma_1 x_i + v_{it}$$

ASO_{it} is the number of ASO created from university i at time t . This information has been collected from Netval (Network for the valorisation of public research) and is available from 2005 to 2011. We also know the number of ASO firms each university generated before 2005.

The main independent variables we test regard the funding channels of universities. This information is provided by MIUR (Ministry of Education) but is available, only from 2005 to 2009. We were able to divide public and third parties funding channels: $PUBINC$ is the total income received by university i at time t (in logarithm); $COMINC$ is the commercial income received by university i at time t (in logarithm).

Given the availability of information regarding ASO firms from 2005 to 2011, considering funding channels from 2005 to 2009, and given the usual approach to the effect of funding on technology transfer activities (Lawson 2013, Powers and McDougall 2005, O'Shea et al 2005), we decided to lag of two years our main independent variables. In this way reverse causality can be controlled.

Our longitudinal dataset includes observations of the 53 Italian public universities responding to the Netval questionnaire. The sample consists of 80% of the population of public universities. Public universities have been identified according to MIUR information and represent 65% of all Italian universities and more than 80% of all Netval respondent universities. We decided to concentrate on public universities to avoid selection bias.

TTO is a dummy variable that is equal to 1 if at university i at time t a TTO is in force, and 0 otherwise. Indication of the year of adoption of such regulation has been collected from MIUR. Indication of the year of constitution of such office has been collected matching information from MIUR and from the Netval surveys.

We then analyse the past experience of the university in dealing with the creation of ASO firms. $ASOSTOCK$ and $NOASO$ are two complementary time invariant variables; the former measures the accumulated number of ASO generated by university i before 2005 in

logarithm¹; the latter reports a value of 1 when the university did not create any ASO firm before 2005, 0 otherwise.

These two variables measure the experience of the university in dealing with the creation of ASO firms. Similar exercises have been done in respect to the propensity of scientists to apply for patents (Lawson 2012, Meissner 2011) and for ASO firms (O'Shea et al 2005). By including this measure we assume that the different experience in creating ASOs with which universities enter the interval of analysis is a main cause of unobserved heterogeneity and the inclusion of a pre-sample measure of the dependent variable allows us to control for such heterogeneity (Blundell et al 1995, Lawson 2012).

PATUNI measures the number of patents a university apply for in the time interval 2005-2009, extracted by priority date. As explained above literature indicates that those universities which are highly involved in patenting activities are also presumed to be more involved in the generation of ASO firms (Shane 2004). We collected this data from the Espacenet database, and we registered all the patent applications in which the university is an applicant at the European Patent Office (Popp 2005).

We then check if the scientific productivity (*SCIEPROD*) of a university has an influence on the propensity of a university to generate more ASOs. The variable is the result of the multiplication of the total number of publications the personnel of each university reported in a given year (from 2005 to 2009) and the average number of citations those published items received in the three following years. We gathered such information from the Thomson Reuters database. The two variables on which we built the index are the most diffuse in discussing scientific productivity (e.g. Lawson 2013, Agarwal and Henderson 2002, Fabrizio and Di Minin 2008, Powers and McDougall 2005).

We then also found literature evidence that the context of reference represents an important element affecting our dependent variable. Scholars noted that technology transfer activities are favoured in those contexts which show a higher level of innovative activities (Friedman and Silverman 2003). We therefore measured the number of patent applications undertaken in the region (NUTS 2) in which the university is localised as a proxy of regional innovativeness: *PATREG* is the logarithm of the number of patent applications at the EPO by the firms located in the region of the university i at time t . We obtained such data from Eurostat.

¹ Unfortunately we do not know the years of constitution of these ASOs and we are not able to create a more fine indicator of university experience

Finally, we included in the model some control variables. First, we controlled for the size of the various institutes: we inserted a variable named *SIZE* (in logarithm) which measures the number of tenured positions at each university in each year. Then we controlled for the presence in the university of a medical school, in literature this is highly related with the propensity to create spin-off (Shane 2004) (z_i). In addition, due to the different levels of industrial development in the Italian regions, we controlled for the localisation of the university (Baldini 2010). We therefore inserted a dummy time invariant variable, *SOUTH*, that would take value of 1 if the university is located in the southern regions of Italy, and 0 otherwise. These regions are considered less developed compared to the other regions. Finally we control for time specific effects by including variables x_{it} , while v_{it} is the error term.

