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Attractiveness and efficiency of European universities as hosts for Marie Curie grant holders

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Abstract

This study provides novel empirical insights into the attractiveness of European Universities for Marie Skłodowska-Curie Actions (MSCA) grant holders and investigates how efficient universities are in this respect relative their potential. To explore the attractiveness, factors explaining both the probability of a university being chosen as host for a MSCA grant holder as well as the number of grants are estimated by use of a zero-inflated negative binomial model. The analysis is based on the universe of MCSA grant holders from the EU Cordis H2020 database for the year 2017, linked to the 2016 information from the Times Higher Education database on 390 European universities. Approximately half of the universities hosts MSCA fellows in 2017. Estimations based on the zero-inflated negative binomial model reveal that research performance, share of international students as well as size of the university are significant factors of importance for the probability of attracting MSCA grant holders. Research performance, citations and the student staff ratio are significant predictors for the extent of grant holders. A comparison of actual and potential number of grant holders attracted reveals that some universities mainly in the Northwest of Europe (University of Copenhagen, KU Leuven, Eindhoven University of Technology, University of Antwerp, Aarhus University, University of Oslo, University of Vienna, University of Birmingham and University of Leeds) all receive far more MSCA fellows than would have been expected given their attributes, while Imperial College London and University College of London receive fewer.

Keywords: higher education, academic mobility, postdoctoral researchers, universities, count data model.

JEL: I20, I23

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1 Introduction

Academic mobility across countries, be it students or researchers, is well-established, well-analysed and increasing over time (Auriol, Misu and Freeman, 2013; Stephan, Scellato and Franzoni, 2015). Commonly, the starting point for these studies is the determinants of mobility at the individual level (Van Bouwel and Veugelers, 2013; Janger and Nowotny, 2016), while less is investigated about the role of single universities (see Reiner, Meyer and Sardadvar, 2017 for an exception) despite rising competition between them for academic talent (Wildavsky, 2012). The Marie Skłodowska-Curie Action (MSCA) is a major grant established by the European Commission to support research within its domain. Data available on these grants allows studies from the perspective of the single university.

The MSCA programme was founded in 1996, was significantly expanded in the EU Horizon 2020 programme (€6 billion for the period 2014-2020) and aims to promote development and training of researchers at all stages of their careers (European Commission, 2018). In addition, the scholarship is expected to enable research-oriented organisations (universities, research centres and companies) to host talented foreign researchers. According to the founder, MSCA fellowships are among the most competitive and prestigious awards in Europe, aimed at supporting the best and the most promising scientists (European Commission, 2018).¹

To date, universities in the United Kingdom are among those most successful in attracting MSCA fellows, representing almost a third of the 5000 scholarships granted between the years 2014 and 2018 (source: Cordis H2020 database). Oxford, Cambridge, Imperial College and University College of London (UCL) receive the largest number of fellows. Danish and Irish

¹ See also <https://ec.europa.eu/programmes/horizon2020/en/h2020-section/marie-sklodowska-curie-actions> accessed, 2018 December 10.

universities attract a disproportionately large number of grant holders given their sizes, while the opposite situation is found for German and Italian universities.

The aim of this study is to provide novel empirical insights into the attractiveness of European Universities for Marie Skłodowska-Curie Actions (MSCA) grant holders and to investigate how efficient universities are in this respect relative their potential, based on information from the Cordis H2020 database and the Times Higher Education Ranking (THE). Particular focus is put on the role of excellence (research performance and citations). A zero-inflated negative binomial count data model is used to investigate if and to what extent universities attract MSCA grant holders. The dataset includes 390 European universities that are listed in the 2016/2017 THE university ranking list, of which 205 hosted MSCA fellows in 2017. Unlike previous studies that use a limited number of characteristics of the university, this analysis investigates a broader set of features.

Literature identifies several possible quantifiable factors that influence the decision to study abroad or to go abroad for a postdoctoral position. Besides personal aspects and socio-economic characteristics quality of the university is identified as a main factor (Stephan, 2012; Van Bouwel and Veugelers, 2013), but there is no consensus in the literature about the strength of each factor.

The structure of this paper is as follows: Section two outlines the conceptual background, Section three describes the empirical approach while Section four introduces the dataset and the descriptive statistics. The results are presented and discussed in Section five and Section six concludes.

2 Conceptual background

Literature on the attractiveness of universities for young researchers and scientists is scarce, although there is plenty of studies on mobility of students and researchers as well as on location of R&D activities. This study benefits from these different strands of research in modelling the attractiveness of universities as MSCA grant holder hosts.

