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Monolithic vs Freak Collaboration Style: the impact on research productivity *

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Abstract

This paper analyses the role played by individual creativity in shaping collaborations styles and its impact on research productivity. To operationalise creativity we consider two contrasting visions of collaboration style: the *Freak collaboration style* that we define according to a popular characterization of creative individuals, and a *Monolithic collaboration style* that we define as Freak style's opposite. We then observe the relationship between the collaboration style and research productivity - measured by the number of publications - by estimating a Tobit model. Explanatory variables include a set of traditional variables plus preferences of collaborators in terms of gender, nationality, age, cognitive distance, as well as the reason for collaborating and the circumstances in which the collaboration began. The model shows that there are great gender differences in collaboration styles. Many of the outcomes of the estimation procedures are in line with extant researches on scientific collaborations, while some are not. In particular cognitive distance between collaborators shows a positive linear relationship and not an inverted U-shape one, partially in contrast with literature's findings. Finally, and more intriguing, uncommon ways of meeting collaborators are found to positively affect researchers' productivity. These less common ways are indeed linked to the personal attitude of establishing relationships with people met in social occasions (e.g., while talking in a cafeteria, attending a conference), in line with the literature on creative societies.

Jel codes: I23 O31 O32 Keywords: Research Productivity, Creativity, Collaboration

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Contents

1 Introduction

In the economic literature, many different variables have been regarded as determinants of research productivity. At the individual level, scholars have analysed many idiosyncratic and generational characteristics, such as gender (Levin and Stephan, 1998; Xie and Shauman, 1998), age, cohort and life cycle (Levin and Stephan, 1989, 1991; Hall et al., 2007). At the aggregate level, determinants of research productivity of different units of analysis (teams, labs, departments, etc.) have been analysed under several observational lenses (Carayol and Matt, 2004).

Among the most acknowledged determinants of research productivity, the positive influences of collaboration (both international and local) have been theorized and tested in a number of ways (He et al., 2009; Beaver and Rosen, 1978, 1979b,a; Katz and Martin, 1997) leading to the creation of many policy instruments aiming to encourage collaborative research.

In the plentitude of studies adreessing the determinants of research productivity, creativity – which is the ability to do new things that have some utility (Amabile, 1983) - has been largely neglected. In the last decades, many scholars have stressed the importance of creativity for economic growth and development in all its facets (Aghion and Howitt, 2008; Phelps, 2013). At a macro level, creativity is a basic economic input that strongly shapes technological change (Mokyr, 1992) while at a micro level, fostering creativity may have the side effect of increasing well-being and self-determination of individuals (Dolan and Metcalfe, 2012; Ryan and Deci, 2000). Additionally, an eminent scholar has argued that the lack of creative ideas has played a role in condemning nations to poverty similarly compared to the lack of tangible assets (Romer, 1993). Despite the number of studies celebrating the importance of creativity fro growth, innovation and development is increasing, empirical studies have showed controversialfinding by demonstrating that uncreative researches might collect higher pay-off than creative ones Hutter et al. (2015).

In this work, we endeavour bringing together scientific output, collaboration and creativity by analysing the relationship between research productivity and collaboration and discriminating between creative and not creative collaboration style. In particular, we argue that creative people establish their scientific collaboration according to their creative cognition and creative personality. As clarified by Piffer, "creative cognition can perhaps best be defined as the set of cognitive traits that concur in the process of generation of a

creative product. Creative personality is a set of personality variables that are commonly found among creators and are thought to influence a person's creativity" (Piffer, 2012, p. 2). We claim that these cognitive traits result in different collaborations styles, and that different styles might have a different impact on research productivity. We test this hypothesis without imposing any *a priori* relationship between styles and research productivity. To do so we use data coming from a survey of two French public labs.

To operationalise creativity we consider two contrasting visions of collaboration style: the *Freak collaboration style* that we define according to a popular characterization of creative individuals, and a *Monolithic collaboration style* that we define as Freak style's opposite. We then observe the relationship between the collaboration style and research productivity - measured by the number of publications - by estimating a Tobit model. Explanatory variables include a set of traditional variables plus variables accounting for collaboration style: preferences of collaborators in terms of gender, nationality, age, cognitive distance, as well as the reason for collaborating and the circumstances in which the collaboration began.