Given the characteristics of our dependent variable, in which almost half of our observations report a 0 value, we estimate a zero inflated negative binomial model. This methodology allows us to separate the processes that generate positive value from the processes that generate zero values. The model includes a logit equation that tests the probability of observing zero as an outcome and a negative binomial equation that models the count outcomes.

In the first stage logit model we use as predictors the following variables: *ASOSTOCK* and *NOASO*. We believe, in line with innovation persistency literature (e.g. Peters 2009), that a main determinant in not generating spin-off is the total absence of such activity before the time interval taken into consideration. In other words, we test if the zero outcome in our dependent variable linked to ASO stock is an issue related to the total absence of ASO generation activity by the university or not.

The zero inflated model is preferred to a negative binomial because of the presence of excess zeros and it is preferred to a zero inflated Poisson regression because of the over-dispersion of our dependent variable. The zip and the vuong tests, checking for the best solution, confirm our choice. All regression results present robust standard errors. Finally, given that the variables often register high correlation coefficient we run a test for multicollinearity which revealed to reject the presence of multicollinearity (VIF mean equal to 2.94; with the highest value of 6.13).

Table 1: correlation matrix

	ASO	PUBINC	COMINC	TTO	ASOSTOCK	NOASO	PATUNI	SCIEPROD	PATREG
ASO									
PUBINC	0.3692								
COMINC	0.3019	0.7196							
TTO	0.33	0.1422	0.0342						
ASOSTOCK	0.4324	0.4297	0.4854	0.2729					
NOASO	-0.3694	-0.349	-0.3941	-0.279	-0.6654				
PATUNI	0.2087	0.4304	0.4165	0.1174	0.4598	-0.2661			
SCIEPROD	0.3413	0.7579	0.5711	0.2922	0.4489	-0.4928	0.3461		
PATREG	0.0812	0.2926	0.2747	-0.1125	0.307	-0.0585	0.3374	0.2101	
SIZE	0.3139	0.8747	0.7029	0.0751	0.3863	-0.3702	0.4083	0.7521	0.1981

4. Results

The first two specifications report the model presented in the above section. Specification (1) refers to the basic model in which we test the effect of research income, presence of TTO, experience of the university and technology transfer activity; in specification (2) we add the influence of the context and the scientific productivity of the university. From these two specifications we can see how the number of ASOs a university generates is positively and significantly influenced by the amount of public income received, whilst commercial income does not play a significant role. More specifically it emerges that an increase of 10% of public funding leads to an increase in roughly 4% the number of ASO firms created by such university. The results point to a very important role played by the public funding on the propensity of the university to create ASO firms.

We also find that the presence of a TTO and past experience in dealing with the ASO phenomenon plays a positive and significant effect. Although past experience is not correlated with the rate of ASO generation by universities that do spur ASO firms, we can note from the inflated part of the model that having generated ASOs before 2005 negatively influences the propensity of a university to create zero ASO in the time interval we analysed. Conversely the experience of the university in dealing with other technology transfer activities does not influence the propensity of a university to create ASO firms.

We also do not find any significant effect exerted by university scientific productivity. Our results contrast previous literature findings on the positive relationship between scientific

productivity and ASO generation, in both Anglo Saxon countries (Powers and McDougall 2005, Di Gregorio and Shane 2003) and in Italy (Baldini 2010). At the same time, however, our results do not reveal an opposite relationship: we simply find they are not related to each other.

In addition we find that the innovativeness of the context is negatively related with the propensity of a university to generate ASO firms. This result is partially in line with the results of Baldini (2010) who states that very rich regions are not the main context in which an ASO is generated. In other words, also taking into consideration the non correlation between ASO firms generation and university commercial income, it seems that in Italy the ASO phenomenon is a substitute for the collaboration with industry rather than a complementary activity. In order to strength this consideration we testes if the commercial income variable would prove significant when interacting with other variables: we did not find any significant effect. In particular we could expect a negative effect of the interaction between commercial income and the innovativeness of the context, but this interaction term did not prove relevant.