In recent decades, the international mobility of students and researchers has attracted attention from both policy and science (Cañibano, Otamendi and Solís, 2011; Cantwell, 2011; Appelt et al., 2015). Postdoctoral scholars are often of special interest since they make a significant contribution to international cooperation, joint research projects and the flow of knowledge (Stephan, 2012; Edler, Fier and Grimpe, 2011). Thus, there is strong competition among universities for this group. Academic mobility between Europe and the United States or between developing and emerging countries on the one hand and Western countries is sometimes regarded as a brain drain (Morano-Foadi, 2005). Although this risk may be smaller in Europe, universities in the Northwest attract the major share of MSCA grant holders, indicating an uneven spread across countries (source: Cordis H2020 database).

Intra-European mobility of researchers is also seen as an instrument to promote cooperation, knowledge transfer, competition and capacity building (Ackers, 2005, 2008; Flanagan, 2015). Scientific mobility is generally regarded as a temporary process where the researchers return to their home country after having acquired skills, knowledge and contacts during a multi-year stay in another European research system. Results of the OECD's Careers of Doctorate Holders (CDH) survey confirm that the proportion of doctorate holders who wish to move abroad temporarily is high compared to the proportion who plan to do so permanently (Auriol et al., 2013). Professors tend to favour working in the vicinity of high-quality colleagues and at internationally renowned, well-equipped universities (Janger and Nowotny, 2016).

Also important for the formulation of attractive features of universities as MSCA hosts is the literature on student mobility. So called *pull factors* could explain the selection of the host university. Such factors may relate both to the university itself (reputation and quality of the university, institution and its programmes, tuition costs and language, expertise of the staff and degree of innovativeness), to its surroundings (costs of living, opportunity to experience a different culture, possibility of long-term employment in the host country) as well as to other desirable characteristics or amenities of the host city (Mazzarol, 1998; Mazzarol and Soutar, 2002; Eder, Smith and Pitts, 2010; González, Mesanza and Mariel, 2011; Perkins and Neumayer, 2011; Van Bouwel and Veugelers, 2013; Beine, Noel and Ragot, 2014; Stephan et al., 2015; Bratti and Verzillo, 2019).

In addition, Perkins and Neumayer (2011) suggest that, beyond the role and importance of tuition fees as well as the position of universities in international rankings, the attractiveness to international students depends on geographical proximity, presence of a common language, presence of colonial ties, presence of a well-established national community in the host country and the role and importance of social ties and networks. Van Bouwel and Veugelers (2013) demonstrate that academic quality of the host country, measured by the relative impact of a country's publications and by the number of universities among the 200 best in the Shanghai ranking, is a significant factor determining the size and direction of aggregate student flows for 18 European countries, while Stephan (2012) suggests that research excellence and the career prospects play a crucial role in attracting foreign students and postdoctoral researchers (Stephan, Franzoni and Scellato, 2013).

There are also similarities between university attractiveness as grant holder hosts and factors determining the international location of R&D activities. Several studies examine these factors (Ito and Wakasugi, 2007; Shimizutani and Todo, 2008; Siedschlag et al., 2013; Belderbos et

al., 2014; Belderbos, Leten and Suzuki, 2017; see Dunning and Lundan, 2009 for a review) and show that size of the local market and the local knowledge base such as the scientific infrastructure and educational qualifications of the workforce are key factors in attracting foreign direct investment in R&D and related activities. The importance of local universities as a factor for foreign R&D is well-documented in the literature (Hall, Link and Scott, 2003; Belderbos et al., 2017; Belderbos et al., 2014). Empirical studies demonstrate that the scientific strength of local universities is crucial for the international location of R&D (Alcacer and Chung, 2007; Belderbos et al., 2017; Siedschlag et al., 2013). Arauzo-Carod and Viladecans-Marsal (2009) indicate that metropolises are the preferred location for R&D activities and high-tech companies.

The Marie Skłodowska Curie Action (MSCA) offers individually tied scholarships following a bottom-up call for proposals. Selection criteria include measurement of research excellence, valuation of the quality of the research project as well as an assessment of the supervisor and the host institution (European Commission, 2018). This means that top universities are expected to attract more MSCA grant holders. Excellence of universities can be determined in several ways. The most common measure of research performance is the number of publications (Moed et al., 1985), usually adjusted for size of the department or university. an alternative measure is the number of citations, which measures the relevance, dissemination and possibly also the impact of the of the research.

