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Potential and partnerships in innovations in EU-funded research projects

Daniel Nepelski† and Giuseppe Piroli*

Abstract

We analyse the relationship between the composition of innovation partnerships and the potential of their innovations developed within EU-funded research projects under the Seventh Framework Programme for Research and Technological Development (FP7), the European Union's Research and Innovation funding programme for 2007-2013. Innovation potential is assessed using a formal framework capturing three different dimensions: innovation readiness, management and market potential. Both the analysed innovations and innovators were identified by external experts during periodic Framework Programme reviews. Thus, our population includes participants in the FP7 projects that are considered as key organisations in the project delivering innovations in FP7 projects. We show that the innovative potential of research output of homogenous partnerships, e.g. between two SMEs or two large companies, is likely to be higher, as compared to heterogeneous partnerships, e.g. an SME and a large company. The impact of universities on the potential of innovations is unclear. The total number of key organizations in delivering an innovation has a negative impact on its potential. Neither project funding nor duration affects the potential of innovation. Our results contribute to the discussion on the most appropriate design of R&D consortia of organizations in publically-funded projects.

Keywords: R&D consortia; innovation policy; framework programme, small and medium-sized enterprises

JEL Classification: L52, L53, O31, O32, O25

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1. Introduction

The European Union's (EU) Framework Programme (FP) constitutes an important share in R&D expenditures in Europe (EC, 2007).[1] In addition to financing science and technology development, one of their main objectives of the FP is to foster international collaboration among research organizations and private firms, both large and SMEs. However, relatively little is known about the effectiveness of partnerships and how their composition influences the development of new technologies and innovations. The reason is that most of the assessment exercises are limited to the accounting for scientific output and filled patent applications (EC-CONNECT, 2014). Other studies look at the collaboration benefits of participating organizations but not at the innovation potential of the output of joint R&D collaboration (Barajas, Huergo, & Moreno, 2012; Bayona-Sáez & García-Marco, 2010).

This paper attempts to tackle the issue of innovation partnerships and the innovative output of FP7 research projects. We proceed in two steps. First, we use the output of the assessment of innovation potential of over 500 innovations identified in FP7 research projects in the domain of information and communication technologies (ICT). This is done using a formal innovation potential assessment framework and aggregating answers to a novel innovation survey questionnaire used in the assessment of FP7 projects. The aggregated indicators capture the level of innovation readiness, management and market potential and through a composite indicator the overall potential of an innovation. Second, we examine the relationship between the potential of innovations and the type pf partnerships involved in the development of these innovations. By partnership we mean the type of organizations that were identified by reviewers of the FP7 projects as "*key organisation(s) in the project delivering an innovation*". We distinguish between the same types of organizations, e.g. two universities, or two SMEs,

[1] The FP7 has a budget of over €50 billion with €9 billion allocated to ICT for the period from 2007 to 2013 (EC, 2007). In comparison, the ICT sector R&D annual expenditures in the EU reached almost €30 billion in 2011 (JRC-IPTS, 2014).

or mixed partnerships, e.g. at least one university and one SME, or at least one SME and one large company.

In this paper, we use data provided by the Innovation Radar (IR) project, an EC support initiative launched in August 2013 (De Prato, Nepelski, & Piroli, 2015). In its first release, the IR project collected data between May 2014 and January 2015 on 279 ICT FP7 and Competitiveness and Innovation Framework Programme (CIP) projects or 10.6% of all ICT FP7/CIP projects.

The current paper is structured as follows: Section 2 reviews some key findings of the existing evidence on the performance of R&D partnerships and formulates the research questions that we tackle. Section 3 explains the topic of assessment of innovation and technology-based ventures and the methodology of constructing innovation potential assessment indicators. Section 4 presents the data used in the current study. Sections 5 show a descriptive analysis of innovations and Section 7 present the results of the innovation potential assessment. Section 8 concludes.

2. Research questions

The Framework Programme of the EU is one of the main policies of developing research for the global knowledge-based economy. One of its main features is an increasing emphasis on collaborative research, both within the EU and with external research partners. This is grounded in the expectation to increase the production and internalization of knowledge spillovers. Indeed, the theory shows that R&D cooperation increases a firm's incentives to perform some types of R&D activity, mainly if results are difficult to be appropriated (Katz, 1986). In fact, joint R&D efforts, in absence of perfect price discrimination, minimise issue of appropriation of R&D outcomes and increase private benefits of a firm.

Theoretical conjectures are complemented by empirical works in the field of innovation economics that offer a wide range of explanations of the determinants of R&D collaboration.

Companies are willing to join forces provided that they can access to complementary resources (Caloghirou, Tsakanikas, & Vonortas, 2001; Kogut, 1988; Sakakibara, 1997). Other explanations focus on the issue of overcoming transaction costs, strategic management or reducing risk associated with uncertain R&D outcomes (Hagedoorn, Link, & Vonortas, 2000).