The remainder of this paper is organized as follows: section 2 reviews the literature on creativity and research productivity, focussing in particular on works addressing the effect of collaboration; section 2.1 formulates the hypotheses; section 3 presents the methodology used for data collection while section 3.1 illustrates variables construction; section 4 shows the results of the model estimation and section 4.1 discusses the main findings. Section 5 concludes the article.

2 Background

In the massive literature investigating the determinants of research productivity, collaboration has been extensively analysed. Starting from the seminal work of de Solla Price and Beaver (1966), a plethora of quantitative studies has been elaborating on collaboration thanks to the popularity of bibliometric data and co-authors' information, surveys and interviews (while a smaller amount of research has been making use of CV screening) (Lee and Bozeman, 2005; Bozeman and Gaughan, 2011; Melin, 2000). Both measures have their pro and cons: bibliometric data are a widely available unobtrusive source which provide information on millions of records that, on the other hand, suffer from drawbacks related to inaccuracy, redundancy, plenitude, homonyms, different habits in acknowledging individual

contribution to the research, ghost-authorship etc. (Katz and Martin, 1997; Melin and Persson, 1996; Laudel, 2002). On the contrary, surveys and interviews have usually a limited coverage in terms of analytical units and time span, they are not available to the public, they are subject to instrument bias and present issues in terms of privacy constraints. However, survey and interviews data can be tailored to specific research purposes, they can deal with many of the inaccuracy of bibliometric data and can thus provide a much richer wealth of information.

At team level, productivity and the size of collaborative teams have been largely investigated with no conclusive results (Seglen and Aksnes, 2000), while finding a clear correlation between productivity and the decrease in collaboration's costs, the division of labour, the international mobility and placement of former alumni, and resource availabilities for transnational projects (Adams et al., 2005; Jonkers and Tijssen, 2008). Moreover, researches demonstrating the importance of local and international networks and interdisciplinary research have changed the concept of collaboration from a interpersonal relation to the synergistic acts of scientists that might be collaborating but not know each other. (Hicks and Katz, 1996)

Collaboration has been analyzed at individual level as well although studying collaboration at individual level may sound counter-intuitive. As states by Ziman, the fall of barriers to personal mobility and communication has resulted in a cosmopolitan scientist. Nevertheless, the author claimed, a single researcher does not represent the organizational units of modern science, groups do Ziman (1994). Despite the natural object of collaboration studies are 'at least two people', what triggers collaboration from an individual's point of view can be of a great interest.

2.1 Creativity, individual and social aspects

Among thousands of researches analysing determinants of research productivity, individual creativity has been poorly considered (Laudel, 2001). The reason for that is probably rooted on the following argument: during the vast part of the last century, the economic and social psychology literature has mistakenly interpreted the term "creative" as a synonym of the term "artistic", and hence has associated it merely with specific types of activities and a limited number of industries.

Although the importance of creativity as a determinant of economic productivity has

now been widely acknowledged at individual and team level, to date, very limited attempts have been made to disentangle the relationship that exists between research productivity and individual creativity, the reason probably being the ambiguous definitions of creativity and the difficulties in its operationalization.

Defining creativity is not an easy task. During the last century, dozens of scientists working in several fields provided multiple slightly different definitions. The most commonly used in economic and organizational science is the one originated in the "Componential Theory of Creativity" by Teresa Amabile (1983). In her theory, Amabile defines creativity as the ability to do new things which have some utility. Moreover, she specifies that something (or someone) is creative only when more than one appropriate observer acknowledges so (Amabile, 2012; Amabile et al., 1996).

Creativity has two faces: from a psychological point of view, it has been studied as a feature of individuals, putting a greater attention on the natural factors that determine creative abilities. According to this literature, individual creativity is related to emotions and can be both innate or induced by environment during the infancy, it has spontaneous manifestations and is related to the capacity of providing short term responses to problems (Lopez-Gonzalez, 2015; Feist, 2010)

From a social psychology perspective, creativity has been investigated by referring to the ability of providing long-term methodical creative solutions to problems. This type of creativity is strongly influenced by environmental factors such as the work environment, in particular by human relationships with employers, co-workers and employees. In light of this, managerial and organizational sciences have been focussing on external stimuli and on the creation of a pro-creativity work environment (Anderson et al., 2014). Subsequently, scholars have tested many aspects of the work environment to formulate suggestions in several directions such as how to organize work life, workspace, how to build relationships between colleagues, as well as how to exchange effectively knowledge (Amabile et al., 1996).