In other words we simply find that the commercial income of a university does not play a role in the propensity of a university to spur ASO firms, neither positive nor negative, nor in relations with other factors such as the innovativeness of the context. This consideration is also corroborated by other studies that highlight that in Italy ASO firms may often be the results of the willingness of young scholars, unsatisfied with their academic career, to leave the university and find an occupation related with their academic background (Rizzo 2012).

Other than interaction terms in the empirical exercise we also tested various non linear effects. We did not find any quadratic significant effect apart from the one referring to public income as reported in specifications (3) and (4). These two specifications replicate specifications (1) and (2) with the insertion of the squared value of the public income. We can note that the relationship between the public income and the propensity of the university to generate ASO firms has an inverted U-shape form. More specifically our results lead us to acknowledge that the effect of the public income is positive up to the value of 35.5 million euros. When a university receives as public income more than 35.5 million euros, the effect on the propensity of the university to spur ASO becomes negative. Such negative effect is present only for very large universities as the threshold at which public income become negative remain at the 88th percentile of our distribution. This result is complementary with the findings of Baldini (2010) who claims that very rich contexts are not the best ones for the

generation of ASOs. We can add to this claim that very rich universities in terms of public income received are not the ones which spur more ASOs. Only four universities (Bologna, Firenze, Torino, Roma Sapienza) received a public income higher than the threshold for all the five years of our time frame. And only 5 other universities for at least one year.

Finally the control variables SIZE and MED do not exert any significant effect. This latter element is in line with other studies which confirm that in Italy the medical schools are not the main drivers of the creation of academic spin-off (Baldini 2010).

Summing up we can state that university capacity in creating ASO firms is positively related to the amount of income received in form of public grant, both directly provided by the state to the university or by means of competition grants. This is true up to a certain threshold of very high value. Moreover we can state that there is no effect relating to the commercial income. That is, hypothesis H1a is not rejected, while hypothesis H1b is rejected.

The main result of this work points to a recognition that the phenomenon of ASO firms in Italy is quite unusual and considerably different from that most widely studied in the Anglo Saxon countries. In fact, not only is the relationship between the capacity of a university to create ASO and the source of income a university received peculiar, but other features also behave differently from what expected. By rejecting hypothesis H3b, H4 and H5 we saw that averagely agreed determinants of the ASO phenomenon mostly identified in the Anglo Saxon scenario do not hold in the Italian context.

Table 2: Zero inflated negative binomial regression analysis

	1	2	3	4
ASO				
PUBINC	0.355*** (0.129)	0.425*** (0.133)	4.364*** (1.507)	4.782*** (1.519)
COMINC	0.0034 (0.0842)	-0.0165 (0.0805)	0.0166 (0.0855)	-0.00437 (0.082)
PUBINC_SQ			-0.210*** (0.0776)	-0.228*** (0.0782)
NOASO	-0.397 (0.258)	-0.363 (0.246)	-0.361 (0.254)	-0.322 (0.242)
ASOSTOCK	0.103 (0.0825)	0.0979 (0.0806)	0.0793 (0.0806)	0.0755 (0.0789)
TTO	0.891*** (0.242)	0.680*** (0.25)	0.899*** (0.249)	0.707*** (0.25)
PATUNI	-0.00212 (0.0141)	0.00876 (0.0153)	-0.00236 (0.014)	0.00634 (0.0151)
PATREG		-0.114** (0.0575)		-0.104* (0.0564)
SCIEPROD		0.0935 (0.113)		0.0804 (0.125)
Control variables				
SIZE	-0.102 (0.173)	-0.246 (0.183)	-0.0432 (0.173)	-0.163 (0.185)
MED	0.239 (0.167)	0.161 (0.178)	0.176 (0.17)	0.0894 (0.179)
SOUTH DUMMY	Yes	Yes	Yes	Yes
YEAR DUMMIES	Yes	Yes	Yes	Yes
Inflate				
NOASO	-2.243 (2.041)	-2.021 (1.389)	-1.738 (1.47)	-1.577 (1.121)
ASOSTOCK	-22.06*** (1.235)	-19.91*** (1.456)	-33.26*** (1.03)	-41.83*** (1.064)
Wald chi2	81.89***	83.65***	81.02***	81.96***
Vuong	1.689**	1.785**	1.607*	1.687**
N	260	258	260	258