Regarding the outcomes of such partnerships, R&D collaboration activities do not only benefit firms involved in such activities. The existence of larger collaboration networks increases also the innovation performance of individual locations and regions (Asheim, Boschma, & Cooke, 2011; Tödtling & Trippl, 2005). Despite some contrasting views on marginal private and social benefits of R&D collaboration, the general conclusion is that there is room for public intervention in overcoming the problems of coordination and risk sharing in knowledge production.

One of the key questions in this field is the issue of designing the composition and structure of project consortia. In general, collaboration between public and private organization is encouraged, while recently an increasing emphasis is put on the involvement of small and medium size enterprises (SEMs). It is argued that small firms participate in larger R&D project that involve, among others, universities in order to get access to novel knowledge and technology and to benefit from spillovers (Chun & Mun, 2012). Those companies are seen as vehicles for the transfer of novel knowledge and technologies to the market. However, there are also some counteracts showing that SMEs can benefit more from R&D collaboration with larger firms rather than with universities (Okamuro, 2007).

The question we address in this paper concerns mainly the relationship between innovative performance of research projects and research partnerships. In contrast to the previous research efforts that focus, for example, on the impact of FP7 participation on firm-level outcomes like economic productivity (Barajas et al., 2012; Bayona-Sáez & García-Marco, 2010). First of all, we analyse the relationship between the number of organizations in developing an innovative product or service within publically-funded research project and its innovation potential. In doing this, we make a distinction between innovation readiness, management and market potential, i.e. elements influencing innovation performance. Second, we distinguish between different types of partnerships. In particular, we are interested in the question of which type of partnerships are associated with higher innovation potential of the R&D outcomes. Here we distinguish between homogenous, e.g. university and university or SME and SME, and heterogeneous, e.g. university and large company or large company and SME, partnerships.

3. Methodology

This section describes two main elements of the methodology applied in this paper. It uses the output of the Innovation Radar (IR) project, an EC support initiative to assess the innovation potential of innovations developed within the FP research projects and identify the bottlenecks to their commercialisation (De Prato et al., 2015). Below we explain the innovation potential assessment criteria used in the current study (Section 3.1) and the measures of innovation partnerships (Section 3.2).

3.1 Innovation potential assessment criteria

The principles of the IR rest on the concept of innovation and new technology venture assessment. This type of activity is commonly performed by large research organizations, technology-based companies, universities or venture capitalists screening companies or projects with respect to their new product development, technological readiness and market potential of new products (De Coster & Butler, 2005; Liao & Witsil, 2008). In general terms, one can differentiate between two types of assessment of new innovations and technology projects. One is a process-based and the other culturally-based (Cooper & Kleinschmidt, 1997; Khurana & Rosenthal, 1998). Table 1 provides a synthesis of the main characteristics of the two approaches.

The process-based assessment uses established procedures for assessing proposals for funding. It is mainly used by, for example, banks granting loans to small, technology-based enterprises, or large research organizations, e.g. NASA, when choosing new products to develop from various technological projects. The process-based assessment tends to be regular, with proposals arriving and being reviewed on a methodological basis. A regular process warrants an investment in methods and tools that lend themselves to comparing several options simultaneously and that keep records so that future opportunities can be compared with past opportunities. In contrast, the culturally-based approach does not assess all projects against a formal methodology. Instead, the assessment is based on the assessor's experiences both individually and collectively. Business angels and venture capitalists are the most common users of the culturally-based approach to assessing new technology ventures. The assessment is usually done on a case-by-case basis by a team consisting of experts with different backgrounds.

Table 1: Approaches to innovation and technology-based ventures assessment

	Approach type	
	Process-based	**Culturally-based**
Methodology	Automatic or semi-automatic, deploying pre-defined questionnaires and assessment templates	Individual evaluation based on a set of pre-defined criteria Intensive due-diligence of company, its staff and market
Scope and intensity	A set of pre-defined dimensions with a list of questions	In-depth evaluation of individual cases
Outcome	Selection based on a relative or absolute score	Selection based on the in-depth analysis and consensus of an evaluating team
Number of assessments	Many	Few
Examples	Banks granting loans Evaluations performed by research funding-agencies Large corporations evaluating internal research projects	Venture Capitalist Business Angels

Source: (De Prato et al., 2015) based on (De Coster & Butler, 2005).

Within this framework, the IR methodology can be seen as a process-based approach to innovation and new technology assessment. It applies a structured framework to assessing the potential of innovations and innovative capacity of organisations that play a key role in delivering these innovations.

In order to provide synthetic comparable results for further analysis and interpretation, the IR innovation potential assessment framework uses three assessment criteria that are commonly referred to in the context of innovation potential assessment exercises: Market Potential, Innovation Readiness and Innovation Management (De Coster & Butler, 2005; Liao & Witsil, 2008).

