"Is there a gender gap in research spin-offs financing? The signalling effect of the entrepreneurial team composition"

Lauto, Giancarlo
Udine University
giancarlo.lauto@uniud.it

Salvador, Elisa
ESSCA School of Management
elisa.salvador@essca.fr *corresponding author*

Visintin, Francesca
Udine University
francesca.visintin@uniud.it

Résumé : La vaste littérature sur les entreprises spin-off de la recherche a examiné diverses dimensions du phénomène, notamment la création, le développement et la croissance. Cependant, aucune étude n'a abordé la discrimination entre les sexes dans le financement. Alors que le contexte des entreprises spin-off de la recherche pourrait atténuer les différences entre les hommes et les femmes en tant que entrepreneurs universitaires, nous soutenons que les investisseurs associent la présence des femmes dans l'équipe entrepreneuriale comme un signal négatif pour la décision de financement. Une analyse effectuée sur un échantillon de 239 entreprises spin-off de la recherche italienne révèle qu'une présence croissante des femmes dans l'équipe entrepreneuriale et une plus grande diversité des genres sont associées à une moindre probabilité d'obtenir un financement externe. La présence d'une université en tant que *stakeholder* augmente la pénalité pour les entreprises spin-off de la recherche auxquelles participent les femmes.

Mots-clés : Entreprises spin-off de la recherche ; Entrepreneuriat académique; Transfert de technologie; Signalisation; Discrimination fondée sur le genre.

Abstract: The extensive literature on research spin-offs has examined various dimensions of the phenomenon, including creation, development, and growth. However, no studies have addressed gender discrimination in financing. While the context of research spin-offs might

smoothen the differences between male and female academic entrepreneurs, we argue that investors associate the presence of women into the entrepreneurial team as a negative signal for the financing decision. An analysis carried out on a sample of 239 Italian research spin-offs reveals that a growing presence of women in the entrepreneurial team and a higher gender diversity are associated with a lower likelihood to obtain external funding. The presence of a university as a stakeholder increases the penalty for spin-offs participated by women.

Keywords: Research spin-off firms; Academic entrepreneurship; Technology transfer; Signalling; Gender-based discrimination.

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1. INTRODUCTION

According to the latest World Economic Forum annual report (2017: vii) "*the gaps between women and men on economic participation and political empowerment remain wide*". Depending on the circumstances, gender discrimination has been described as puzzling (Cole & Zuckerman, 1984) or hidden (Carter et al., 2007). The debate about the existence or not of a more or less deep gender discrimination is still a tricky matter, even with regard to the business sector. The role of gender in entrepreneurship is receiving increasing attention (Brush et al., 2006; De Bruin et al., 2006), insomuch specialized journals exist (e.g., International Journal of Gender and Entrepreneurs) and women-owned businesses have been recently described as a growing entrepreneurial segment (Brush & Cooper, 2012). Much of this literature focuses on how men's and women's different resource endowments and cognitive models impact on the early stage of opportunity recognition and, more in general, on company start-up and development.

As financial resources are among the most critical resources for the success of entrepreneurial activity, the literature has paid a great effort to ascertain whether women entrepreneurs are penalised in the access to finance. While there is little proof of a real discrimination issue (Orser et al., 2006; Verheul & Thurik, 2001), empirical evidence clearly shows gender differences in entrepreneurs' access to financial capital (Brush et al., 2004, 2006; Alsos et al 2006; Carter et al 2007; Brush & Cooper, 2012).

Notwithstanding the significant importance of high-tech start-ups in driving countries' economic growth (Nesheim, 2000; Colombo & Grilli, 2010), and the evident underrepresentation of female entrepreneurs in high-tech industries (Tan, 2008), very little evidence has been collected about a gender funding gap in these industries (Becker-Blease, Sohl, 2007). In particular, to our knowledge, no study has been carried out on research spin-offs (RSOs). Indeed, much of the scholarship on RSOs has focused on aspects related to the

creation, growth, and development of RSOs (e.g. Shane, 2004; Mustar et al., 2006; Wright *et al*., 2007; Van Geenhuizen & Soetanto, 2009; Bathelt et al., 2010; Benghozi & Salvador, 2014; Rasmussen & Wright, 2015), neglecting this topic that has instead received much attention with regard to low- and medium-technology based firms.

One possible reason may be that one does not expect that the world of scientific knowledge from which RSOs come from could be influenced by gender discriminations given that the reasons typically ascribed to explain the funding gender gap (structural barriers, human capital differences, and strategic choices, see Greene et al. 2001) appear to characterize the whole group of the academic community in comparison to other types of entrepreneurs rather than the sub-groups of male and female academic entrepreneurs. As reported by Ndonzuau et al. (2002), three factors limit academics in their technology transfer activities: 1) the 'publish or perish' rule, as the early publishing of the scientific results, necessary for career purposes, discloses all the novel contributions before the product/process launch, therefore, reducing its economic value (strategic choice); 2) academics appear to have an ambiguous relationship with money as they are more interested in funding for the purpose of carring out further research rather than for the exploitation of the research results on the market (strategic choice); 3) pursuing profit oriented applications is often perceived as a 'betrayal of science' (strategic choice). Further, academics operating in the hard sciences (the ones that more often produce scientific results that could have a market application), typically lack even basic management and marketing skills (human capital), do not have a practical commercial orientation (human capital) and do not belong to the business and financial networks that could support in the identification of market opportunities, collection of appropriate resources (including human and financial), and company set up and development (structural barriers).