Robust standard errors in parenthesis

* p<0.1, ** p<0.05, *** p<0.01

4.1 Robustness check

In order to strengthen our analysis we conducted some robustness checks. We ran the same specifications through a negative binomial model. Results are very similar. We find positive and significant effect of the amount of public income on the probability of generating ASO firms up to a certain high value threshold. We do not find any effect of on the commercial income. The effect of the TTO is strongly significant and also the number of ASO generated before 2005 plays a significant and positive effect.

The only difference with the zero inflated negative binomial model regards the innovativeness of the context, which in this case is again negative but not significant. As in the previous regressions once again the number of academic patents and the scientific productivity of the university are not related to the propensity of universities to spur more ASO firms.

Table 3: Robustness check: negative binomial regression analysis

	1	2	3	4
ASO				
PUBINC	0.354*** (0.133)	0.395*** (0.137)	4.595*** (1.513)	5.083*** (1.535)
COMINC	0.0266 (0.0854)	0.00633 (0.0843)	0.0335 (0.0877)	0.0103 (0.0864)
PUBINC_SQ			-0.224*** (0.0779)	-0.246*** (0.079)
NOASO	-0.224 (0.212)	-0.195 (0.212)	-0.252 (0.216)	-0.225 (0.218)
ASOSTOCK	0.209** (0.0877)	0.209** (0.0871)	0.172** (0.0874)	0.172** (0.0865)
TTO	0.846*** (0.24)	0.664*** (0.253)	0.878*** (0.248)	0.709*** (0.253)
PATUNI	-0.00791 (0.0156)	-0.00296 (0.0161)	-0.00386 (0.0156)	0.00144 (0.0165)
PATREG		-0.0711 (0.059)		-0.0739 (0.0578)
SCIEPROD		0.106 (0.113)		0.102 (0.127)
Control variables				
SIZE	-0.076 (0.178)	-0.191 (0.189)	-0.0344 (0.176)	-0.145 (0.191)
MED	0.162 (0.163)	0.06 (0.177)	0.137 (0.164)	0.0388 (0.173)
SOUTH DUMMY	Yes	Yes	Yes	Yes
YEAR DUMMIES	Yes	Yes	Yes	Yes
Wald chi2	100***	98.78***	97.79***	98.27***
N	260	258	260	258

Robust standard errors in parenthesis

* p<0.1, ** p<0.05, *** p<0.01

5. Conclusions

The main result of our work is the acknowledgement that commercial income received by a university does not exert any effect on the propensity of that university to generate ASO firms. On the contrary public income is positively and significantly correlated up to a certain high value, to become negative afterwards. We moreover find that having experience in dealing with the ASO phenomenon is important for the university in not producing zero ASOs, and that setting up a TTO office positively influences the probability of a university to generate more ASO firms. We also find that university scientific productivity and patenting activity is not related with the propensity of a university to create ASO firms. Finally, the innovativeness of the context seem to be negatively correlated with the capacity of a university to spur ASO firms: however, the significance of the correlation is weak compared to the other variables tested.

The findings of this work seem to indicate that the ASO phenomenon in Italy is substantially different in respect to the other more widely studied contexts, such as Anglo Saxon ones. This study therefore contributes to an understanding of the heterogeneity of the ASO phenomenon across countries.

It has been shown that ASO firms in Italy tend to be service firms rarely exploiting patented technologies (Netval 2011), and their creation emerges as a substitutive effect of the collaboration with the external environment. Although further research is required to shed more light on this point, it seems that ASO firms in Italy represent a mechanism of technology transfer where firms and universities collaborate less.