Innovation readiness: the innovation readiness criterion relates to the technical maturity of an evolving innovation. It aims to define the development phase of the innovation, e.g. conceptualization, experimentation or commercialisation. It also takes into account the steps that were taken in order to prepare innovation for commercialisation, e.g. prototyping, demonstration or testing activities or a feasibility study, and to secure the necessary technological resources, e.g. skills, to bring the innovation to the market. In addition, this criterion takes into account the development stage of an innovation and the time to its potential commercialisation.

Innovation management: the innovation management criterion addresses the issue of the project consortium and its commitment to bring an innovation to the market, an element that is often seen as the most important success indicator of a technology venture. This concept aims to research or confirm the capability of the project's development and/or management team to execute the necessary steps to transforming a novel technology or research results into a marketable product and, finally, to prepare its commercialisation. These steps may include, for example, clarifying the related ownership and IPR issues, preparing a business plan or market study, securing capital investment from public and/or private sources, or engaging an end-user in the project.

Market potential: the market potential criterion relates to the demand and supply side of an innovation. Regarding the demand side, it concerns the prospective size of the market for a product and the chances of its successful commercialisation. Its aim is to assess how the product satisfies a market sector and to indicate that there is potential customer base. With respect to the supply side, it aims to assess whether there are potential barriers, e.g. regulatory frameworks or existing IPR issues, which could weaken the commercial exploitation of an innovation. In the current undertaking, the focus is placed on the supply side. This is mostly related to the fact that information on markets for individual innovations is not available.

In order to observe and measure the above specified criteria, each of them was matched with relevant questions of the Innovation Radar Questionnaire (see Section 0). The outcome of the matching process is presented in Table 6 (see Section 8.2). In this way, composite sub-indicators for each assessment criterion were recreated defining the Innovation Readiness Indicator (*IRI*), the Innovation Management Indicator (*IMI*) and the Market Potential Indicator (*MPI*). Each of the three indicators is an arithmetic aggregate of all relevant information in the domain of innovation readiness as defined in Section 3.1 and scoring system presented in Table 6 in Section 8.2. In the second step, the Innovation Potential Indicator (*IPI*) is constructed. *IPI* is an arithmetic composite indicator which aggregates the values of the three earlier sub-indicators, i.e. *IRI, IMI* and *MPI*.

An important issue related to the construction of composite indicators is the one of weighting. Unfortunately, no agreed methodology exists to weight individual indicators (EC-JRC, 2005). In particular the context of the current study does not make the choice of a weighting scheme easy. All three elements are considered equally important for a successful innovation commercialization. Considering this, equal weighting is applied as following:

$$IPI = \frac{1}{3} IRI + \frac{1}{3} IMI \frac{1}{3} MPI. \quad (1)$$

In order to make the values on each indicator among different innovations and innovators as easily comparable as possible, a normalisation procedure is applied. Observed values of each indicator are brought to the scale between 0 and 100 in the following way:

$$I_{i \cdot NormalizedScore} = \frac{I_{i \cdot ObservedScore}}{I_{i \cdot MaxScore}} \times 100, \quad (2)$$

where $I_{i \cdot}$ is one of the innovation potential assessment indicators specified above.

3.2 Innovation partnerships

In our study, we use different concept of organizations participating in innovation partnerships. Instead of relying on administrative information on project consortia, we use information on organizations that were identified by experts during project reviews as "*key organisation(s) in the project delivering an innovation*" (see the Innovation Radar innovation questionnaire in Section 8.1). The rationale behind identifying organizations in this way is to point at individual organizations among the consortium partners that play the most relevant role in innovation development. This way, our population includes participants in the FP7 projects that are considered as the main drivers of development of new technologies and innovations.

The project reviewers can identify up to three organizations per innovation. According to the FP procedures, there are five types of organizations that are eligible to participate to the research projects: High Education and Schools and Research Centres (HES/REC); Public Bodies (PUB); Small Medium Enterprise (SMEs); Large companies (LARGE) and Other organisations (NIL) (EC, 2007). Based on this classification and on the fact that the IR provides information on up to three organizations involved in the development and delivering of an innovation, we distinguish between:

- Homogenous innovation partnerships, e.g. university and university or SME and SME, and
- Heterogeneous innovation partnerships, at least one university and one SME, or at least one SME and one large company.

In addition, in order to control for the size of a partnership, in the proceeding analysis, we use a variable controlling for the number of key organizations to deliver the innovation.

4. Data

The data used in the current project was collected during periodic reviews of ICT FP7/CIP projects between 20 May 2014 and 19 January 2015 (see Table 3). The reviews were conducted by external experts commissioned by European Commission Directorate General for Communications Networks, Content & Technology (DG Connect). During this time, in addition to a standard review procedure, DG Connect deployed the Innovation Radar questionnaire (see Section 0) to spot innovations originating from the FP7 projects and the key organizations behind them. The research activities monitored are the ICT research actions and the e-Infrastructures activity under the Seventh Framework Programme 2007-2013 (under Cooperation and Capacities themes), and the policy support actions carried out under the Competitiveness and Innovation Framework Policy Support Programme (CIP ICT PSP).