As Raina (2016: 3, 4) has recently argued "*VC-financed tech startups are different from the general workforce. Your typical small business is not a future Uber or Facebook. Tech startups imply a science and engineering focus, two fields that are known to be less popular with women*". And "*there is no meaningful difference in the success rates of female and male-led startups when they are financed by VCs with women partners*".

By drawing on the established literature, therefore, one would not expect to find a funding gender gap in research spin-offs (RSOs).

More recently a number of works have put forward that also signalling mechanisms could impact on the financer-entrepreneur relationship, by favouring those entrepreneurs that best succeed in employing signals perceived to reduce the information asymmetry between the two parties. Extent and prestige of education, acquaintances, previous business experiences are only some among a large number of signals that are employed to convey a message of success.

In this paper, we apply signalling theory (Spence, 1974) to build and test hypotheses about a funding gender gap in RSOs. As it will be better explained in Section 3, we argue that due to the "Matthew effect" (Merton, 1968, 1988; Beaudry & Larivière, 2016) characterizing the scientific world, whereby male academics are in a better position to signal the scientific and original value of their research and therefore have easier access to funding rather than female academics, RSOs led by women present proportionally a lower access to external funds than male-led companies.

Further, as RSOs represent a specific case of knowledge-intensive firm because of the presence of a parent institution that can actively operate in order to support the commercial viability of these firms (Salvador & Benghozi, 2015; Meoli & Vismara, 2016), we put forward that the presence of the parent university among the shareholders can itself represent a signal to external financers and mitigate the previously mentioned bias against female academic entrepreneurs.

The purpose of this paper is therefore twofold. First, we aim at ascertaining whether a gender bias with regard to the access to finance also exists in RSOs. Second, we explore whether the engagement of the parent institution in the RSOs as a financial partner affects gender-based differences in the access to finance.

The results of our analysis revealed the existence of gender discrimination towards RSOs in which women are part of the entrepreneurial team.

This article is organised as follows: Section 2 develops the theoretical framework. We examine the causes of gender bias in external financing decisions with specific regard to the case of RSOs; specifically, we take the theoretical perspective of the signalling theory. Section 3 presents the research design, description of variables, descriptive statistics and correlations. Section 4 illustrates the results of the analysis with descriptive statistics and

regression analysis outcome. Finally, Section 5 provides discussion and some concluding remarks.

2. THEORETICAL FRAMEWORK

2.1 Causes of gender bias in external financing decisions

Resourcing is a critical stage of the entrepreneurial process, with specific regard to financial resources given their function of enabling the acquisition of other kinds of resources. Both in traditional and in new technology-based firms, financing affects key dimensions of the development of the firm, such as survival, earnings, and growth (Alsos et al., 2006).

Financing of entrepreneurial ventures takes place through multiple channels, which are typically activated in subsequent stages of the firm life cycle. The literature emphasises that ventures favour bootstrapping (i.e., creative forms of financing and minimisation of financing needs) and the acquisition of personal, family, and friends' funds over bank loans and equity, especially in their early stages (Watson & Wilson, 2002). Equity financing is typically offered by venture capitalists or "angel investors", who provide capital in exchange for shares of the firm (Berger & Udell, 2003; Ebben & Johnson, 2006).

Empirical evidence shows the existence of a funding gap for women entrepreneurs (Brush et al. 2004, 2006; Brush & Cooper, 2012). Among many others, Alsos et al. (2006) found that Norwegian women entrepreneurs obtained significantly less financial capital, both regarding loans and equity, to develop their firm and that those firms experience a lower early growth compared to men-led businesses. Acs et al. (2011) underlined the role played by access to finance as a main constraint explaining the lower proportion of women engaged in entrepreneurship.

The reasons are ascribed in the literature to several causes among which, the most significant appears to be the following ones. Women tend to be less endowed with specific resources that are valuable in a new venture, such as previous entrepreneurial experience and financial capabilities (Carter et al. 2003). Further, entrepreneurial activities seem to be perceived as a male-dominated field (Alsos et al., 2006). De Bruin et al. (2006) put forward that women are often perceived as less capable and less entrepreneurial than men: this sometimes leads to affirming that women should not be entrepreneurs at all and to associate primarily entrepreneurial activities to men. This way of thinking is associated with the perception that women are expected to stay at home to care for family responsibilities (De Bruin et al., 2006).

Also, there tends to be a systematic preference of male and female entrepreneurs for specific industries, which are related to different education preferences, while high-tech high-growth industries typically see a proportionally lower presence of women (Sullivan & Meek, 2012; Becker-Blease & Sohl, 2007).