After accomplishing (or approaching) the difficult challenge of defining creativity, scholars have found out that measuring it is even more complicated. The main problem of agreeing on a general framework to measure creativity is ultimately its subjective nature. Innate creativity is commonly measured by psychological test and experiments (Torrance, 1988; Charness and Grieco, 2014), while creative environments have been assessed by measuring their different components (Amabile et al., 1996). To date, no universally accepted proxy

for creativity has been individuated and, consequently, only a limited number of empirical studies testing the impact of creativity on productivity are available.

Nowadays, a conventional definition of "creative industries" has brought to consider the output of some human activities as creative *per se*, while many other sectors lack a clear categorization of what is creative and why, and an unambiguous differentiation between a new creative product and just a new product. In the field of scientific research, scholars have suggested the use of a wide range of figures to approximate creativity, mainly disentangling its components and thus considering a combinations of novelty, originality and impact measurements (Lee et al., 2015), as well as measures of cognitive distance of keywords and references (Stumpf, 1995; Martinez, 2015). Researchers have shown how some of the proposed measurement are conflicting to one another: for example, Uzzi et al. (2013) have demonstrated that publications building on conventional combinations of prior works have higher impact in terms of forward citations. Although beyond the scope of their study, the authors clarify that novelty and citations undergo two different phenomena, hence casting some doubt on the correct way to measure creativity by using the former or the latter figure. In this article, we abandon the challenge of measuring creativity itself and we focus on characterizing collaboration, one on the most important determinant of research productivity, according to creativity features.

2.2 Creative collaboration and hypothesis development

Among all the determinants of productivity, collaboration looms up as a fundamental driver for creativity as well. Many researchers have stressed the role of collaboration for creativity. According to this literature, individuals have proven to be less creative when they act on their own, as "generative ideas emerge from joint thinking, from significant conversations, and from sustained, shared struggles to achieve new insights by partners in thought" (John-Steiner, 2000, p. 3). Differently, some scholars claim that even in collaborations, creativity is always a solo act, a feature of individuals, which is spread to others via interactions (Laudel, 2001). Some other deny the possibility that someone can truly be creative as a single entity, stating that each creative outcome is a co-creation act also when accomplished in solitude (Glăveanu, 2014, chapter 3).

In 2001, Laudel proposed an analysis of collaboration and creativity, by affirming that the two phenomena cannot be truly understood without considering them jointly. From

a sample of 300 collaborations, she concluded that the type of creativity varies according to the role played in a research team, and that science benefits from the collaborations of different forms of creativities. Moreover, she argued that relying on bibliometric information solely can be of a poor utility because they suffer from severe drawbacks related to reward habits of research teams (Laudel, 2002, 2001)

In this work, we consider the collaboration style of scientists working in the field of hard science by characterizing them accordingly to their three main collaborative relations. To do so, we have to express collaboration characteristics in terms of creativity. However, the sector under investigation poses a unique challenge. By following the work of Amabile, assessing collaboration in terms of its creative characteristics would imply taking into consideration the organization of the work environment. Nevertheless, in the case of scientific public research, where – especially from a certain status on – collaboration is primarily an issue of individual choice (for both opportunistic and sympathetic reasons), the outcomes of organizational science cannot be easily applied. Unlike the common work place, in which co-workers are usually forced to work together because of exogenous reasons, researchers often experience some degree of freedom in choosing collaborators. This implies that the work environment of scientists is not fully environmentally generated – they somehow create it. In 2000, Melin (2000) presented a micro analysis of collaboration on a sample of 195 researches aimed to disentangle the reasons behind collaboration. The author concluded that individuals are extremely pragmatic in engaging in collaborations and do not tolerate easily top-down intrusion in the choice of their collaborators. Thus, for researchers the choice of a collaborator is no longer a mere organizational aspect, but mainly a behavioural one, which depends on individual choice and individual personality and hence, on individual creativity.