Table 2 shows the distribution of all FP7 projects and projects reviewed using the Innovation Radar methodology by Strategic Objective (SO), including e-Infrastructures and CIP ICT PSP activities (EC-CONNECT, 2013a, 2013b). Overall, the correlation coefficient between the number of FP7 projects and projects reviewed using the Innovation Radar methodology by theme is 0.76, which, together with the absolute number of reviewed projects, i.e. 279 or 10.6% of all ICT FP7/CIP projects, show that the sample of the reviewed projects is representative for the population of ICT FP7/CIP activities. The largest number of projects belongs to the Future and Emerging Technologies (FET) (12.1%), Future Networks and

Internet (8.1%) SO and to the CIP ICT PSP (8.9%). Concerning the distribution of the reviewed projects by SO, CIP ICT PSP (10%), Software, Services and internet connected objects (9.7%) and FET (9.3%) are the largest sub-groups. None of the projects belonging to the International Cooperation SO was reviewed using the Innovation Radar methodology.

In order to complement the survey data, information on FP7 projects' characteristics was retrieved from the CORDIS database (EC, 2015). This database is the European Commission's public repository of information on all EU-funded research projects and their results. For the purpose of this study we retrieved, among others, information on the type and location of organizations that were identified as key organizations to bring the innovations to the market, EC funding at the project and organization level, location of organizations.

Table 2: Number of FP7 ICT EC, e-Infrastructure and CIP-ICT-PSP projects (cumulated figures 2007 – 2013) and number of reviewed projects by Strategic Objective

Strategic Objective	Number of projects*	% of Total	Number of reviewed projects	% of Total	Reviewed projects as % of all projects
01 Future Networks and Internet	214	8.1%	24	8.6%	11.2%
02 Software, Services and internet connected objects	114	4.3%	27	9.7%	23.7%
03 Trustworthy ICT	90	3.4%	13	4.7%	14.4%
04 Networked Media	72	2.7%	7	2.5%	9.7%
05 Cognitive Systems and Robotics	150	5.7%	6	2.2%	4.0%
06 Nanoelectronics	66	2.5%	7	2.5%	10.6%
07 Micro/nanosystems	64	2.4%	4	1.4%	6.3%
08 Embedded Systems	150	5.7%	14	5.0%	9.3%
09 Photonics	105	4.0%	5	1.8%	4.8%
10 Organic and large area Electronics	43	1.6%	4	1.4%	9.3%
11 Language Technologies	66	2.5%	16	5.7%	24.2%
12 Intelligent Information Management	69	2.6%	10	3.6%	14.5%
13 ICT for Health	137	5.2%	14	5.0%	10.2%
14 ICT and Ageing	29	1.1%	3	1.1%	10.3%
15 ICT for Inclusion	51	1.9%	6	2.2%	11.8%
16 ICT for Governance and Policy Modelling	26	1.0%	5	1.8%	19.2%
17 ICT for Energy Efficiency	119	4.5%	11	3.9%	9.2%
18 ICT for Transport	93	3.5%	15	5.4%	16.1%
19 ICT for the Enterprise	69	2.6%	7	2.5%	10.1%
20 ICT for Learning	85	3.2%	15	5.4%	17.6%
21 Digital Libraries	15	0.6%	1	0.4%	6.7%
22 FET	318	12.1%	26	9.3%	8.2%
23 International Cooperation	56	2.1%	0	0.0%	0.0%
24 Accompanying Measures	52	2.0%	5	1.8%	9.6%
e-infrastructures	140	5.3%	6	2.2%	4.3%
CIP ICT-PSP	233	8.9%	28	10.0%	12.0%
Total	**2626**	**100%**	**279**	**100%**	**10.6%**

Source: (De Prato et al., 2015)

Data: *European Commission DG Connect (EC-CONNECT, 2013a, 2013b)

5. Descriptive analysis

According to Table 3, between May 2014 and January 2015, 279 projects were reviewed using the IR Questionnaire, i.e. 10.6% of all ICT FP7, e-Infrastructures and CIP ICT PSP projects (see Table 2). As a result, 517 innovations were identified. This means that, on average, an ICT FP7/CIP project produces nearly 2 innovations. The number of distinct organizations considered as key organisations in the project delivering these innovations amounted to 544. The average number of innovators per innovation was 1.23.

6. Table 3: Innovations in ICT FP7/CIP projects – key facts

Review period	20.05.2014 and 19.01.2015
Number of reviewed projects	279
Number of innovations	517
Number of distinct innovators	544
Average number of innovations per project	1.85
Average number of innovators per innovation	1.23

Source: (De Prato et al., 2015)

Data: European Commission DG Connect

Table 4 reports the summary statistics of the three innovation potential assessment sub-indicators, i.e. Innovation Readiness (*IRI*), Innovation Management (*IMI*), Market Potential (*MPI*) and the composite Innovation Potential (*IPI*), for all analysed innovations and by innovation potential category. In addition, we show details on the key organizations in the project delivering an innovation, as identified during project reviews, and such project features as duration in months and total EC funding in Euro.

