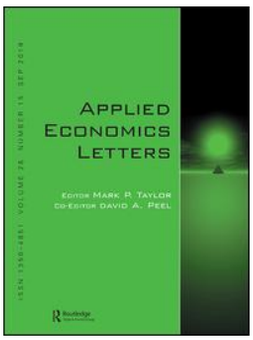

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ARTICLE

Bringing home the bacon: the relationship between firm characteristics and participation in EU Horizon 2020 projects

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ABSTRACT

Why some countries are more successful than others at securing European research and innovation grants is a question that has recently received significant attention in the research and policy communities. This article helps answer this question by investigating the role of firms in securing financial returns from EU Framework Programmes. More specifically, it explores how three firm characteristics – size, industrial sector, and country – can lead to increased participation in and larger grants from EU projects. The analysis is carried out using logistic and linear regressions on a combined data set consisting of data on Framework Programmes participation and firm characteristics. The analysis presents results for firms from four Nordic countries – Denmark, Finland, Norway, and Sweden – and their involvement in Horizon 2020.

KEYWORDS

Horizon 2020; Nordic countries; firm characteristics; research; innovation

JEL CLASSIFICATION

D21; L60; L80; O30

I. Introduction

In many European countries, there has been a heated debate about the costs and benefits of participating in the EU Framework Programmes (FPs) for Research and Innovation. Many of these countries have experienced that their financial contribution to the FPs has been growing faster than the financial returns that they have managed to secure. This gap, in turn, has prompted research authorities in many European countries to a search for ways of increasing their countries' participation in the FPs and inspired many European researchers to explore why some countries are more successful than others at securing European research and innovation grants. The result of this effort is that there is now an extensive literature discussing factors that primarily enable universities to obtain funding from the FPs (Enger and Castellacci 2016; Lepori et al. 2015; Neufeld, Huber, and Wegner 2013), less so on private firms.

Nevertheless, this literature is strongly biased towards research and higher education institutions. In the FPs, there is roughly a 30-30-30 distribution of funding between actors from the higher education sector, not-for-profit research institutes and private firms (the remaining 10 per cent is obtained mostly by the public sector and NGOs). Still, most existing studies have focused on the role of higher education institutions and research institutes in securing research grants and thereby neglected the role of private firms. To the best of our knowledge, no comprehensive studies, at the national level, have yet compared characteristics between firms which participate in and receive grants from FPs and those that do not. This article aims to help close this gap in the literature.

More specifically, this article will analyse the participation of firms in four Nordic countries (Denmark, Finland, Norway, and Sweden) in the latest FP, that is, Horizon 2020 (H2020). The article aims to answer the following research questions:

(1) What characterizes firms that are able to participate in H2020 projects (i.e., the probability of participation)?
(2) What determines the amount of funding that these participating firms receive (i.e., the size of grant)?

The literature on FP participation, in particular, and the science, technology, and innovation literature, more generally, gives some pointers as to the firm characteristics that might be important for participation in and the size of the grants received

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from FP projects. The literature on FP participation points out that participants tend to be strong and well-established institutions and organizations that are embedded in robust research networks, while the literature on science, technology, and innovation informs us that the research and innovation intensity varies significantly between different sectors in a country (Castellacci 2008). Inspired by this literature, we suggest the following three hypotheses. Firms are more prone to participate in and more likely to receive large grants from H2020 projects if:

H1: The firms are large and well-established

H2: The firms are part of research-intensive industries

H3: The firms are connected to strong research institutions

The three hypotheses will be tested in a two-stage analysis. In the first stage, we will investigate the validity of the hypotheses for participating in H2020 projects by using logistic regression on a data set consisting of private firms in the four Nordic countries. In the second stage, we will investigate the validity of the hypotheses for grant size by using linear regression on a data set consisting of private firms in the same countries *that have participated* in an H2020 project.

II. Data and methods

In our empirical analysis, we use firm-level data, which consist of firms in four Nordic countries: Denmark, Finland, Norway, and Sweden. These data are gathered from two sources. The first data source is the Amadeus database at NIFU (Nordic Institute for Studies in Innovation, Research and Education), which is provided by Bureau van Dijk. From this database, we use information about the industrial sector (alphabetical NACE code level, SIC2007) and size of the firms. Firm size is measured as the number of employees for the last available year (Y_{LA}) in the period 2015–2018. (In cases where Y_{LA} is not available, one of the years 2015–2017 has been used). We have included only firms with at least one employee in the analysis. The second data source is the EU's data warehouse eCORDA, which covers H2020 projects with a -starting year in the period 2015–2019. From these data, we have extracted information about research grants received by private-for-profit firms, which we define as the total amount of funding that the firm has received from H2020 (measured in million Euro). Firms are defined at the enterprise level in the analysis since this is the unit employed in both the Amadeus and eCORDA data. In both data sets, firms are identified by unique organization numbers, which were used to link the two data sets. Descriptive statistics are given in Table 1.