In this paper, we put forth the argument that productivity is positively influenced by collaboration and that, in the case of scientific public research, collaborators are picked according to personal attitudes. We also claim that collaborations are not all equal in terms of impact on research productivity, and that some styles may have a greater impact. At the same time, we acknowledge that the scientific definition of creativity is characterized by two polarities: plausibility and validity on the one hand and originality on the other. The first two criteria, which call for conformity, and the last one, that encourages dissent, suggests that the most productive creative individual might possesses contrasting traits. To disentangle this issue we depict two polar styles of collaboration: at the upper bound we

define a stereotyped individual by following the popular belief on eccentric personality, while at the lower bound we place its' opposite vision of a rigid person. The first characterization results in the following: an individual that is *i.* original and behave in uncommon ways, *ii.* opened to new experience and, *iii.* with strong love for diversity and complexity and hence good at producing valuable ideas by uniting fuzzy ones. We call collaborations of this type the *Freak collaboration style* and we compare them to its opposite, that we call the *Monolithic collaboration style*. We define a set of variables describing the collaboration styles to observe their relationship with scientific productivity in search for positive correlations. To do so, we observe the collaboration style of individuals working in the French public research system, where typically collaborators are chosen with a high degree of freedom (and hence can reflect personal attitudes in this regard), and we analyse the correlation between research productivity, collaboration style, and a number of other variables.

We calculated a score for collaboration style as the sum of the three features of the popular definition of creative individuals: love for diversity and complexity, love for variety of experiences and originality of behaviour. For the former we looked at the tendency to chose collaborator which are different from themselves in terms of age, nationality, gender and competencies. For the second we observed the persistence of the collaborative tie while, for the latter, we considered the commonness of the circumstances in which the collaboration started by looking at the reasons that triggered the collaboration and the place where collaborators met.

The model we estimate is the following:

$$\begin{aligned} Publications_i = \alpha + \beta_1 age_i + \beta_2 gender_i + \beta_3 nationality_i + \beta_4 status_i + \\ \beta_5 careerpath_i + \beta_6 Industry_i + \beta_7 tenure_i + \beta_8 collaborationStyle_i + \epsilon_i \end{aligned} \tag{1}$$

According to the extant literature, we can formulate some predictions on what will be the outcome of this research.

Science suffers from a well acknowledged tension between the criteria peers use to value a research : on the one hand plausibility and validity criteria call for conformity and hence encourage convergent thinking while, on the other hand, originality and novelty criteria call

for dissent, and hence encourage divergent thinking. The popular definition of creative individuals we propose in this work probably originates from the fact that for years, creativity has been measured through the Divergent Thinking Test, contributing to make the two terms ("creativity" and "divergent thinking") being understood as synonyms (Piffer, 2012). Nevertheless, scientific research has empirically proven that "convergent thinking" is of great utility in enhancing productivity (Cropley, 2006).

Hypothesis 1 *Neither Freak or Monolithic style have an univocal significant correlation with research productivity.*

Following Hypothesis 1, we acknowledge that there is a need to look at the collaborative styles by considering the impact of each one of its components. Consequently, we develop the following predictions for the single components.

Hypothesis 2.1 *Freak collaboration style has a positive correlation with research productivity in terms of age, nationality and gender, but the latter applies only to female researchers*

As Laudel (2001) pointed out, research productivity benefits from the collaborations of people belonging to different stages of the life-cycle, and thus to different ages. Furthermore, in line with the vast literature on international collaborations (Adams et al., 2005; Jonkers and Tijssen, 2008; Okubo et al., 1992), we expect that choosing collaborators with different nationality from your own is likely to have a positive impact on research productivity. Finally, as demonstrated by numerous papers (Xie and Shauman, 1998; Van Den Besselaar and Sandström, 2016), women show lower productivity performance, in particular in hard science and life science (Beaudry and Larivière, 2016). Hence, females whose main collaborators are males (individuals with an higher probability to publish) should present a greater number of publications.