The average value of the *IPI* among all the innovations is 45.52 out of the total 100 points. The innovation with the highest score obtained 84.17 points, while the lowest-ranked innovation only 14.17 points. When looking at the individual sub-indicators, one can observe that *MPI* has the highest and the *IMI* has the lowest average value. The average *MPI* score is 64.39 and the average *IMP* score is 35.67 points. The average score of the *IRI* is 36.49 points.

Based on the presented evidence, it can be concluded that, on average, market potential and innovation readiness are among the strongest dimensions of the innovations coming out of the reviewed ICT FP7/CIP projects. In contrast, innovation management represents the weakest dimension of these innovations.

Table 4: Descriptive statistics of the innovation potential assessment indicators

		Nr of innovations	Mean	Std. Dev.	Min.	Max.
Innovation Assessment Indicator	Innovation Readiness	517	36.49	21.72	2.5	100
	Innovation Management	517	35.67	15.17	0	95
	Market Potential	517	64.39	13.29	27.5	95
	Innovation Potential	517	45.52	12.69	14.17	84.17
Key organisation(s) in the project delivering an innovation	High Education and Schools and Research Centres	517	0.90	0.88	0	3
	Public Bodies	517	0.02	0.16	0	2
	Small Medium Enterprise	517	0.45	0.65	0	3
	Large companies	517	0.35	0.63	0	3
	Other organisations	517	0.03	0.19	0	2
Project features	Duration	517	36.79	6.54	18	67
	EC funding in Euro	496	543203.50	384948.1	0	2851000

Source: (De Prato et al., 2015) and own calculations

Data: European Commission DG Connect

Note: The table includes computations on innovation potential assessment indicators as defined in section 3.1. Total number of reviewed projects: 279. Total number of innovations: 517. Review period: 20.05.2014 and 19.01.2015.

Considering the type of organizations that are identified as "*key organisation(s) in the project delivering an innovation*", Table 4 shows that, on average, there is almost always an university or research centre (mean=0.9) involved in an innovation developed within an FP7 project. In contrast, there are 0.45 SMEs per innovation and only 0.35 large companies per innovation. The involvement of other types of organizations, e.g. public bodies, is even less significant. As indicated by the values of standard deviation, there are considerable differences between innovations with respect to the type of organizations involved in their development. Thus, there are cases where only universities or only SMEs are indicated as the key organisations in delivering an innovation.

It is worth noting that SMEs accounted in FP7 for 16% of total participations (2,935 in total) and 14% of total EC funding (€850 million in total) (EC-CONNECT, 2013c). Hence, their involvement as key organizations in delivering innovations in FP7 projects is threefold their participation rate. In comparison, High Education and Schools and Research Centres account for 29% of the total number of organizations, but they represent by far the most significant category of recipients in terms of funding (63%) and large companies are the 29% of participating organisations and represent 20.5% of funding.

7. Innovation potential and innovation partnerships

In order to explain the dependencies between the potential of innovations developed in ICT FP7 projects and the type of partnership of organizations involved in their development, we define our dependent variable y_i as one of the previously specified indicators of innovation potential, i.e. *IRI, IMI, MPI* and *IPI* (see Section 3.1). Among the independent variables there are six dummy variables that control for the type of partnerships of organizations that were identified by project reviewers as "*key organisation(s) in the project delivering an innovation*" (see Section 8.1). Three of these variables control for the existence of homogenous partnerships, i.e. *University & University*, *SME & SME*, *Large & Large*. In each case, there are at least two organizations of the same type. The other three dummy variables control for the existence of heterogeneous partnerships, i.e. *University & SME*, *University & Large* and *SME & Large*. In this case, the dummy variables take value 1 when there are at least two organizations belonging to different class, e.g. one university and one SME, or SME and one large company. In addition, to control for the size of partnership we include the *Number of key organizations* variable, where the maximum is 3.

Moreover, we include two further dummy variables that control for the maturity of the project. One is *First review* and the other is *Interim review*. Each of them takes value 1 if the project is reviewed for the first or second time respectively and 0 otherwise. The reference group is in this case the final review of a project. Two last variables used in the study relate to the amount of funding the project consortium received (*Project funding*) and the total duration of the project (*Project duration*).

Table 5 reports the results of OLS estimations of the above described independent variables on the innovation potential measured by our four indicators of innovation potential, i.e. *IRI, IMI, MPI* and *IPI* (see Section 3.1) Regarding the first test of *IRI*, i.e. innovation readiness relating to the technical maturity of an evolving innovation, there are two variables controlling for the type of partnerships that are statistically significant. Whereas *SME&SME* has a positive, the *SME&Large* variable has negative impact on the *IRI* score. In other words, homogenous partnerships of among SMEs are more likely to positively influence the technological development of the innovation. This involves such steps necessary to commercialise new products or service as prototyping, demonstration or testing activities or a feasibility study, and to secure the necessary technological resources, e.g. skills, to bring the innovation to the market. In contrast, the involvement of an SME and a large company in the development of new innovation is likely to slow down the process of technology maturing.