Furthermore, women may show a lesser interest in the firm growth, especially when growth is traded for control (Cliff, 1998; Davis & Shaver, 2012). This may explain the lesser interest of women in seeking finance from business angels (Becker-Blease & Sohl, 2007). Moreover, the literature on risk-taking suggests that women are more risk-averse than men (Croson & Gneezy, 2009), and may refrain from investments that could be conducive to growth although risky. Therefore, the expected risk and earnings of women-led ventures are lower compared to men's, diverting the interest of investors. However, the attitudes to the growth of highly educated female entrepreneurs do not differ from those of men (Welter, 2006).

As mentioned in the introduction, the aforementioned causes appear to be less prominent in the RSOs world. Indeed, academics, both male and female, particularly those from the hard sciences, tend to share the same weakness usually ascribed to female entrepreneurs. Not only they lack business competencies and are scarcely risk-oriented, but they are also typically outside of the networks of financers. Further, RSOs are usually founded to collect research funds or to employ PhD students that are not hired by universities, rather than in order to pursue profits and high-growth strategies. Finally, the vast majority of RSOs are founded, both by male and female academics in high-tech sectors (Wright et al., 2004; Vohora et al., 2004; Colombo, Piva, 2012; Tietz, 2013), therefore the structural barriers mentioned above should not apply.

On the basis of the existing literature, therefore, one should not expect to find gender funding gaps within RSOs. However, as it will be explained in the next section, the use of signalling theory leads to the opposite conclusion.

2.2. The gender-bias in financing RSOs

An extensive scholarship has examined the issue of access to external sources of finance, i.e., bank loans and equity (Brinckmann et al., 2011) and a review of all the fields of research on this topic goes beyond the scope of this work. The point of departure of most of the existing literature is the observation that the relationship between a firm – especially new ventures bringing an innovation to the market – and external investors is characterized by information

asymmetry about the actual potential value of the business (Jain et al., 2008), the nature of the firm's assets (Gompers & Lerner, 2004), and the commitment of the entrepreneurial team (Busenitz et al., 2005; Prasad et al., 2000). Indeed, entrepreneurs control information about the unobservable features of their venture, such as its economic potential, which investors cannot access. The investment decision is therefore surrounded by high uncertainty. Investors address this problem by staging their investment so that further rounds of funding are provided if the firm reaches predefined targets (Barry et al., 1990) or by preferring firms that combine tangible and intellectual assets, as the former are valuable even if the innovation proves unsuccessful (Gompers & Lerner, 2004).

Moreover, investors adopt specific heuristics to appreciate the viability of a venture. Among other approaches addressing the issue of information asymmetry, signaling theory (Spence, 1974) is gaining momentum in entrepreneurial finance to further the understanding of the relationship between firms and investors about the funding decision (Jain et al., 2008; Ozmel et al., 2013; Prasad et al., 2000). According to this perspective, investors seek specific pieces of information that the firm may disclose to assess the quality of the business. Investors tend to make more extensive use of signals that are observable, disregarding weak signals and tend to consider more credible those that are more expensive to gather (Connelly et al., 2011). On the other side, the firm controls private information that is not accessible to the investor, and may strategically communicate it to convey organisational attributes that are correlated with the underlying characteristics that are relevant to the decision maker (Kirsch et al., 2009). Entrepreneurs are incentivised to offer credible information about the firm, as it reduces the investor's uncertainty and lowers the cost of the financing.

There is a large body of evidence that supports the argument that male academics are in a better position than female academics in signalling to financers the value of their research and human capital. While the Mertonian norm of universalism, whereby the research achievement of scientists are assessed irrespective of their personal characteristics, it has been shown that those academics that are more renown tend to receive a disproportionate number of citations and rewards[1] - the so-called "Mathew effect". As this phenomenon appears to favour male

[1] "*Eminent scientists get disproportionately great credit for their contributions to science while relatively unknown scientists tend to get disproportionately little credit for comparable contributions*" (Merton, 1968: 57). The selection process to concentration in the hands of those who are better known, all expressed in "*the principle of cumulative advantage that operates in many systems of social stratification to produce the same result: the rich get richer at a rate that makes the poor become relatively poorer*" (Merton, 1968: 62).

academics, in 1993, Rossiter named it as the "Matilda effect". Several later studies produced a substantial amount of support for this effect both with regard to citations and projects funding (Rossiter, 1993; Heilman & Haynes, 2005; Lincoln et al., 2012). Research on academic communities finds that male scholars are more likely to achieve higher rankings (e.g. full professorship, department directorship) and therefore to have more opportunities to interact with industry, to have access to research funding (Bozeman & Gaughan, 2011; Bozeman et al., 2013; Link et al., 2007; Thursby & Thursby, 2005). In particular, Frietsch et al. (2009) highlight that even if the percentage of female professors vs male ones employed at universities has increased, it is still true that "*the higher the academic degree or position, the lower the share accounted for by women*". This is shown in the well-known phenomenon of the "leaky pipeline", meaning a decrease in number of women in high steps of the ladder.

Importantly, Beaudry & Larivière (2016) show that researchers that publish with a higher proportion of female co-authors are less cited than academics collaborating mostly with male co-authors. In other words, the Matilda effect goes as far as to be detrimental to the scientific reputation of their male colleagues, as suggested by the lower citation-rate.

Although the existing literature has not addressed the gender gap in the financing of RSOs[2], for all the above reasons we can argue that:

Proposition-1: RSOs whose entrepreneurial team is controlled by men are more likely to access external funding than those controlled by women.