Given the lack of similar studies, the empirical model in this study is influenced by the literature on the determinants of researcher and student mobility (González, Mesanza and Mariel, 2011; Van Bouwel and Veugelers, 2013; Stephan et al., 2015; Janger and Nowotny, 2016) as well as by the location of R&D activities (Dunning and Lundan, 2009). Particular focus is put on indicators reflecting the quality of a university (number of publications and citations), size,

international students, industry grants as well as university and industry collaboration. The main expectation is that a bundle of factors affects the attractiveness of the universities as MSCA grant holder hosts, although universities with a relatively high number of publications and citations are expected to be more attractive in general. Another factor which might influence the lure of a university for MSCA grant holders is its international atmosphere and the extent of international collaborations. The attractiveness of universities as MSCA fellow hosts is also likely to increase with a higher staff-student ratio. Several other factors could be of importance for the attractiveness of universities such as reputation, appeal of the city, infrastructure, but these factors are either difficult to quantify or limit geographically, although they may play important roles in the deviation between the potential and actual attractiveness of a university.

3 Empirical approach

The empirical model is influenced by the literature on determinants of academic and student mobility as well as by research on international location for R&D activities (Dunning and Lundan, 2009; Van Bouwel and Veugelers, 2013; Stephan et al., 2015). This leads to a specification where the number of MSCA grant holders a university manages to attract depends on a set of variables including excellence, international atmosphere and size:

$$\begin{aligned} MSCA_i = & \beta_1 + \beta_2 Research_i + \beta_3 Citations_i + \beta_4 Industry\ Income_i \\ & + \beta_5 International\ Outlook_i + \beta_5 \ln(Students)_i + \beta_6 Students/Staff_i \\ & + \beta_7 Sh_International_students_i + \sum_{c=1}^N CountryDummies_i + \varepsilon_i. \end{aligned}$$

The explanatory variables are all lagged one year and subscript i denotes university. A description of the variables is found in Table 1.

Table 1. Variable descriptions

Independent variable	Description
Research	Composite index on research performance based on research volume, research income and reputation.
Citations	Number of times a university's published work is cited by scholars globally (Index).
Industry Income	Research income an institution earns from industry (adjusted for PPP), scaled against the number of academic staff it employs (index).
International Outlook	Composite indicator comprising of international-to-domestic-student ratio, international-to-domestic-staff ratio and international collaboration (index).
ln (students)	Number of full-time students (ln() natural logarithm).
Students/Staff	Number of full-time students per academic employee.
Sh_ International Students	Share of international students.

Source: The THE.

Dependent variable is the number of MSCA-fellowships in 2017 (or alternatively 2016), ranging from 0 to 38. Since the median is 1 and the mean is 2.2, Ordinary Least Squares (OLS) estimations would give distorted results and cannot be employed. Instead, a count-data model is best suited for the data. Because half of the European universities in the 2017 sample does not receive any MSCA fellows, the assumption of a Poisson or negative binomial distribution is violated and therefore the standard count-data model is not optimal. This leads to the zero-inflated Poisson model (ZIP) or the zero-inflated negative binomial model (ZINB) (Cameron and Trivedi, 1998), which allows zeroes to be generated by two distinct processes: one for the probability of a university hosting a MSCA fellow (Logit or Probit) and the other for the number of MSCA grant holders (count-data part). Thus, the likelihood to (not) receive a MSCA grant may be modelled either by the Probit or the Logit model while the number of MSCA fellows can be estimated by the negative binomial or the Poisson distribution. With the number of MSCA fellows following the zero-inflated negative binomial distribution, the probability distribution is written as follows (for a given year):

Probability of zero: $\Pr(0 = MSCA_i) = \pi_i + (1 - \pi_i) \left(\frac{\phi}{\mu_i + \phi}\right)^\phi$

Probability of counts: $\Pr(MSCA_i = y_i) = (1 - \pi_i) \frac{\Gamma(y_i + \phi)}{\Gamma(\phi) y_i!} \left(\frac{\phi}{\mu_i + \phi}\right)^\phi \left(\frac{\mu_i}{\mu_i + \phi}\right)^{y_i}$ for $y_i > 0$,

where $MSCA$ reflects the number of grant holder for the i th university, μ_i is the expected value of the model, $1/\phi = \alpha$ is the over dispersion parameter, π denotes the probability of excess zeros (universities that attract no grant holders in a given year) and $\Gamma(\cdot)$ is the gamma function. The zero-inflated link function can be specified either as the logistic function or the standard normal cumulative distribution function (the Probit function). In this case, the probability of hosting no grant holders is modelled as Probit function. If α approaches zero, the zero inflated negative binomial (ZINB) model is reduced to the zero inflated Poisson (ZIP) model. A Likelihood ratio test can be used to investigate whether α is significant. The Vuong test (Vuong, 1989) can be used to investigate whether the zero-inflated negative binomial model is more appropriate than the standard negative binomial count data model.