Relatively similar results are for the *IMI* that captures issues related to innovation management. Here, again, we can see that *SME&SME* has a positive and the *SME&Large* variable negative impact on the *IMI* score. However, the *Large&Large* variable has a positive influence on the likelihood of undertaking such steps as, for example, clarifying the related ownership and IPR issues, preparing a business plan or market study, securing capital investment from public and/or private sources, or engaging an end-user in the project. The results of the impact of the type of innovation partnership on the market potential are inconclusive.

In the final estimation, i.e. the aggregated innovation potential indicator, we can see that the existence of homogenous innovation partnerships of SMEs or large companies is positively related with innovation potential measured by *IPI.* In contrast, heterogeneous partnerships between SMEs and large companies seem to have a negative impact on the innovation potential. Because none of the variables controlling for the involvement of university as "*a* *key organisation(s) in the project delivering an innovation"* is statistically significant, no firm conclusions can be made. However, in all cases the sign of the coefficient controlling for the presence of a university in a partnership is negative.

Regarding the overall number of organizations involved in delivering an innovation in a FP7 project, it can be seen that for all measures of innovation potential it has negative impact. The same observation can be made with respect to the review time. As compared to the final review, coefficients of dummies controlling for the first and interim review are negative. In other words, we can say that the innovations mature and increase their potential, as projects progress.

Concerning the remaining features of the project, we can say that, overall, neither project funding nor duration has an impact on the measures of innovation potential. Though very small, only the variable controlling for project funding has a positive impact on the *IMI* and *IPI*.

Table 5: Regressions on innovation potential indicators and innovation partnerships in EC-funded research projects

		Innovation potential indicators			
		Innovation Readiness	Innovation Management	Market Potential	Innovation Potential
Type and number of organizations identified as key organizations to bring the innovation to the market	University & University	-2.840	3.572	-5.931	-1.733
		(5.560)	(3.957)	(3.779)	(3.267)
	SME & SME	11.319**	14.647***	-0.214	8.584***
		(5.451)	(3.879)	(3.706)	(3.204)
	Large & Large	5.884	10.476***	1.139	5.833*
		(5.549)	(3.949)	(3.772)	(3.261)
	University & SME	1.545	-4.580	1.003	-0.677
		(5.313)	(3.781)	(3.612)	(3.123)
	University & Large	-4.813	-3.854	3.482	-1.728
		(5.334)	(3.796)	(3.626)	(3.135)
	SME & Large	-10.417**	-10.326***	-2.054	-7.599**
		(5.128)	(3.650)	(3.486)	(3.014)
	Number of key organizations	-2.202*	-4.139***	-3.291***	-3.211***
		(1.303)	(0.927)	(0.886)	(0.766)
Review time – reference point: Final review	First review	-17.624***	-5.479***	-2.697*	-8.600***
		(2.217)	(1.578)	(1.507)	(1.303)
	Interim review	-13.908***	-5.895***	-0.597	-6.800***
		(2.155)	(1.534)	(1.465)	(1.267)
Project features	Project funding	0.000	0.000*	0.000	0.000*
		(0.000)	(0.000)	(0.000)	(0.000)
	Project duration	-0.054	0.006	-0.005	-0.018
		(0.140)	(0.100)	(0.095)	(0.082)
	Constant	46.815***	35.088***	74.970***	52.291***
		(6.753)	(4.806)	(4.591)	(3.969)
	N	496	496	496	496
	Prob > F	0.000	0.000	0.000	0.000
	R2	0.208	0.165	0.234	0.234
	Adjusted R2	0.190	0.150	0.217	0.217

Notes: The dependent variable is the score in individual innovation potential assessment criteria and the final composite index of innovation potential, as defined in Section 3.1. The list of explanatory variables includes: First, a set of variables on the type and number of organizations identified as key organizations to bring the innovation to the market, i.e. where with the at most three key organizations to bring the innovation to the market are such combinations as two universities (University & University), SMEs (SME & SME), large companies (LARGE & LARGE) or at least one university and one SME (University & SME), or at least one university and one large company (University & LARGE) or at least one SME and one large company (SME & LARGE), and the number of key organizations to bring the innovation to the market (Number of key organizations). Second, information on the project review time, where the reference point is the final review. Third, such project features as project funding and duration.

All models report OLS regression estimates. Standard errors are reported in parentheses.

*** Significant at the 1 percent level.
** Significant at the 5 percent level.
* Significant at the 10 percent level.

Source: Own calculations based on the data from Innovation Radar by DG Connect (De Prato et al., 2015) and Cordis (EC-CONNECT, 2013b).