Hypothesis 2.2 *Monolithic collaboration style has a positive correlation with research productivity for stability of collaborative ties and for gender, but the latter applies only to male researchers*

Although very few researches address the persistence of collaborative relations (Dahlander and McFarland, 2013), repeated interactions have been associated with higher research productivity because they underlie greater certainty, trust and effectiveness of communications while reducing start-up and transaction costs (Marsden and Campbell, 1984; Uzzi, 1997). As for the impact of gender differences on male researcher, in line with the reasoning applied to prediction 2.1, males which main collaborators are males (individuals with a higher probability to publish) should present a greater number of publications.

Hypothesis 2.3 *Neither Freak or Monolithic collaboration style has a positive correlation with research productivity for cognitive distance*

In line with Nooteboom, to the extent that researchers have aquired knowledge in different fields, "...they interpret, understand and evaluate the world differently"(Nooteboom et al., 2007, pag.2). Building on both bibliometric-based and survey-based research, the optimal level of interdisciplinarity in collaboration has been deeply investigated. Among contrasting findings, scholars tend to align with an inverted U-shape of the relationship between productivity and cognitive distance Nooteboom et al. (2007).

While the variables presented so far can be linked to a love for diversity and variety of scientists, the last two variables we observe pertain the commonness of certain habits of researchers, in particular their reasons for starting a collaboration and the place where one meet the collaborators. These two variables are proxies for the originality of researches behaviour with respect to the norm (common habits). To the best of our knowledge, commonness of reasons for starting a collaboration and its impact on research productivity have never been analysed, although the literature suggests that commonness should be overcome by strategy and pragmatism (Bozeman and Gaughan, 2011; Melin, 2000). Nevertheless, we cannot exclude that strategy and pragmatism can be indeed the most or least common reasons, hence revealing respectively a positive or negative correlation with the dependent variable. Finally, only limited contributions have addressed (tangentially) the issue of where collaborators meet (Chai and Freeman, mimeo) and no predictions can be made on this matter.

3 Data collection and methodology

The first step of the investigation consisted of a web survey, which was conducted in 2015 in two French labs. Out of 470 invitations (permanent staff excluding administrative personnel, plus non-permanent researchers, including Ph.D. candidates), we received 161 reliable and complete responses (with a response rate of 34.2 percent). The sample is composed for 70% by males (Table 1) and includes 38 foreign scientists.

Table 1: Sample Overview

	Engineers	Professors	Non permanent researchers	Permanent Researchers	Total
Male	28	29	30	26	113
Female	14	8	14	12	48
Total	42	37	44	38	161

The survey allows us to map the performance of researchers in terms of scientific productivity, and to create variables to grasp their collaborative style. Each respondent was asked to provide details about her three current main collaborators, thus focusing on people whose have a personal relationship with the respondents, namely direct ties. The decision to overlook indirect ties relies on the following two reasons: first, indirect ties do not require a relationship and rarely derived from a personal choice, and second, while direct ties have been demonstrated to play a central role in the creation of new knowledge, indirect ties have been proved to be more useful for knowledge transfer Wang (2016). In the survey, we asked the researchers the following information for their three main collaborators: gender, age category, nationality, background and research specialities (same as me/complementary to mine/different and apparently disconnected). We also investigated the reason for starting the collaboration and the place where the collaboration started.

The first five variables were used to compute a similarity score, while the last two were used to compute commonness indicators by counting the frequency of a given answer, and then assigning a higher score to those occurring more often. A variable accounting for the average length of the collaborations has been added to check the stability of collaborative relationships (for further information about the variables see appendix 1) A set of control traditional variable has been added to the model, including the gender, nationality, the age (as lag between the youngest and the oldest respondent), the type of career path (research driven, academics, engineers), the status, tenure vs contractual position and the connec-

tion with the industry sector. Table 2 presents the traditional variables and the variables describing collaborators.