The existing literature has focused on firms that are either solely male- or female-owned (e.g. Gicheva & Link, 2013), disregarding the effects of the composition of the entrepreneurial team. To this purpose, the features of top management teams greatly influence the decision-making processes and the strategic posture of firms, especially the smaller and newer ones (Ensley & Hmieleski, 2005). Scholars have investigated the effects of the heterogeneity of the entrepreneurial teams in RSOs and high technology firms, examining particular aspects such as education and professional background (e.g. Visintin & Pittino, 2014). Gender diversity, instead, is much less explored, despite this demographic feature carries a signalling role for investors, given the aforementioned differences between men and women regarding resources and attitudes. Such difference may trigger a cognitive conflict stimulating a more thorough

[2] Only a work refers to the phenomenon, namely Gicheva & Link (2013) studied technology-based firms that developed a project funded by the American National Institutes of Health, finding that women-led firms are 16% less likely to attract private funding.

examination of strategic alternatives and the activation of organisational learning processes that enable flexible reactions to complex problems. Therefore, gender heterogeneity is expected to contribute to innovative outcomes in ill-defined contexts (Herring, 2009). Furthermore, the presence of women in the entrepreneurial teams may indicate a more inclusive and collaborative organisational culture (Dwyer et al. 2003; Dezso & Ross, 2011). However, contrary to the expectations, Quintana-García and Benavides-Velasco (2016), find that American dedicated biotechnology firms with a diverse top management team were penalised in accessing external financing through an initial public offer. The authors explain the divergence of their results with the theoretical expectations and previous empirical findings (e.g. Krishnan & Parsons, 2008; Welbourne et al., 2007) by noticing that the biotechnology industry is male-dominated: by relying on social identity theory, they put forward that the minority group is expected to receive more negative evaluations compared to the majority one, and such penalty is more pronounced when the minority group is women.

It is therefore possible to expect:

Proposition-2: The gender heterogeneity of the entrepreneurial team hinders an RSO to access external funding.

Parents institutions may enact multiple strategies to support RSOs, including the offering of technology transfer services, the use of the institution's brand, and the provision of capital. Typically, the parent institution operates an assessment of the scientific and commercial viability of the RSO before granting such support. Increasingly strict criteria of evaluation are adopted to provide more sophisticated and expensive forms of support.

From a signalling theory perspective, the parent institution reduces the uncertainty surrounding the RSOs by providing resources and legitimacy.

Therefore, we expect

Proposition-3: The presence of the parent institution among the shareholders of an RSO enables the access to external funding.

It is an empirical matter to ascertain if the support of the parent institution offsets the penalty associated with the gender gap, or if this gap persists even in the presence of the institution's support. One of the aims of our empirical analysis is to offer evidence about this relationship.

3. RESEARCH DESIGN

3.1 Sample and data

The empirical study was conducted on a dataset of Italian academic spin-offs. The initial sample consisted of all the spin-offs included in the list of NetVal (Netval is the Italian University Network for the Valorisation of Research, see http://www.netval.it) and consisted of 899 companies. Data were collected in September 2015 through phone interviews by means of a structured questionnaire, and we obtained 239 valid responses (i.e., a response rate of 27% in line with comparable research projects, e.g. Criaco et al. 2014). The questionnaire aimed to collect information on the composition of the founding teams, the means of financing, the strategic posture and the extent of investments in R&D. Further data on employees and turnover were withdrawn from the Bureau Van Dijk database.

3.2 Description of variables

The outcome of our analysis is the binary variable *External funding*, that takes value 1 if the RSO has among its shareholders an individual (e.g. business angel), financial institution (e.g. venture capitalist or a bank), or a firm (i.e. industrial partner), and 0 otherwise.

The main explicative variables are *Share of women* and *Gender concentration*. The former captures the percentage of women in the entrepreneurial team of the RSO, and therefore ranges from 0 (all-male entrepreneurial team) to 1 (all-female team). Following Quintana-García and Benavides-Velasco (2016), we calculate *Gender concentration* with the formula concentration= $\Sigma\ Si^2$, where S_i is the proportion of the entrepreneurial team in the i^{th} gender; being the genders two, the variable takes the minimum value of 0.50, indicating an entrepreneurial team evenly distributed between the genders, and the maximum of 1, indicating that a single gender is represented in the team. The binary variable *University participation* takes value 1 if a university owns a stake in the capital of the RSO, and 0 otherwise.

We consider a further set of variables that we introduce as controls in the regression analysis.

First, we consider the size of the entrepreneurial *Team*. This variable is relevant because larger teams offer the opportunity for increasing the heterogeneity of members; however, with the increase of the size of the team the possibility of detrimental personal conflict may arise. For this reason, in the regression model, we consider the quadratic effect of the standardised variable.

Turnover expresses the maximum value of turnover generated by the RSO during its existence. The relationship between turnover and access to external capital is twofold: from one side, investors may find initiatives with growth and profit potential as more appealing; on

the other side, the financial resources provided by external investors may trigger the growth of an RSO. We standardise the variable before introducing it into the regression, to improve readability. We gathered the data for this variable from the Bureau Van Dijk database.