This work is not without its limits. It represents a preliminary study of the determinants of the ASO firms at Italian university level: a more fine grained analysis with more detailed data on funding channels and faculty characteristics could strength the preliminary findings we put forth. In fact it would be interesting to distinguish the amount of block grant in respect to the amount of research grant gained through competition projects: in this way better knowledge of the influence of the public university expenditure would provide valuable information. Moreover further research would also test our hypothesis at the level of the different departments. Studies at department level, rather than at university level could lead to more precise results and indication (Rasmussen et al 2013).

However this work leads to important policy implications. In fact it contributes to understanding the characteristics of the ASO phenomenon in countries which are not fully endowed with entrepreneurial factors (Benneworth and Charles 2005). As a consequence the design and implementation of ad-hoc policies and not the replication of best practices that were successful in very different contexts (Rose 1991, Hospers and Beugelsdijk 2002), and in which the phenomenon is different in nature, may benefit the development of the phenomenon in question.

References

- Agrawal A., Henderson R. (2002), "Putting patents in context: exploring knowledge transfer from MIT", *Management Science* 48, 44-60
- Antonelli C. (2008), *The Localised Technological Change. Toward the economics of complexity*, Routledge, London and New York
- Baldini N. (2010), "University spin-offs and their environment", *Technology Analysis & Strategic Management* 22, 859-876
- Baldini N., Grimaldi R., Sobrero M. (2006), "Institutional changes and the commercialization of academic knowledge: A study of Italian universities' patenting activities between 1965 and 2002" *Research Policy* 35: 518-532
- Benneworth P., Charles D. (2005): "University spin-off policies and economic development in less successful regions: Learning from two decades of policy practice", *European Planning Studies* 13
- Blumental D., Campbell E.G., Causino N., Seashore Louis K. (1996), *The New England Journal of Medicine* 1734-1739
- Blundell R., Griffith R., van Reenen J. (1995) "Dynamic count data models of technological innovation", *Economic Journal* 105, 333-344.
- Czarnitzki D., Hussinger K., Schneider C. (2012), "The nexus between science and industry: evidence from faculty inventions", *Journal of Technology Transfer* 37, 755-776
- Chang YP, Yang P.Y. (2008), "The impacts of academic patenting and licensing on knowledge production and diffusion: a test of the anti-commons effect in Taiwan", *R&D Management* 38, 321-334
- Chiesa V., Piccaluga A. (2000), "Exploitation and diffusion of public research: The case of academic spin-off companies in Italy", *R&D Management* 30: 329-339
- Colyvas J., Crow M., Gelijns A., Mazzoleni R., Nelson R.R., Rosenberg N., Sampat B.N. (2002), "How do university inventions get into practice?", *Management Science* 48: 61-72
- Di Gregorio D., Shane S (2003), "Why do some universities generate more start-ups than others?", *Research Policy* 32
- Fabrizio K., DiMinin A. (2008), "Commercializing the Laboratory: Faculty Patenting and the Open Science Environment", *Research Policy* 37, 914-931
- Fontes M. (2005), "The process of transformation of scientific and technological knowledge into economic value conducted by biotechnology spin-offs", *Technovation* 25: 339-347
- Friedman J., Silverman J. (2003), "University technology transfer: Do incentives, management and location matter?", *Journal of Technology Transfer* 28: 17-30
- Gomez Gras J.M., Galiana Lopera D.M., Mira Solves I., Verdu Jover A.J., Sancho Azuar J. (2008), "An empirical approach to the organizational determinants of spin-off creation in European universities", *International Entrepreneurship Management Journal* 4:187-198
- Hospers G., Beugelsdijk S. (2002), "Regional cluster policies: learning by comparing?", *Kyklos* 55, 381-402

Hottenrott H., Thorwarth S. (2011), “Industry Funding of University Research and Scientific Productivity”, *KYKLOS* 64, 534--555

Krabel S., Mueller P. (2009), “What drives scientists to start their own company? An empirical investigation of Max Planck Society scientists”, *Research Policy* 38: 947-956