Based on the estimates, the best performing university is identified given its attributes by use of nonparametric methods and by stochastic production functions at the boundaries. These methods are often employed to rank firms according to their level of productivity (Battese and Coelli, 1988) or destinations according to their competitiveness in travel and tourism (Cracolici, Nijkamp and Rietveld, 2008; Barros et al., 2011; Assaf and Josiassen, 2012). Since the dependent variable takes on many zeroes, a simple deterministic border production function developed by Aigner and Chu (1968) is chosen, where the estimates are based on the predictions derived from the count-data model.

Thus, universities with the highest number of MSCA grant holders given their characteristics are considered to be the most efficient ones, where one particular university is defined as the top performer (100% efficient). This university hosts the largest number of grant holders given

its attributes. By using this approach, the central research question of attractiveness to MSCA grant holders is translated into efficiency terminology, where those universities close to or on the frontier (hosting the highest numbers of MSCA grant holders) are also the most attractive ones.

4 Data

Information about the MSCA is found in the Cordis H2020 database and excellence as well as other university features are available in the Times Higher Education (THE) database (<https://www.timeshighereducation.com/world-university-rankings>). The THE database includes a mix of quantitative and qualitative information (Marginson and Van der Wende, 2007). This listing, as well as the Shanghai university ranking, is commonly used to compare the performance of universities (Jöns and Hoyler, 2013; Reiner et al., 2017) and in analyses of the economics of innovation (Siedschlag et al., 2013). Aguillo et al. (2010) show that there are reasonable similarities between the different rankings (including also the CWTS Leiden ranking, Waltman et al., 2012), although each employs a different methodology (Olcay and Bulu, 2017). In this case, the THE database is used because it encompasses a broader set of features of the universities.

The MSCA has four actions: host research, training and career development activities for young researchers with doctoral degrees, individual fellowships for experienced researchers (post-docs), RISE - Research and Innovation Staff Exchange Scheme and COFUND – Co-funding of regional, national and international research programmes (European Commission, 2018). In the H2020 period, the programme focuses on individual MSCA Fellowships (MSCA IF) for researchers moving within Europe. The number of MSCA grants assigned during the period

2014 to 2017 ranges between 1200 and 1360 per year (Source Cordis H2020 database).² However, in this study the year 2016 is selected for the university specific indicators because the THE database is significantly expanded from then onwards, covering 390 universities in Europe. The year 2017 is selected for the scholarship data, while information on university characteristics refers to 2016. The reason for this is that the application and acceptance of the scholarship do not appear simultaneously. From 2016 onwards the THE also includes a richer set of universities. Information on individual scholarship holders is aggregated at the host institution level. The list of MSCA grant holders also includes public research institutions such as CRNS in France or the Fraunhofer Institute in Germany. These institutions (approximately ten per cent of the universe of host institutions) cannot be included in the empirical analysis as there is no information about their performance in the THE database. As a robustness check the number of MSCA fellowships in 2016 is used.

The ranking of the top 30 universities with the highest number of MSCA grant holders reveals that these fellows are often found at United Kingdom universities, confirming that this is one of the leading scientific nations in Europe (Table A1, Appendix A). The ranking does not change much across years. In addition, data also shows that German universities host a disproportionately small number of MSCA fellows given their sizes.

Research performance, originating from the THE database, is a composite indicator based on research volume, research income and reputation.³ Research productivity is built on the number of articles published in scientific journals, indexed per scientist by the Elsevier Scopus database, scaled for institutional size and normalized for subject. This gives an idea of ability of the

² The numbers for the different years are as follows: 1,361 in 2014, 1,209 in 2015, 1,252 in 2016 and 1243 in 2017. Source: Cordis H2020 database.

³https://www.timeshighereducation.com/world-university-rankings/2017/world-ranking#!/page/0/length/25/sort_by/rank/sort_order/asc/cols/stats accessed 2018 dec 10.

university to publish in high quality peer reviewed journals. Number of publications are commonly used as an indicator of research performance (Jonkers and Cruz-Castro, 2013). Research revenues are adjusted for the number of scientific employees, the Purchasing Power Parity (PPP) and the reputation of the university. Research productivity and research income each account for 20 per cent of the variable and the remaining part is allocated to reputation.