As female entrepreneurship tends to specialise in specific fields, and industries vary in their attractiveness for investors, we consider the *Industry* in which an RSO operates. The variable considers six broad sectors, defined according to the NACE classification. The firsts category includes the RSOs operating in low and medium low technologies, such as Agriculture, Manufacturing, Trade and Repair (NACE code up to 50 and 95); the second focuses on ICT: Computer programming, consultancy and related activities and Information service activities (NACE 62 and 63); the third groups together management consulting and training (NACE 70, 73, 82, 85, 88); the fourth category contains architectural and engineering activities and technical testing (NACE 71); the fifth considers and scientific R&D (NACE 72); finally, the sixth is residual and considers other professional scientific and technical activities and those related to human health (NACE 74, 86).

We account for territorial differences in the financial opportunities for RSOs by considering the *Area* in which the firm is based. We distinguish four Areas that are homogeneous in terms of industrial and social structure and development of the financial system: North-West; North-East; Centre; South.

The variable *Age of the firm* expresses the number of days between the establishment of the RSO and the date of the survey. This variable is relevant to account for the length of the process of identification and negotiation of a deal with a potential investor. We gathered the data for this variable from the Bureau Van Dijk database.

Finally, *Strategy* appreciates the positioning of the firm between specialisation R&D and technology development and manufacturing and commercialisation of a product. Specifically, through the questionnaire, we asked our informant to report the percentage of activity that the firm devotes to manufacturing and commercialisation. The strategy of the firm has a two-fold relationship with financing: it defines the risk profile of the initiative and the expected returns, therefore influencing the appeal for investors; on the other hand, firms that benefit from external funding can engage in more resource-consuming strategies.

3.3 Descriptive statistics and correlations

Table 1 reports the descriptive statistics of the variables considered in the analysis and Table 2 presents the correlation coefficients. The correlation coefficients between the independent

variables are below 0.40 except the case of *Age of the firm* and *Turnover* (0.56). As this result is accompanied by value of VIF below the threshold of 10 in each regression variable, it is possible to consider that the results of the regression analysis are not affected by multicollinearity.

Table 1 – Descriptive statistics on analytical variables

Variable	Mean	Std. Dev.	Min	Max
1. External funding[1]	0.5565	0.4978	0	1
2. Share of Women	0.2180	0.2899	0	1
3. Gender concentration	0.8265	0.2111	0.5	1
4. University participation[1]	0.3222	0.4683	0	1
5. Team[2]	3.6569	1.6007	1	8
6. Turnover[2]	419,378	475,032	0	2,230,811
7. Industry-1[1]	0.1464	0.3543	0	1
8. Industry-2[1]	0.1883	0.3918	0	1
9. Industry-3[1]	0.0669	0.2505	0	1
10. Industry-4[1]	0.1255	0.3320	0	1
11. Industry-5[1]	0.3640	0.4822	0	1
12. Industry-6[1]	0.1088	0.3120	0	1
13. Area-NW[1]	0.2636	0.4415	0	1
14. Area-NE[1]	0.2469	0.4321	0	1
15. Area-C[1]	0.2594	0.4392	0	1
16. Area-S[1]	0.2301	0.4218	0	1
17. Age of the firm	2057	971	342	5384
18. Strategy	0.5415	0.3126	0	100

Observations: 239

[1]Categorical variable; mean indicates the percentage of cases falling into a given category.

[2]A standardised version of the variable is introduced in the regression analysis.

Table 2 – Table of correlations

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	1.00																	
2	-0.13	1.00																
3	0.18	-0.58	1.00															
4	0.13	0.07	-0.12	1.00														
5	-0.21	0.17	-0.40	0.09	1.00													
6	0.11	-0.17	0.07	0.02	-0.09	1.00												
7	0.13	-0.08	0.11	-0.01	-0.13	0.12	1.00											
8	-0.11	-0.19	0.15	-0.01	0.02	0.09	-0.20	1.00										
9	-0.03	0.06	0.07	0.07	-0.05	-0.04	-0.11	-0.13	1.00									
10	0.01	-0.07	0.01	-0.05	-0.03	0.01	-0.16	-0.18	-0.10	1.00								
11	-0.01	0.20	-0.22	0.00	0.00	-0.11	-0.31	-0.36	-0.20	-0.29	1.00							
12	0.01	0.04	-0.05	0.02	0.18	-0.07	-0.14	-0.17	-0.09	-0.13	-0.26	1.00						
13	0.06	0.02	0.05	-0.15	-0.11	0.07	0.16	0.03	-0.01	-0.03	0.00	-0.18	1.00					
14	-0.11	-0.15	0.13	0.06	-0.06	0.09	-0.02	0.17	-0.11	-0.01	-0.09	0.05	-0.34	1.00				

15	0.03	0.12	-0.22	0.06	0.14	-0.06	-0.08	-0.16	0.11	0.01	0.05	0.13	-0.35	-0.34	1.00			
16	0.03	0.01	0.03	0.03	0.03	-0.10	-0.06	-0.03	0.01	0.03	0.04	0.00	-0.33	-0.31	-0.32	1.00		
17	0.09	-0.21	0.15	-0.02	-0.19	0.56	-0.02	0.22	0.03	0.16	-0.18	-0.17	0.02	0.17	-0.19	0.00	1.00	
18	0.11	0.05	0.02	-0.01	0.05	0.12	-0.12	0.08	0.15	-0.05	-0.13	0.16	0.03	-0.03	0.13	-0.13	0.08	1.00

4. RESULTS

We investigate the existence of a gender gap in the external funding of Italian RSOs, in two steps: after examining the descriptive statistics on the results of the survey, we present the outcome of the logistic regression analysis.