Lawson C. (2013), “Academic patenting: The importance of industry support”, in *Journal of Technology Transfer*, forthcoming

Lissoni F., Pezzoni M., Poti B., Romagnosi S. (2013), “University autonomy, IP legislation and academic patenting: Italy, 1996-2007” *Industry and Innovation*

Lockett A., Wright M. (2005), “Resources, capabilities, risk capital and the creation of university spin-out companies”, *Research Policy* 34: 1043-1057

Lockett A., Siegel D., Wright M., Ensley M.D. (2005), “The creation of spin-off firms at public research institutions: Managerial and policy implications” *Research Policy* 34, 981–993

Meissner C. (2011), “Academic Patenting: Opportunity, Support or Attitude?”, LEI and BRICK working paper

Muscio A., (2010), “What drives the university use of technology transfer offices? Evidence from Italy” *Journal of Technology Transfer* 35, 181–202

Netval (2008), V Rapporto Netval sulla Valorizzazione della Ricerca nelle Università Italiane, downloaded from <http://www.netval.it>

Netval (2011), VIII Rapporto Netval sulla Valorizzazione della Ricerca nelle Università Italiane, downloaded from <http://www.netval.it>

Nosella A., Grimaldi R. (2009), “University-level mechanisms supporting the creation of new companies: an analysis of Italian academic spin-offs”, *Technology Analysis & Strategic Management*, 21:6, 679-698

O’Shea R.P., Allen T.J., Chevalier A., Rochea F. (2005), “Entrepreneurial orientation, technology transfer and spinoff performance of U.S. universities” *Research Policy* 34 994–1009

O’Shea R.P., Chugh H., Allen T.J. (2008), “Determinants and consequences of university spinoff activity: a conceptual framework”, *Journal of Technology Transfer* 33, 653–666

Peters B. (2009), “Persistence of innovation: stylised fact and panel data evidence”, *Journal of Technology Transfer* 34, 226-243

Powers J.B., McDougall P.P. (2005), “University start-up formation and technology licensing with firms that go public: a resource-based view of academic entrepreneurship”, *Journal of Business Venturing* 20: 291-311

Proton Europe (2010), Proton Europe Annual Survey, 2009. www.protoneurope.org

Rizzo U. (2012), “Why do scientists create academic spin-offs? The influence of the context.”, Paper presented at the Third International Workshop on Entrepreneurship, Culture, Finance and Economic Development, Namur, Belgium, 15th June 2012

Rizzo U., Ramaciotti L. (2012), “The determinants of academic patenting at Italian universities”, paper presented at the Innovation Dynamics workshop, Braga, Portugal

Roberts E.B., Malone D.E. (1996), “Policies and structures for spinning off new companies from research and development organizations” *R&D Management* 26

- Rose R. (1991), "What is lesson-drawing?", in *Journal of Public Policy* 11, 3-30
- Shane S. (2001), "Technological Opportunities and New Firm Creation", *Management Science* 47(2): 205-220
- Shane S. (2004), *Academic entrepreneurship: University spin-offs and wealth creation*, Edward Elgar, Cheltenham
- Siegel D.S., Waldman D.A., Atwater L.E., Link A.L. (2003), "Commercial knowledge transfers from universities to firms: improving the effectiveness of university–industry collaboration" *Journal of High Technology Management Research* 14 111–133
- Vincett P.S. (2010), "The economic impacts of academic spin-off companies, and their implications for public policy", in *Research Policy* 39, 736–747
- Wright M., Vohora A., Lockett A. (2004) "The Formation of High-Tech University Spinouts Through Joint Ventures of the" *Journal of Technology Transfer* 29 287-310.
- Wright, M.; Clarysse, B.; Mustar, P. Lockett, A. (2007). "Academic Entrepreneurship In Europe"
- Zucker L.G., Darby M.R., Brewer M.B. (1998), "Intellectual human capital and the birth of U. S. biotechnology enterprises", *American Economic Review*, 88, 290-336
- Zucker L.G., Darby M.R., Armstrong J.S. (1998), "Geographically localized knowledge: Spillovers or markets?", *Economic Inquiry* 36, 65-86