Citations are measured by the frequency with which the published work of a university is quoted by scientists worldwide.⁴ The database encompasses 56 million citations of 11.9 million journal articles, conference proceedings, books and book chapters published between 2011 and 2015. The data include the 23,000 scientific journals indexed by the Elsevier database Scopus and all indexed publications between 2011 and 2015. All data are standardised to reflect differences in citation volume between disciplines. This means that institutions with high research activity in subjects with traditionally high citation numbers do not receive any unjustified advantages.

The international orientation (staff, students, research) measures the ability of a university to attract students, postgraduates and lecturers from all over the world. This composite indicator also includes the proportion of research articles by the university that has at least one international co-author.

Industrial income is another measure of knowledge transfer. This category aims to capture knowledge transfer activities by investigating how much research revenue an institution generates from industry (adjusted for PPPs), weighted by the number of scientific employees. The category gives an indication of the extent to which companies are willing to pay for research and the ability of a university to raise funds in the commercial market of institutional quality.

⁴https://www.timeshighereducation.com/world-university-rankings/2017/world-ranking#/page/0/length/25/sort_by/rank/sort_order/asc/cols/stats accessed 2018 December 10.

Descriptive statistics reveal that the average number of MSCA fellows at a university are two and that the standardised number of publications and citations are 27 and 59, respectively (Table 2). There are 22 students per university academic staff on average. The average number of students is 16,320 (log value is 9.7), one out of five is international.

Table 2: Descriptive statistics main variables

	# Obs	Mean	Std. dev.	Min	Max
MSCA fellows in 2017	390	2.1	4.1	0.0	38.0
Research (index)	390	26.9	17.3	3.2	99.1
Citations (index)	390	59.0	24.1	3.7	100.0
Industry Income (index)	390	44.8	16.7	32.1	100.0
International Outlook (index)	390	58.9	20.7	14.5	99.9
In Students	390	9.7	1.1	2.7	11.7
Student-Staff ratio	390	21.9	13.2	0.1	100.3
Share International Students in per cent	390	20	30.2	0.0	100.0

Sources: Cordis H2020 database 2017 and the THE 2016/2017.

5 Empirical results

Just like for individual flows of students, researchers and investments in R&D, excellence (measured as number of articles) is important for attracting MSCA scholars to a university, as is its size (number of students) and international openness (share of international students). The extent of these scholarships is related to similar factors, but also to a deepening of the excellence (number of citations), indicating the efficiency of the research performance (Table 3). Industry income and international outlook are not relevant while the student-staff-ratio matters for the number of MSCA fellows.

The ZINB model comprises two parts: one equation explains the probability of hosting a MSCA fellow and the other is the number of MSCA fellowship holders. Probit estimations demonstrate that the probability of a university hosting a MSCA grant holder increases with the research performance and the share of international students. Given the two-part model approach, technically, the Probit estimates indicate the probability of not hosting a MSCA fellow. This probability decreases with the research performance of the host university given its size,

measured as the number of students. The Vuong test shows that the negative binomial model is rejected against the zero-inflated negative binomial model.

Beside research performance and citations, the count-data part indicates that a larger number of students relative to the number of employees is associated with fewer MSCA grant holders. This implies that MSCA fellows prefer research universities rather than teaching universities.

To give an indication of the magnitude of the associations, the effect of an increase in the research and citation index of one standard deviation is calculated. A one standard deviation increase in the research performance index leads to a rise in the number of MSCA fellows by 1.2 (calculated as 0.07×17.3). The corresponding effect for citations is 1.0. An increase in size of the university by one standard deviation is associated with a surge of 0.5 and a reduction in the student-staff ratio by one standard deviation is related to an increase of 0.65 grant holders. Thus, these calculations reveal that quality of the university, measured as research performance or citations, is the most important factor in attracting MSCA fellows.