4.1 Descriptive statistics

4.1.1 Gender heterogeneity of the entrepreneurial team

Not surprisingly, an entrepreneurial team typically controls the ownership of the RSOs in our sample, although we find 19 cases (7.95%) of single-ownership. The team size ranges from 2 to 8 people, with a median value of 4. The presence of men characterizes the entrepreneurial teams (Table 3): in 128 (53.56%) RSOs, the entrepreneurial team is composed only of men; in an additional 21.77% of cases, women control up to the 33% of the shares of the RSO – constituting therefore a "symbolic" presence. Only in the 23.01% of the firms, women control at least 50% of the capital; of these, 11 cases (4.60%) are women-only RSO. These data suggest characterizing the field of Italian RSOs as "male-dominated".

Table 3 – Distribution of share of capital controlled by women.

Share of women capital	Frequency	Percentage	Cumulated percentage
0	128	53.56	53.56
13	1	0.42	53.97
17	8	3.35	57.32
20	7	2.93	60.25
25	15	6.28	66.53
29	1	0.42	66.95
33	20	8.37	75.31
38	1	0.42	75.73
40	3	1.26	76.99
50	26	10.88	87.87
60	4	1.67	89.54
67	5	2.09	91.63

75	1	0.42	92.05
80	5	2.09	94.14
83	3	1.26	95.40
100	11	4.60	100.00
Total	239	100.00	
RSOs with women	111	46.44	

Interestingly, the share of capital controlled by women tends to increase with the size of the entrepreneurial team (Table 4), suggesting that RSOs requiring a more articulated entrepreneurial team also value gender diversity.

Table 4 – Relationship between size of entrepreneurial team and ownership by women.

Size of entrepreneurial team	Frequency of size of entrepreneurial team	Percentage of size of entrepreneurial team	Mean of share of capital controlled by women	Std. dev. share of capital controlled by women
1	19	7.95	15.79	8.59
2	48	20.08	15.63	4.25
3	48	20.08	20.79	4.40
4	49	20.50	20.91	3.45
5	38	15.90	26.32	5.18
6	33	13.81	31.27	4.13
7	1	0.42	29.00	.
8	3	1.26	25.33	7.22

It is important to notice that in 104 out of 111 cases of RSOs with a female presence, all the women in the entrepreneurial team are academics. Anyhow, the characterization of the professional background does not seem to be affected by the gender, as in 207 cases out 228, all the men in the entrepreneurial team are academics. If there are non-academic men, there is usually only one.

In our sample, RSOs tend to specialize in services related to scientific research and development and in the industries of ICTs; however, the presence of low-technology industries is not negligible. Table 5 suggests that the presence of women tends to be noticeably more intense in some industries, namely scientific research and development services (Industry-5) and professional and human health activities (Industry-6).

Table 5 – Ownership of women across industries.

	Frequency (%) of RSO	Mean (S.D.) of capital owned by women	Median capital owned by women
Industry-1	35 (14.64)	16.09 (4.71)	0
Industry-2	45 (18.83)	10.56 (3.06)	0
Industry-3	16 (6.69)	28.63 (9.85)	0
Industry-4	30 (12.55)	16.63 (4.35)	0
Industry-5	87 (36.40)	29.39 (3.24)	25.00
Industry-6	26 (10.88)	25.31 (5.94)	18.50

4.1.2 Patterns of access to external funding

The majority (55.65%) of the RSOs in our sample finance themselves exclusively with resources of the entrepreneurial team: obtaining external funding is not an obvious step in RSOs life-cycle. Table 6 suggests the existence of a pattern between the presence of women in the entrepreneurial team and external financing: the 60.90% of the RSOs with external investors have only men in their entrepreneurial team, while the 44.34% of those without external funding are controlled only by men. In other words, among the RSOs with the presence of women, those that do not access to external funding prevail, while the opposite characterizes those without presence of women. Indeed, on average, women control 18.37% of externally funded RSOs and 26.09% of those without external funding (median 0% and 20% respectively).

Table 6 – Relationship between access to external funding and presence of women.

	Absence of women	**Presence of women**	**Total**
Without external funding	47	59	106
Row	44.34	55.66	100.00
Col	36.72	53.15	44.35
With external funding	81	52	133
Row	60.90	39.10	100.00
Col	63.28	46.85	55.65
Total	128	111	239
	53.56	46.44	100.00
	100.00	100.00	100.00

External financing seems to be a resourcing pattern that may, but not necessarily does, combine with funding from the parent university. Indeed, Table 7 suggests that receiving funding from a university institution is not taken for granted for the RSOs in our sample, as only less than one-third them does so. RSOs may combine university and external financing (20.91% of the cases) or benefit from each funding channel separately (34.72% only external funding; 11.30% only university funding). Importantly, one-third of the RSOs in our sample does not access to either funding source, indicating a possible structural financial weakness.