8. Conclusions

The current paper uses the outputs of the EC Innovation Radar, which can be described as a formal attempt to identify and assess the potential of innovations developed within the FP7 projects and the innovative capacity of organizations playing the key role in delivering these innovations. Our aim was to look at the relationship between the composition of the innovation partnerships and the innovation potential of their products and services.

Our results show that the composition of innovation partnerships has an impact on the innovation potential of innovations developed in publicly-funded research projects. In particular, we show that the innovative potential of research output of homogenous partnerships, e.g. between two SMEs or two large companies, is likely to be higher, as compared to heterogeneous partnerships, e.g. an SME and a large company.

The above point is mainly visible in the context of innovation readiness and innovation management. The concept of innovation readiness covers such issues as prototyping, demonstration or testing activities or a feasibility study, and to secure the necessary technological resources, e.g. skills, to bring the innovation to the market. In contrast, innovation management refers to the capability of the project's team to execute the necessary steps to transforming a novel technology or research results into a marketable product and, finally, to prepare its commercialisation. The steps may include, for example, clarifying the related ownership and IPR issues, preparing a business plan or market study, securing capital investment from public and/or private sources, or engaging an end-user in the project. Considering this, it can be said that, due to, for example, coordination requirements or differences in organizational processes , organizations of the same type, e.g. two SMEs or two large organizations, are more likely to find solutions to the problems that may arise when bringing an innovation to the market.

We find that neither project funding nor duration affects the potential of innovation. While the total number of key organizations in delivering an innovation has negative impact on its potential, we could not identify a significant impact of universities on the potential of innovations to which development they contribute.

Appendix

8.1 Innovation Radar Questionnaire

Innovation Radar Questionnaire by EC DG CONNECT

Note: the first 16 questions below are to be answered for **each** innovation the project develops (up to a maximum of 3 innovations).

1) **Describe the innovation (in less than 300 characters, spaces included):**

2) **Is the innovation developed within the project…:**
    a) Under development
    b) Already developed but not yet being exploited
    c) being exploited

3) **Characterise the type of innovation (only to be answered if 2b or 2c is selected)**

    - Significantly improved product
    - New product
    - Significantly improved service (except consulting ones)
    - New service (except consulting ones)
    - Significantly improved process
    - New process
    - Significantly improved marketing method
    - New marketing method
    - Significantly improved organisational method
    - New organisational method
    - Consulting services
    - Other

4) **If other, please specify:**

5) **Characterise the macro type of innovation (only to be answered if "under development" is selected for Q2):**
    - Product
    - Marketing method
    - Organisational method
    - Process
    - Service (non-consulting)
    - Consulting service
    - Do not know yet

6) **Will the innovation be introduced to the market or deployed within a partner:**
    a) Introduced new to the market (commercial exploitation)
    b) Deployed within a partner (internal exploitation: Changes in organisation, new internal processes implemented, etc.)
    c) No exploitation planned

7) **If no exploitation planned, please explain why no exploitation is planned (answer only if 6(c) is selected)**

8) Is there a clear owner of the innovation in the consortium or multiple owners?
- A clear owner
- Multiple owners

9) Indicate who is the "owner" of the innovation: …

10) Indicate the step(s) already done (or are foreseen) in the project in order to bring the innovation to (or closer to) the market (answer only if 6(a) is selected)

	Done	Planned in project	Not Planned	Desirable
1. Technology transfer				
2. Engagement by Industrial research team of one of their company's business units in project activities				
3. Pilot				
4. Capital investment (VC, Angel, other)				
5. Investment from public authority (national, regional)				
6. Business plan				
7. Prototyping				
8. Market study				
9. Demonstration or Testing activities				
10. Feasibility study				
11. Launch a start-up or spin-off				
12. Other				

11) If other, please specify

12) Indicate which participant(s) (up to a maximum of 3) is/are the key organisation(s) in the project <u>delivering</u> this innovation. For each of these identify under the next question their needs to fulfil their market potential.

Org1:
Org2:
Org3:

13) Indicate their needs to fulfil their market potential

	Investor readiness training	Investor introductions	Biz plan development	Expanding to more markets	Legal advice (IPR or other)	Mentoring	Partnership with other company (technology or other)	Incubation	Start-up accelerator
Org 1									
Org 2									
Org 3									

14) When do you expect that such innovation could be commercialised? (answer only if 6(a) is selected)
- Less than 1 year
- Between 1 and 2 years
- Between 3 and 5 years
- More than 5 years

15) Have any of the project partners…

(only to be answered if "Done" or "Planned in Project" is chosen for 10.5 "Investment from public authority")

a) already applied for support from private investors
b) already applied for investment from public authorities
c) Planning to start discussions with private or public investors

16) Which partners are in discussion with investors (or are planning such discussions)?

(the above questions are to be answered for **each** innovation developed by the project, up to a maximum of 3 innovations)

General Questions

(questions below are to be answered once in the project review, not for each innovation)

1) How does the consortium engage end-users?