Dependent variables

This article investigates how firm characteristics influence the firm's probability of participating in EU FPs and the size of the grants that a firm receives by using two dependent variables: H2020 participation and H2020 grants. H2020 participation is a dummy variable that is '0′ if a firm has not participated in any H2020 projects and '1′ if it has participated in one or more projects. The H2020 grants variable is continuous and measures research grants and is calculated as the total current grants a firm has received through its participation in all H2020 projects.

The H2020 participation variable has a distribution that may cause concern for biases when certain statistical techniques are used since participation occurs so seldom that it can be considered what the literature describes as a 'rare event'. In our sample of 824,733 firms, only 1,723 firms participate in H2020 projects. Nevertheless, the literature points out that the bias problem is not specifically related to the rarity of events but rather to the number of rare events in the sample (Allison 2012). This suggests that a sample of 1,723 rare events should be sufficient to use statistical techniques such as logistic regression safely.

With regards to the H2020 grants variable, there is a considerable number of the participating firms in the four Nordic countries that receive no financial funding from a single H2020 project. However, since this is only the case for 13% of these firms when the analysis is based on the total amount of funding from

Table 1. Descriptive statistics, all firms and the participating firms.

	All firms		Participating firms	
	Numbers	Per cent	Numbers	Per cent
Country				
Denmark	142,802	17.3%	405	23.5%
Finland	181,137	22.0%	406	23.6%
Norway	138,310	16.8%	283	16.4%
Sweden	362,484	44.0%	629	36.5%
Industrial sector				
Agriculture, forestry and fishing (A)	35,117	4.3%	27	1.6%
Mining and quarrying (B)	1,471	0.2%	17	1.0%
Manufacturing (C)	51,687	6.3%	450	26.1%
Electricity, gas, steam and air conditioning supply (D)	2,051	0.2%	52	3.0%
Water supply; sewerage, waste management and remediation activities (E)	3,076	0.4%	9	0.5%
Construction (F)	108,870	13.2%	27	1.6%
Wholesale and retail trade; repair of motor vehicles and motorcycles (G)	132,571	16.1%	87	5.0%
Transportation and storage (H)	35,812	4.3%	21	1.2%
Information and communication (J)	47,051	5.7%	314	18.2%
Financial and insurance activities (K)	23,743	2.9%	10	0.6%
Real estate activities (L)	49,310	6.0%	18	1.0%
Professional, scientific and technical activities (M)	125,680	15.2%	613	35.6%
Administrative and support service activities (N)	36,980	4.5%	23	1.3%
Public administration and defence; compulsory social security (O)	1,221	0.1%	7	0.4%
Education (P)	15,733	1.9%	11	0.6%
Human health and social work activities (Q)	38,874	4.7%	14	0.8%
Arts, entertainment and recreation (R)	26,403	3.2%	9	0.5%
Other service activities (I,S,T,U)	82,231	10.0%	11	0.6%
Unknown	6,852	0.8%	3	0.2%
Number of employees				
1–9 employees	691,493	83.8%	653	37.9%
10–49 employees	105,306	12.8%	501	29.1%
50–249 employees	21,875	2.7%	262	15.2%
250 employees or more	6,059	0.7%	307	17.8%
H2020 participation variable				
Non-participating firms	823,010	99.8%		
Participating firms	1,723	0.2%		
Number of firms	824,733	100.0%	1,723	100.0%

all H2020 projects, we do not find that the distribution of the H2020 grants variable is sufficiently skewed to prevent us from using linear regression.

Explanatory variables

The article aims to investigate how the probability of H2020 participation and the grant size are affected by three firm characteristics. The first characteristic is firm size, which we measure as the number of employees. Firm size is used as a categorical variable in order to account for any non-linear relationship with the dependent variables and has the following categories (represented by four dummy variables): 1–9 employees, 10–49 employees (the reference category), 50–249 employees, and 250 employees or more. The second characteristic is the industrial sector (alphabetical NACE code level, SIC2007), where the group of manufacturing firms is used as the reference category. The third characteristic is research networks and institutional embedding, which are represented by country affiliation. Since we include only Nordic countries in the analysis, the firms are classified as either Danish, Finish, Norwegian (the reference category), or Swedish.