Table 2: Variables statistics

Variable	Mean	Std. Dev.	Min.	Max.
Female	0.298	0.459	0	1
Nationality	0.236	0.426	0	1
Age lag	18.596	11.478	1	53
Career path	1.484	1.119	0	3
Status	1.006	0.787	0	2
Tenure	0.627	0.485	0	1
Industry link	0.54	0.5	0	1
Monolithic	28.824	6.82	7	48
Gender similarity	1.981	0.978	0	3
Age similarity	0.261	0.565	0	3
Nationality similarity	1.72	1.179	0	3
Cognitive proximity	4.012	1.387	0	6
Collaboration length	1.818	1.207	0	4
Place commonness	4.845	2.74	0	9
Reason commonness	14.186	5.74	0	20
Number of observations		161		

The Freak collaboration style has been then defined as one's diversity from collaborators in terms of personal characteristics and uncommonness of reasons and circumstances that triggered the collaboration. On the contrary, Monolithic collaboration style is defined as one's similarity from collaborators in terms of personal characteristics and commonness of reasons and circumstances that triggered the collaboration. We decided to express the variable in terms of Monolithic style, thus we assigned a similarity and commonness score to collaborators and we summed the score for each of the three collaborators. Hence, a higher score indicates the tendencies of choosing collaborators that are similar to themselves and pick up colleague in a common way or for common reasons.

We estimated the impact of the personal attitude in collaboration style on research productivity as given by the average number of publications of the last 5 years ("How many papers did you publish in the last 5 years?"). Respondents could choose between the following 5 options 0, 1-2, 3-5, 6-9, 10-14, more than 15. The reliability of the dependent variable has been checked by mean of WOS and institutional databases of publication records. Considering the average number of publications of the last 5 years allows us to approximate the recent history of researchers in terms of publishing activity, which we assume can depict the average personal attitude towards publications (Lee and Bozeman, 2005). This assumption poses some questions: in particular, for Ph.D students we acknowledge that there is large possibility that they were not involved in research activities in the last 5 years (although

several Ph.D candidates declared they were already working in the field of research before starting the doctorate programme). We controlled for this problem by discarding people that arrived at the lab less than 5 years before the survey, and who did not declare being involved in research before starting their job there. Hence, we estimated a Tobit model (Tobin, 1958) using our categorical censored dependent variable showed in Figure 1 varying between 0 and 5. We recall that all the explanatory variables have been expressed in term of similarity and commonness, hence Monolithic style will be characterized by high scores, while low scores depict freak style.

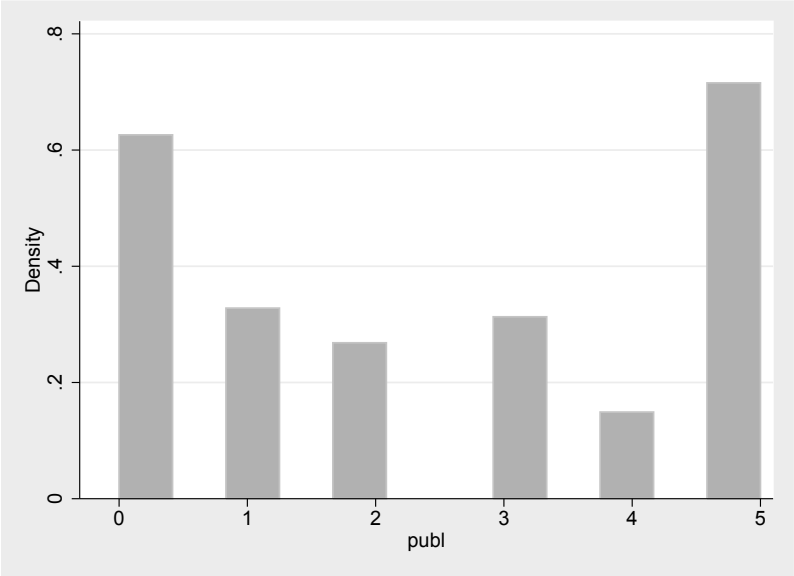

Figure 1: Dependent variable

4 Results

The results from model 1 of the estimation (Table 3) are in line with *Prediction 1*, showing no significant result for the variable accounting for the sum of the whole variables. By looking at the second model we acknowledge that some elements of the Monolithic collaboration style have a negative impact on research productivity (meaning that the Freak style is preferable). Moreover, we see that there is a strong difference between male and female scientists.