Table 7– Relationship between access to external funding and university funding.

	Without external funding	**With external funding**	**Total**
Without university funding	79	83	162
Row	48.77	51.23	100.00
Col	74.53	62.41	67.78
On the total	33.05	34.72	67.78
With university funding	27	50	77
Row	35.06	64.94	100.00
Col	25.47	37.59	32.22
On the total	11.30	20.92	32.22
Total	106	133	239
	44.35	55.65	100.00
	100.00	100.00	100.00

With regard to the gender differences, we find that a slight prevalence of university financing for RSOs that include women in the entrepreneurial team over those only with men (36.94% vs 28.13%).

The descriptive statistics seem to indicate different patterns in the access to university and external funding of RSOs that feature women in their entrepreneurial team. In order to assess the relationship controlling for possible spurious effects, we conduct a regression analysis.

4.2 Regression analysis

To ascertain the association between the composition of the top management team, the participation of a research organisation as a shareholder and external funding, we specify four logistic regression models. First, we distinctly consider the two variables expressing the composition of the entrepreneurial team (Share of women and Gender concentration);

subsequently, we interact these variables with one expressing the presence of a university as a shareholder. In this way, we can capture whether the effect of the structure of the entrepreneurial team is contingent on the presence of the university. Table 8 presents the models.

Table 8– Results of logistic regression. Dependent variable: External funding. N=239.

	Model 1		**Model 2**		**Model 3**		**Model 4**	
	Coef. (Std.Err)	p	Coef. (Std.Err)	p	Coef. (Std.Err)	p	Coef. (Std.Err)	p
Share of women	-1.151** (0.524)	0.028	-0.869 (0.609)	0.154				
Gender concentration					1.916** (0.774)	0.013	1.491* (0.890)	0.094
University participation	0.949*** (0.328)	0.004	1.200*** (0.440)	0.006	0.994*** (0.332)	0.003	-0.164 (1.254)	0.896
Share of women * University participation			-0.996 (1.126)	0.376				
Gender concentration * University participation							1.483 (1.559)	0.341
Team	-0.538*** (0.162)	0.001	-0.523*** (0.163)	0.001	-0.431** (0.170)	0.011	-0.426** (0.170)	0.012
Team Sq.	0.159 (0.132)	0.227	0.147 (0.132)	0.264	0.144 (0.132)	0.275	0.132 (0.132)	0.317
Turnover	0.058 (0.183)	0.752	0.063 (0.183)	0.730	0.088 (0.182)	0.631	0.105 (0.183)	0.567
Industry (Baseline: 1)								
2	-1.279** (0.548)	0.020	-1.287** (0.550)	0.019	-1.291** (0.551)	0.019	-1.323** (0.554)	0.017
3	-1.437* (0.733)	0.050	-1.484** (0.744)	0.046	-1.612** (0.736)	0.028	-1.689** (0.748)	0.024
4	-0.695 (0.584)	0.234	-0.725 (0.586)	0.216	-0.634 (0.591)	0.283	-0.665 (0.592)	0.262
5	-0.533 (0.478)	0.265	-0.535 (0.479)	0.264	-0.484 (0.483)	0.316	-0.498 (0.484)	0.303
6	-0.330 (0.618)	0.593	-0.389 (0.622)	0.531	-0.347 (0.618)	0.575	-0.378 (0.620)	0.542
Area (Baseline: North-West)								
North-East	0.878** (0.422)	0.037	-0.867** (0.423)	0.040	-0.880** (0.423)	0.038	-0.858** (0.426)	0.044

Centre	-0.064 (0.419)	0.879	-0.041 (0.419)	0.922	0.043 (0.424)	0.920	0.060 (0.423)	0.886
South	-0.011 (0.431)	0.980	0.049 (0.435)	0.911	-0.042 (0.431)	0.922	0.028 (0.438)	0.948
Age of firm	0.177 (0.190)	0.350	0.174 (0.190)	0.358	0.210 (0.192)	0.274	0.187 (0.194)	0.336
Strategy	0.001** (0.005)	0.046	0.010** (0.005)	0.041	0.009** (0.005)	0.067	0.009* (0.005)	0.062
Constant	0.430 (0.528)	0.415	-0.007 (0.621)	0.991	-1.386* (0.832)	0.096	-1.031 (0.908)	0.256
Log likelihood	-143.451		-143.057		-142.756		-142.297	
Pseudo R2	0.126		0.128		0.130		0.133	

As logistic regression is a non-linear model, the interpretation of the results requires estimating the marginal effects of the variables. We calculated the marginal effects for each instance of the categorical variables while keeping the continuous variables at their means, except the key variables of interest *Share of women* and *Gender concentration*, which were considered at the levels 0%, 50% and 100% and 0.50, 0.75 and 1, respectively. As this specification produces a high number of combinations, we offer the complete table of marginal effects upon request, while presenting here only the most meaningful ones.