Conjectures and estimation methods

In the first part of the empirical analysis, we examine how the probability of H2020 participation is affected by the explanatory variables. Since H2020 participation is a dummy variable, the estimation is based on logistic regression (see the 'rare events' discussion above). In the second part, we examine how the total amount of funding is affected by the explanatory variables, using the H2020 grants variable as the dependent variable. Since few firms have no financial funding when aggregating over all H2020 projects, and very few of the fitted values of the H2020 grants variable are less than 0 (only 1.5% of the participating firms), we prefer to use linear regression in the second part of the analysis.

Based on the research literature and the specification of the statistical models, we expect to see higher participation rates and greater grant sizes for:

(i) Firms that have a larger number of employees.
(ii) Firms that belong to research-intensive industries – such as 'information and communication' and 'professional, scientific and technical activities'.
(iii) Firms located in countries with especially strong research institutions – such as Denmark and Sweden.

III. Estimation results

From Table 2, we see that the estimation results support one of the conjectures about participation, but only partially corroborate the other two. The estimation results show that the probability of participating in H2020 projects increases with the number of employees. Compared to the reference category with 10–49 employees, the probability of participating in H2020 projects is lower among firms with 1–9 employees and higher among firms with 50–249 employees and 250 employees or more – which confirms our conjectures about firm size.

In terms of industrial sectors, we see that only firms within 'electricity, gas, steam and air conditioning supply' and 'information and communication' have a significantly higher probability of participating in H2020 projects than the reference group of manufacturing firms. This is in line with our expectations in terms of information and communication firms but refutes our conjecture about firms engaged in 'professional, scientific and technical activities'. Furthermore, we see that the probability of participating in H2020 projects is significantly higher among firms in Denmark and

Table 2. The effects of the explanatory variables on the probability of participating in H2020 projects, logistic regression.

Explanatory variables	Coef.	SE
Country		
Denmark	0.387***	0.080
Finland	0.264***	0.079
Sweden	−0.144*	0.074
Industrial sector		
Agriculture, forestry and fishing (A)	−1.603***	0.200
Mining and quarrying (B)	0.184	0.256
Electricity, gas, steam and air conditioning supply (D)	0.962***	0.154
Water supply; sewerage, waste management and remediation activities (E)	−0.912***	0.339
Construction (F)	−2.960***	0.199
Wholesale and retail trade; repair of motor vehicles and motorcycles (G)	−2.147***	0.118
Transportation and storage (H)	−2.380***	0.224
Information and communication (J)	0.323***	0.076
Financial and insurance activities (K)	−3.175***	0.322
Real estate activities (L)	−2.300***	0.242
Professional, scientific and technical activities (M)	0.128*	0.066
Administrative and support service activities (N)	−2.368***	0.214
Public administration and defence; compulsory social security (O)	−1.805***	0.388
Education (P)	−2.460***	0.306
Human health and social work activities (Q)	−2.929***	0.272
Arts, entertainment and recreation (R)	−2.542***	0.337
Other service activities (I,S,T,U)	−3.596***	0.306
Unknown	−2.983***	0.581
Number of employees		
1–9 employees	−1.727***	0.062
50–249 employees	0.730***	0.078
250 employees or more	2.174***	0.077
Constant	−4.349***	0.079
LR chi-square (24)		5196.160
Prob > chi-square		0.000
Pseudo R2		0.210
Log likelihood		−9755.738
Number of firms		824,733

Notes: 1) *** Significant at the 1 per cent level, ** significant at the 5 per cent level, * significant at the 10 per cent level. 2) The classification of industrial sectors is based on the SIC2007 (alphabetical NACE codes in parenthesis). 3) The reference firm is a Norwegian manufacturing firm with 10–49 employees. 4) The logistic regression model is fitted using maximum likelihood, i.e. the parameter estimates are those values which maximize the likelihood of the observed data. The table reports the log likelihood of the fitted model, denoted LL_M. 5) The pseudo R2 reported is McFadden's R2. Let LL_0 denote the log likelihood when there are no explanatory variables in the model – only the constant term is included. McFadden's R2 is defined as $1-LL_M/LL_0$. 6) LR chi-square is the Likelihood Ratio Chi-Square statistic.

Finland than among those in Norway, while this probability is lower among Swedish firms than among Norwegian firms (but only at the 10 per cent level). The latter results do not support our expectation that we would see the highest participation among the Danish and Swedish firms.

From Table 3, we see that the results for the linear regression model paint a more diffuse picture about grant size. The results support our conjecture that larger firms receive more funding through their participation in H2020 projects, but the effect is only significant for firms with fewer than 10 employees and with 250 employees or more. However, the results do not support the conjectures about industrial sectors. We find no industrial sectors that have significantly higher grants from H2020 participation than the reference sector, even at the 10 per cent level. Research-intensive industries such as 'information and communication' and 'professional, scientific and technical activities' have a significantly lower grant size than the reference sector. Finally, none of the other countries have significantly higher grants from H2020 participation than Norway. Quite the contrary, Swedish and Finish firms have a significantly lower grant size than Norwegian firms.