Table 3: Estimation result

	(1)		(2)		(3)		(4)	
	Total		Components		Females		Males	
model								
Gend	0.186	(0.31)	0.637	(0.92)				
Nat	1.419*	(2.14)	0.439	(0.65)	-2.478*	(-2.07)	1.257	(1.58)
Age	0.0205	(0.63)	0.0206	(0.73)	-0.0103	(-0.17)	0.0188	(0.62)
Careetype	0.935***	(3.87)	0.633**	(3.00)	0.309	(0.96)	0.786**	(3.00)
Status	1.186**	(2.61)	1.048**	(2.66)	1.948**	(2.76)	0.919*	(2.06)
Tenure	3.037***	(3.93)	1.549*	(2.18)	0.437	(0.39)	2.019*	(2.39)
Ind	0.725	(1.35)	0.0364	(0.08)	-0.390	(-0.45)	-0.346	(-0.60)
Monolitich	-0.00320	(-0.07)						
Gensim			0.0906	(0.29)	0.271	(0.60)	0.103	(0.26)
Agesim			0.0365	(0.08)	1.345	(1.23)	-0.0939	(-0.19)
Natsim			-0.492*	(-2.10)	-1.550**	(-3.33)	-0.109	(-0.38)
Compsim			-0.451**	(-2.72)	-1.288***	(-3.96)	-0.256	(-1.34)
Colleng			0.824**	(3.28)	1.370**	(3.20)	0.526	(1.77)
Collwhere			-0.273**	(-3.14)	-0.217	(-1.77)	-0.355**	(-3.26)
Commwhy			0.128*	(2.16)	-0.0554	(-0.53)	0.161*	(2.35)
_cons	-2.953*	(-2.26)	0.0991	(0.07)	7.460**	(3.36)	-0.984	(-0.56)
sigma								
_cons	2.928***	(10.26)	2.467***	(10.43)	1.676***	(5.31)	2.434***	(9.05)
N	161		161		48		113	

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

In particular, gender similarity never shows a significant relationship with research productivity, neither for the male and female sample. The same apply to age similarity. The Monolithic style prevails when it comes to persistence of collaborative ties, in accordance with *Prediction 2.2*, while the Freak style outnumbers it for diversity in nationality, in accordance to prior studies on international collaboration and *Prediction 2.1*. Cognitive distance between collaborators shows a positive linear relationship with the dependent variable and not an inverted U-shape one as stated in *Prediction 2.3*. This result has been confirmed after two tests we performed to hunt for a possible non linear relation. The reason behind

the collaboration shows a slightly positive relationship with research productivity, which happens to be in line with previous finding. In fact, the most common reasons why collaboration starts is strictly related to researchers' self-organization and pragmatism (We had a common idea about a work, see appendix A). The first original - and intriguing - finding of the analysis is that the Freak style of meeting collaborators (uncommon ways) is found to positively affect researchers' productivity. These less common ways to meet collaborators are indeed linked to the personal attitude of establishing relationships with people met in social occasions (e.g., at the cafeteria, at a conference), finding somehow connected to the literature on creative societies (Florida, 2004, 2014). Furthermore, another interesting finding emerges when we split the sample into female and male groups. In fact, we see that variables related to love for diversity and variety are significant only for females researchers, while variables related to originality of habits are significant only for males. We discuss in turn these 2 findings in the next section.

5 Discussion

An interesting differentiation in the results looms up when splitting the sample into two female and male sub-samples. For the female sample, nationality and competences similarities have a negative impact on research productivity, while collaboration length has a positive impact. This might suggest that for women there is a link between productivity and the person they pick as collaborator. On the contrary, men benefit more from their own personal attitudes in terms of reasons and habits irrespective to whom they collaborate with. This analysis does not enable us to shed light on the causal process underling these differences, neither to discriminate whether differences are the result of gender disparities in the research sector or gender specific attitudes in term of collaboration style, nevertheless this finding help to provide some evidence that research policy might affect differently women and men.

Finally, the tobit model seems to suggest that there might be a role played by "physical places" on the capacity of scientists to turn formal and -more importantly- informal encounters into fruitful collaborations. A growing body of literature has already acknowledged a relationship between place and creativity, but the focus is almost entirely on interactions within place-based clusters of creative firms (Drake, 2003). A connection between physical place and creativity has also been made by Richard Florida (2004), The Rise of the Cre-

ative Class. Florida acknowledged the importance of human capital in this link, by stating that creative people are attracted to places that allow them to express their openness to new ideas and new people. By recognising the importance of "social climate" over an "organizational climate", a new crucial factor is introduced into the decision making process of policy actions intended to foster research productivity. In a recent revisited version of his book, Florida (2014) describes a new recruiting methods used by innovative companies: firms send recruiters to "hang-out" and play frisbee outside universities' campus to start casual conversation on mutual interests. While the authors stresses the relevance that creative environments have the power to attract creative individuals, we direct our reasoning in a different direction.