Table 3: Factors affecting the number of MSCA grant holders in 2017

	Probit equation				Count-data part				
	Coeff.	z-stat	dy/dx ^a	z-stat	Coeff.	z-stat	dy/dx ^b	z-stat	
Research	-0.102 ***	-4.11	-0.019 ***	-5.20	0.023 ***	3.98	0.070 ***	4.63	
Citations	-0.008	-0.62	-0.001	-0.62	0.019 **	2.13	0.043 **	2.31	
Industry Income	0.011	0.54	0.002	0.54	-0.002	-0.50	-0.007	-0.71	
International Outlook	0.013	1.01	0.002	1.05	0.008	1.15	0.016	1.02	
Ln Students	-1.008 ***	-3.42	-0.186 ***	-4.74	0.113	0.91	0.446 *	1.83	
Student-staff ratio	0.019	1.27	0.004	1.34	-0.021 **	-2.29	-0.050 ***	-2.94	
Sh_International students	-4.960 *	-1.94	-0.916 ***	-2.20	-0.291	-0.54	0.373	0.38	
Constant	10.579 ***	3.37			-2.287	-1.55			
A	0.601 **								
Number of observations	390				390				
Number of zeros	185								
Log pseudo likelihood	-594.5								

Notes: The dependent variable is the number of MSCA grant holders. Asterisks ***, ** and * denote significance at the 1, 5 and 10 per cent levels. ^aThe marginal effects measure the probability of not hosting MSCA grant holders. ^bThe marginal effects (dy/dx) of the determinants show the influence on the number of MSCA grant holders including zero values representing the joint effect of the inflate equation and the negative binomial model. Standard errors are cluster-adjusted at the country level (33 clusters).

The findings related to the importance of research performance is consistent with the literature on student mobility (Van Bouwel and Veugelers, 2013; Bratti and Verzillo, 2019), mobility of researchers (Janger and Nowotny, 2016) and international location of R&D activities (Alcacer

and Chung, 2007; Belderbos et al., 2017; Siedschlag et al, 2013). As mentioned in the conceptual background, there are several possible alternative factors of importance for the attractiveness of a university for the MSCA fellow, such as city appeal and infrastructure, although these are difficult to quantify or limit geographically. However, this is not expected to be a major problem in the analysis since other variables partly capture these aspects. For instance, without a decent infrastructure a university cannot possibly become large or may find it difficult to attract international students.

Based on the estimations of the zero-inflated negative binomial model, both the predicted number of MSCA grant holders and the efficiency index is calculated. This makes it possible to benchmark the performance of universities against each other. When the predicted numbers of grant holders are compared with the actual ones, a group of universities, mainly in the Northwest of Europe (University of Copenhagen, KU Leuven, Eindhoven University of Technology, University of Antwerp, Aarhus University, University of Oslo and University of Vienna, University of Birmingham and University of Leeds) attracts far more fellows than would have been expected given its attributes while Imperial college London and University College of London, for instance, host fewer (Table A2, Appendix A).⁵ One explanation behind a lower than potential performance by a top ranked university could be that there are other person-bound grants available that lowers the pressure to attract MSCA funding and fellows (Jonkers et al., 2018).

Several robustness checks are conducted. First, an alternative data source is used for university features (the CWTS Leiden Ranking, Waltman et al., 2012). This edition of the ranking provides bibliometric statistics for about 1000 major universities worldwide. Re-estimations

⁵ Venice is excluded in the calculation of the efficiency index because the number of MSCA fellows in 2017 is considerably higher than in earlier years.

with these data give similar results. Nor does the inclusion of age of the university and a dummy variable for Nobel prize winner change the results, since these variables turn out insignificant. An explanation to the latter insignificance could be that a Nobel laureate dummy partly coincide with the excellence variables, or that most prize winners in recent years are based in the United States, and thus have no impact on the attractiveness of European universities as MSCA hosts. A second robustness check employs the standard negative binomial model and the multilevel (country level) negative binomial model for the estimations, without clear discrepancy in results, although the gap between actual and predicted numbers of MSCA grant holders is larger (Table A3, Appendix A). Finally, the empirical model is estimated by using the number of MSCA grant holders for the year 2016, to secure that the results are not sensitive to the period of time chosen, which they are not. Unreported results show that the estimations and the ranking of predicted MSCA grant holders is similar, except Venice that exhibits much fewer grant holders in 2016.

6 Conclusions

The aim of this paper is to empirically investigate the attractiveness of European universities as hosts for Marie Curie (MSCA) grant holders and to explore how efficiently universities perform in relation to their potential in this respect. As opposed to the main literature on research and student mobility, this study takes the novel perspective of the single university instead of the individual as the starting point. This approach has some features in common with the location of international R&D.

Estimations of a zero-inflated negative binomial model based on data for 390 universities show that excellence (measured as number of articles) is important for attracting MSCA scholars to a university, as is its size (number of students) and international openness (share of international students). These results follow those on individual flows of students, researchers and

investments in R&D. The extent of scholarships is related to similar factors, but also to a deepening of the excellence (number of citations), indicating the efficiency of the research performance. A comparison of the actual number of MSCA fellows with the predicted ones, indicates that some universities have potential for improvements in this respect and that others are already performing above their potential. Availability of other kinds of grants could be an explanation behind why, although doing well in this respect, some top ranked universities do not reach their full potential.