- End user organisation in the consortium
- An end user organisation outside of the consortium is consulted
- No end user organisation in the consortium or consulted

2) Are there in the consortium internal IPR issues that could compromise the ability of a project partner to exploit new products/solutions/services, internally or in the market place?

- yes
- no

3) Please provide specifics of the IPR issues:

4) Which are the external bottlenecks that compromise the ability of project partners to exploit new products, solutions or services, internally or in the market place?

- IPR
- Standards
- Regulation
- Financing
- Workforce's skills
- Trade issues (between MS, globally)
- Others

5) Indicate how many patents have been applied for by the project: _________

6) Does the review panel consider the project performance in terms of innovation?

- Exceeding expectations
- Meeting expectations
- Performing below expectations

7) General observations of innovation expert on this project's innovation performance:

8) How would you rate the level of commitment of relevant partners to exploit the innovation?

- Very low
- Low
- Average
- High
- Very High
- None

9) Please indicate the 1 partner (excluding large enterprises) that the panel considers to be the most impressive in terms of innovation potential:

10) **Please enter some tag words (comma separated) to represent what "innovation elements" are strong in the project:**
11) **Please enter some tag words (comma separated) to represent what "innovation elements" can be improved (or are absent) in the project:**

8.2 Innovation potential assessment framework

Table 6 presents the result of matching assessment criteria defined in Section 3.1 with relevant questions of the Innovation Radar Questionnaire.

Table 6: Innovation potential assessment framework: Market potential

Criteria & questions		**Scoring**
Market potential	**Question code***	**Max: 10**
Type of innovation (if Q2b or Q2c selected):	Q3	
New product, process or service		1
Significantly improved product, process or service		0.75
New marketing or organizational method		0.5
Significantly improved marketing or organizational method, other		0.25
Consulting services		0
Type of innovation (if Q2a selected):	Q5	
Product or service		0.5
Process, marketing or organizational method		0
Consulting services		0
Innovation exploitation:	Q6	
Commercial exploitation		1
Internal exploitation		0.25
No exploitation		0
External bottlenecks	GQ4	
No external IPR issues that could compromise the ability of a project partner to exploit the innovation	GQ4a	0.5
No standards issues that could compromise the ability of a project partner to exploit the innovation	GQ4b	0.5
No regulation issues that could compromise the ability of a project partner to exploit the innovation	GQ4c	0.5
No financing issues that could compromise the ability of a project partner to exploit the innovation	GQ4d	0.5
No trade issues that could compromise the ability of a project partner to exploit the innovation	GQ4f	0.5
No other issues that could compromise the ability of a project partner to exploit the innovation	GQ4g	0.5
Needs of key organizations	Q13	
No investor readiness training need	Q13a	0.5
No investor introductions need	Q13b	0.5
No biz plan development need	Q13c	0.5
No expanding to more markets need	Q13d	0.5
No legal advice (IPR or other) need	Q13e	0.5
No mentoring need	Q13f	0.5
No partnership with other company (technology or other) need	Q13g	0.5
No incubation need	Q13h	0.5
No start-up accelerator need	Q13i	0.5
Number of patents have been applied for by the project	GQ5	
<2		0.25
≥2		0.5

Innovation potential assessment framework: Innovation readiness

Criteria & questions		Scoring
Innovation readiness		**Max: 10**
Development phase	Q2	
Under development		0
Developed but not exploited		1
Being exploited		2
Technology transfer**	Q10.1	
Done		1
Planned		0.5
Pilot**	Q10.3	
Done		1
Planned		0.5
Prototyping**	Q10.7	
Done		1
Planned		0.5
Demonstration or testing activities**	Q10.9	
Done		1
Planned		0.5
Feasibility study**	Q10.10	
Done		1
Planned		0.5
Other**	Q10.12	
Done		1
Planned		0.5
Time to market	Q14	
Less than 1 year		1
Between 1 and 2 years		0.75
Between 3 and 5 years		0.5
More than 5 years		0.25
No workforce's skills issues that could compromise the ability of a project partner to exploit the innovation	GQ4e	1

Innovation potential assessment framework: Innovation Management

Criteria & questions		**Scoring**
Management		**Max: 10**
There is a clear owner of the innovation	Q8	1
Business plan **	Q10.6	
Done Planned		1 0.5
Market study**	Q10.8	
Done Planned		1 0.5
Launch of a start-up or spin-off**	Q10.11	
Done Planned		1 0.5
No consortium internal IPR issues that could compromise the ability of a project partner to exploit the innovation	GQ2	1
Company's business unit involved in project activities**	Q10.2	
Done Planned		1 0.5
Capital investment**	Q10.4	
Done Planned		1 0.5
Investment from public authority**	Q10.5	
Done Planned		1 0.5
End-user engagement End-user in the consortium End-user consulted No end-user in the consortium or consulted	GQ1	 1 0.5 0
Commitment of relevant partners to exploit innovation Above average Average Below average	GQ8	 1 0.5 0

*GQ: general questions.

Steps **DONE in the project in order to bring the innovation to the market.

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