As pointed out at page 4, creativity is caught between two polarities, one psychological and the other sociological. In the social psychology and geography literature, places are told to play both a shaping and an attractive role for a creative individual (Drake, 2003; Scott, 2010), while our finding seems to suggest that a good strategy to foster research productivity would imply allowing individuals shaping the context.

As a result of the stream affirming that creative societies attract and shape creative individuals, a plethora of policy fostering the cultural and creative motions of cities and regions has been put in place in order to become appealing for innovative businesses. Taxes and regulations incentives have been overcame by people-based policies, by investing in the creation of dynamics and socially attractive milieu.

Extending this reasoning to the field of scientific research implies the creation of dynamics and socially attractive scientific milieu, which can tempt gifted scientists. This argument assumes that places influence peoples' personal relationship, and - to some extent - identity. Nevertheless, our analysis and other findings in the literature suggest that researchers do not perform at their best when they face any levied structure and over-determination of their act, even when it is meant to enhance creativity. They rather prefer to shape the occasions they have with their cognitives attitudes, and make them suitable to their purposes and attitudes. The reason behind the reluctance of productive scientist to engage in pre-determined collaborations, whatever form they take, might conjecture that political actions in this sense will never be successful and that researchers would never respond positively to any top-down decision (im)posed to their work. However, taking this finding into consideration would help designing policies as less intrusive as possible in the self-determination sphere of scientists.

Appendix A Survey

Collaborator

1. How many years ago did your collaboration start?
   (a) 0-1
   (b) 2-3
   (c) 4-5
   (d) 6-10
   (e) More than 10

   Variable *Collaboration length* varying between 0 (0-1) and 4 (More than 10)

2. Where did you met?
   (a) In my research team
   (b) At a conference
   (c) At the cafeteria
   (d) We were introduced by colleagues/friends
   (e) She/he was a pupil of one of my former professor/collaborator (or vice versa)
   (f) I read his/her publications and contacted her/him (or vice versa)
   (g) He/she was my professor (or vice versa)
   (h) During a visiting in his/her
   (i) Other, please specify

   Variable *Place commonness* varying between 0 (least common) and 3 (more common)

3. Which is his/her position?
   (a) Directeur de recherche
   (b) Professeur
   (c) Assistant ingénieur
   (d) Chargé de recherche
   (e) Ingénieur de recherche
   (f) Maître de conférences
   (g) Ingénieur d'étude

(h) Chercheur contractuel

(i) Post-doctorant

(j) Doctorant

(k) Stagiaire

(l) Industry employee

(m) Other (please specify)

Variable *Status similarity* varying between 0 (different status) and 1 (same status)

4. Which is his/her gender?

(a) Male

(b) Female

Variable *Gender similarity* varying between 0 (different gender) and 1 (same gender)

5. Which is his/her age?

(a) Younger than me

(b) More or less same the age as me

(c) Older than me

Variable *Age similarity* varying between 0 (different age) and 1 (same age)

6. Which is his/her nationality?

(a) We have the same nationality

(b) We have different nationalities

Variable *Nationality similarity* varying between 0 (different nationality) and 1 (same nationality)

7. What is his/her competence?

(a) Same field as me

(b) Complementary to mine

(c) Different and apparently disconnected

Variable *Cognitive proximity* varying between 0 (cognitive distance) and 2 (cognitive proximity)

8. Why did you start collaborating? (Select at most two responses)

(a) We had a common idea about a work

(b) We needed to exchange material/instrumentation and it then turned into a collaboration

(c) We were put in the same research group

(d) He/she is my mentor/tutor

(e) We were pushed to collaborate for political reasons

(f) I get along nicely with the person

(g) There was money offered for such collaborative work

(h) It is nice to collaborate with this famous group

(i) The other groups have competences enriching my own work I'll never manage to have in local

Variable *Reason commonness* varying between 0 (least common) and 6 (most common)

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