The fact that a group of universities do not use their full potential as MSCA hosts has several implications. Promotional measures may be taken internally as well as externally to attract MSCA scholars. Those universities with limited research could consider actively supporting an expansion of these activities, at least within specific fields, to become more attractive as hosts. The MSCA scholarship is most likely a win-win situation for all parties involved, minimal cost for the university and the opportunity of a two-way knowledge transfer. However, it is unclear how universities outside the already existing sphere of academic excellence can gain from the knowledge transfer. The United Kingdom exit from the European Union may affect the country as a European stronghold of academic excellence and holder of most MSCA fellows, independently of participation in framework programmes, implying a need of future analysis of this subject.

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Appendix A

Table A1: Number of MSCA grant holders by university (Top 30)

Rank	Name of the institution	2014	Rank	Name of the institution	2015
1	Centre national de la recherche scientifique	58	1	University of Oxford	54
2	University of Cambridge	55	2	Centre national de la recherche scientifique	37
3	University of Copenhagen	50	3	University of Cambridge	33
4	University of Oxford	48	4	University of Copenhagen	30
5	Imperial College London	32	5	UCL	29
6	UCL	29	6	Max-planck-gesellschaft	21
7	University of Edinburgh	23	7	Imperial College London	20
8	University of Birmingham	22		Agencia Estatal Consejo Superior de	
9	Max-Planck-Gesellschaft	19	8	Investigaciones Científicas	19
	Agencia Estatal Consejo Superior de Investigaciones		9	École Polytechnique Fédérale de Lausanne	19
10	Científicas	17	10	University of Birmingham	18
11	Aston University	13	11	University of Leeds	17
12	Queen Mary University of London	13	12	University of Bristol	15
13	University of Manchester	13	13	Eidgenössische Technische Hochschule Zürich	14
14	University of Warwick	13	14	KU Leuven	13
15	University of Amsterdam	13	15	Queen Mary University of London	13
16	King's College London	12	16	University of Manchester	13
17	The University of Sheffield	12	17	Utrecht University	13
18	University of Bristol	12	18	University of Glasgow	12
19	University of Sheffield	12	19	Newcastle University	11
20	Newcastle University	11	20	University of Warwick	11
21	LMU Munich	10	21	King's College London	10
22	University of Vienna	10	22	University of Edinburgh	10
23	Utrecht University	10	23	University of York	10
24	University of Glasgow	10	24	Aarhus University	9
25	University of Leeds	10	25	Karolinska Institute	9
26	Aarhus University	9	26	TU Delft	9
27	Fundació Institut de Ciències Fotòniques (ICFO)	9	27	Trinity College Dublin	9
28	KU Leuven	9	28	University of Sheffield	8
	Stichting Katholieke Universiteit - Radboud			Institut national de la santé et de la recherche	
29	University	9	29	médicale	8
30	University of Exeter	9	30	The University of Sheffield	8
31	University of York	9	31	University of Zurich	8
32	Wageningen University	9			
Rank	Name of the institution	2016	Rank	Name of the institution	2017
1	University of Copenhagen	46	1	University of Copenhagen	38
2	Centre national de la recherche scientifique	35	2	Centre national de la recherche scientifique	37
3	University of Oxford	35	3	University of Oxford	28
	Agencia Estatal Consejo Superior de Investigaciones				
4	Científicas	26	4	University of Cambridge	25
5	Imperial College London	26	5	Max-Planck-Gesellschaft	24
6	UCL	24		Agencia Estatal Consejo Superior de	
7	University of Cambridge	24	6	Investigaciones Científicas	23
8	Max-Planck-Gesellschaft	23	7	KU Leuven	19
9	University of Leeds	19	8	Aarhus University	17
10	KU Leuven	17	9	University of Birmingham	17
11	University of Birmingham	17	10	UCL	17
12	École Polytechnique Fédérale de Lausanne	14	11	University of Leeds	16
13	University of Amsterdam	13	12	Ca' Foscari University of Venice	14
14	Eidgenössische Technische Hochschule Zürich	12	13	University of Bristol	14
15	King's College London	12	14	University of Edinburgh	13
16	Utrecht University	12	15	Consiglio Nazionale Delle Ricerche	12
17	University of Bristol	12	16	Imperial College London	12
18	University College Dublin	11	17	University of Warwick	12
			18	Lund University	10