Models 1 and 3, that consider the effects of University participation and, respectively, *Share of women* and *Gender concentration*, reveal that access to finance is associated with a decreasing presence of women and therefore a greater concentration in one (the male) gender. Furthermore, the presence of the university is positively associated with the presence of external shareholders. The marginal effects of Share of women are always negative, ranging from -0.26 and -0.143, and are significant at 5% level in 84 out of 96 cases, and at 10% level in 10 other cases. Those of University participation are always positive, ranging from 0.07 and 0.219, with significance level below 1% in 124 out of 144 cases, in 18 cases below 5%, and below 10% in two cases. Finally, the marginal effects of Gender concentration range between 0.195 and 0.430, with significance level below 1% in 54 out 92 cases and below 5% in 40 cases.

Models 2 and 4 consider the interaction between the variables of interest and University participation. Model 2 indicates that the penalty associated with the presence of women in the entrepreneurial team is stronger in RSOs that are participated by the university. The analysis

reveals that in this case, the marginal effect ranges between -0.300 and -0.406 with a significance level at 5% in 38 out 48 cases and at 10% in the other 10. Instead, in RSOs that are not participated by the university, the variable is never significant. Similarly, the marginal effects of Gender concentration appear to differ sensitively if an RSO is participated by a university or not. In those that do not participate, the marginal effects range between 0.143 and 0.341 and is significant at 10% level in 34 out of 48 cases; in the other group, the marginal effect is stronger (between 0.456 and 0.625), and the significance is stronger (in 30 out 48 cases at 1% level and in the other 18 at 5%).

Overall, the results offer support to Proposition-1, expecting that the presence of men in the entrepreneurial team is more conducive to the access to external funding than the presence of women. This relationship seems to also hold in the setting of RSOs, despite the high level of human capital that is possible to assume characterises all the members of the entrepreneurial team. It is possible to relate this finding to the fact that the field of RSOs in Italy is male-dominated, and therefore investors tend to find the presence of women as "unusual".

The dominance of men in the field also helps to explain why the Gender concentration of the entrepreneurial team is positively associated with access to external capital, consistently with Proposition-2.

Also Proposition-3 finds support in the empirical data, as the presence of a University as a shareholder enhances the likelihood to access external capital, consistently with the signalling theory.

The analysis reveals that the presence of a university does not ease the likelihood of women-led RSOs to access external funding; instead, an opposite effect is found. It is possible to argue that the criteria of evaluation of Universities are aligned to those of external investors, thereby their presence as shareholders *extends* the gender gap in the access to finance.

5. DISCUSSION AND CONCLUDING REMARKS *(WORK IN PROGRESS)*

De Bruin et al. (2006: 590) argued that "*women's entrepreneurship research is at the early childhood stage*". After more than ten years, we can affirm that this is even truer about research on women's involvement in RSOs.

Our analysis is one of the first attempts at making light on an increasing phenomenon worldwide (i.e. RSOs creation) through focusing on a very specific aspect until now

neglected, meaning the existence of potential gender discrimination in the funding of this specific kind of companies.

The results of our study support our arguments that the Matthew and the Matilda effects extend from the scientific world to the business one and in particular financial one. While evidence on the disproportionate rewards to male academics for their efforts in terms of citations, prizes and funded projects is well documented, no previous work has shown the existence of a gender funding gap in RSOs. On the basis of our analysis, the data appear to support our hypothesis that a signalling phenomenon extends from the scientific world to the business one, leading to a disproportionate lower external funding of RSOs women led. Not only, but as it was shown for the case of citations by Beaudry and Larivière (2016), the Matilda effect appears to undermine the signalling ability of male academics as the percentage of women on the entrepreneurial team proportionally reduces the probability of obtaining external funding.

Further, while as expected the presence of the University among the shareholders positively influences the extent of external funds obtained, it does not do so for companies which are female dominated. This result is quite surprising, because it suggests that the knowledge-base of RSOs – that arguably should smoothen gender differences – is a factor of lesser importance for private investors.

Langowitz and Minniti (2007) highlighted the lower level of women entrepreneurs compared to men ones, arguing however that any man or woman may be willing to start a business under suitable incentives. Here we have shown that universities appear to perpetuate the distortions that characterise the assessment processes of research results. To provide a more effective contribution, parent institutes could instead help reducing the problem of gender discrimination. More specifically, universities could set up an *ad hoc* committee charged with analysing the effective absence of gender discrimination among their RSOs. Indeed, an improvement in university attention towards RSOs initiatives founded by women could help in improving RSOs performance in general and in boosting women's entrepreneurial initiatives.

As all research, this study is affected by limitations. Our research design does not allow capturing cause-effect relationships between the variables, as the relationship between the composition of the entrepreneurial teams and access to credit may be endogenous. Furthermore, our data do not account for changes in the entrepreneurial team that may be

important drivers of access to university or external funding. Further investigations should consider the adoption of longitudinal approaches. Another limitation refers to the assumption of equivalence of human capital endowment among the members of the entrepreneurial team; such simplification can be considered as reasonable in the context of initiatives generated in an academic context. Despite these limitations, we believe that this article discloses the existence of a gender gap even in the financing of RSOs.

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