Table 3. The effects of the explanatory variables on the H2020 grant size, linear regression.

Explanatory variables	Coef.	SE
Country		
Denmark	−0.156	0.102
Finland	−0.225**	0.102
Sweden	−0.223**	0.094
Industrial sector		
Agriculture, forestry and fishing (A)	−0.669***	0.258
Mining and quarrying (B)	−0.643**	0.320
Electricity, gas, steam and air conditioning supply (D)	−0.178	0.191
Water supply; sewerage, waste management and remediation activities (E)	−0.410	0.436
Construction (F)	−0.464*	0.257
Wholesale and retail trade; repair of motor vehicles and motorcycles (G)	−0.244	0.152
Transportation and storage (H)	−0.452	0.289
Information and communication (J)	−0.259***	0.098
Financial and insurance activities (K)	−0.657	0.414
Real estate activities (L)	−0.609*	0.311
Professional, scientific and technical activities (M)	−0.187**	0.083
Administrative and support service activities (N)	−0.492*	0.278
Public administration and defence; compulsory social security (O)	−0.761	0.493
Education (P)	−0.797**	0.396
Human health and social work activities (Q)	0.300	0.351
Arts, entertainment and recreation (R)	−0.693	0.437
Other service activities (I,S,T,U)	−0.745*	0.396
Unknown	−0.608	0.753
Number of employees		
1–9 employees	−0.166**	0.077
50–249 employees	−0.140	0.100
250 employees or more	0.216**	0.098
Constant	1.014***	0.107
F(24, 1698)		2.510
Prob > F		0.000
Adj R2		0.021
Root MSE		1.292
Number of firms		1,723

Notes: 1) *** Significant at the 1 per cent level, ** significant at the 5 per cent level, * significant at the 10 per cent level. 2) The classification of industrial sectors is based on the SIC2007 (alphabetical NACE codes in parenthesis). 3) The reference firm is a Norwegian manufacturing firm with 10–49 employees. 4) F(24, 1698) is the F statistic with 24 numerator degrees of freedom and 1698 denominator degrees of freedom.

IV. Interpretations and conclusions

In this article, we have investigated what characterizes firms that 'bring home the bacon' in terms of EU research and innovation funds. We started with three hypotheses about what makes firms more prone to participate in and more likely to receive large grants from H2020 projects. We found support for the first hypothesis about the positive effects of firm size, though we found a more pronounced effect for participation than grant size. However, we found little support for the hypothesis that firms that belonged to research-intensive industries or were connected to strong research institutes had a positive effect on participation and grant size. For instance, belonging to the 'information and communication' sector would increase the probability of participation but reduce the chance of receiving large grants. Based on this analysis, research authorities that want to increase the return from EU FPs should focus on involving their large and well-established firms in grants applications.

Would it be more efficient for the Nordic countries to focus on large and well-established firms? In terms of maximizing grants, probably. But in order to achieve economic growth, it might not be the right answer. Audretsch and Acs (1991) argued that firms' R&D productivity declined as the size of the R&D projects increased, hence producing diminishing returns on R&D investment. Kancs and Siliverstovs (2016) investigated the connection between productivity and R&D investment and whether it depends on the R&D intensity. They found that the output elasticity was negative at very low R&D-intensity, but rose

with R&D-intensity, although at a decreasing rate, confirming the existence of diminishing return on R&D investments. Thus, if national authorities only focus on large companies that can bring home large grants, they might lose out in terms of economic growth.

Most European countries have created comprehensive support schemes in mobilizing their R&D institutions to participation in proposals to the EU Framework Programmes. A more targeted focus on large firms would, however, conflict with the aims set by the European Union. Large firms with solid R&D capacity might be better equipped to fulfil the EU's targets in e.g. the European Research Council, whose sole focus is on research quality, and in the pillar 'Societal Challenges' of Horizon 2020 where major concerns shared by European citizens are addressed. But in the large pillar 'Industrial Leadership' the aim is to 'speed up development of the technologies and innovations that will underpin tomorrow's businesses and help innovative European SMEs to grow into world-leading companies'. In future studies, we would therefore suggest that the not-so successful group of SMEs may be more expediently analysed to determine how their participation in EU projects can be increased and what their participation can bring of economic benefits to their member states.

Disclosure statement

No potential conflict of interest was reported by the authors.

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