19	Queen Mary University of London	10	19	Queen Mary University of London	10
20	University of Exeter	10	20	University of Leiden	10
21	University of Manchester	10	21	University of Oslo	10
22	TU Delft	9	22	Cardiff University	9
23	University of Glasgow	9	23	TU Delft	9
24	Aarhus University	8	24	Trinity College Dublin	9
25	Consiglio Nazionale Delle Ricerche	8	25	University of Nottingham	9
	Institut national de la santé et de la recherche				
26	médicale	8	26	University of Glasgow	9
27	Ludwig-Maximilians-Universität Muenchen	8	27	École Polytechnique Fédérale de Lausanne	8
				Fundacio Privada Institut Catala D'investigacio	
28	Trinity College Dublin	8	28	Quimica	8
29	UPV/EHU: University of the Basque Country	8	29	Eindhoven University of Technology	8
30	University of York	8	30	University of Manchester	8
			31	Pompeu Fabra University	8
			32	University of Antwerp	8
			33	University of Amsterdam	8

Source. Cordis H2020 database.

Table A2: Comparison of predicted and actual number of MSCA grant holders (2017)

	MSCA-IF in 2017	FIT MSCA-IF in 2017 ZINB	Ratio	Efficiency score
1 University of Copenhagen	38	6	6.2	100.0
2 University of Cambridge	29	25	1.1	18.4
3 University of Oxford	25	28	0.9	14.5
4 KU Leuven	19	6	3.3	53.8
5 UCL	18	22	0.8	13.3
6 University of Birmingham	17	5	3.1	50.2
7 Aarhus University	17	6	2.7	43.0
8 University of Leeds	16	5	3.2	51.9
9 Ca' Foscari University of Venice ^a	14	1	22.9	
10 University of Bristol	14	8	1.8	29.5
11 University of Edinburgh	13	15	0.8	13.6
12 University of Warwick	12	6	1.9	30.7
13 Imperial College London	12	19	0.6	10.4
14 Queen Mary University of London	10	6	1.6	25.8
15 University of Oslo	10	5	2.1	34.3
16 Lund University	10	6	1.6	25.1
17 University of Vienna	10	4	2.4	38.6
18 Leiden University	10	7	1.5	24.5
19 Cardiff University	9	4	2.1	33.9
20 University of Nottingham	9	5	1.9	31.0
21 Utrecht University	9	5	1.7	27.1
22 University of Glasgow	9	7	1.3	21.3
23 Delft University of Technology	9	6	1.5	24.3
24 Eindhoven University of Technology	8	1	5.8	93.4
25 University of Antwerp	8	2	3.9	62.1
26 Pompeu Fabra University	8	4	2.3	36.5
27 University of Manchester	8	9	0.9	14.1
28 University of Amsterdam	8	8	0.9	15.2
29 École Polytechnique Fédérale de Lausanne	8	11	0.7	11.8
30 Aston University	7	2	4.3	69.2
31 University of Padua	7	2	3.2	51.2
32 Newcastle University	7	4	1.8	29.6
33 University of Bergen	7	4	1.9	30.7
34 Technical University of Denmark	7	3	2.0	32.6
35 University of Southampton	7	6	1.2	18.8
36 University College Dublin	7	3	2.1	34.0
37 Paris-Sorbonne University – Paris 4	6	1	6.0	97.1
38 University of Basel	6	4	1.4	21.8
39 Sapienza University of Rome	6	2	3.1	50.2
40 University of Lausanne	6	5	1.3	21.1
41 KTH Royal Institute of Technology	6	4	1.6	26.1
42 University of York	6	5	1.2	19.2
43 Ghent University	6	3	2.1	33.1
44 University of Sheffield	6	6	1.1	17.5
45 Radboud University Nijmegen	6	5	1.1	17.8
46 Karolinska Institute	6	12	0.5	8.3
47 University of the Basque Country	5	1	5.0	80.3
48 University of Cyprus	5	1	5.1	81.6
49 University College Cork	5	1	3.8	61.3
50 Royal College of Surgeons in Ireland (RCSI)	5	2	3.2	50.8
51 École Normale Supérieure	5	5	1.0	15.7
52 Polytechnic University of Milan	5	2	2.3	37.2
53 Vrije Universiteit Amsterdam	5	5	1.1	17.6
54 University of Exeter	5	6	0.9	14.2
55 University of Geneva	5	4	1.1	17.9
56 University of Zurich	5	7	0.8	12.1
57 LMU Munich	5	9	0.6	8.9

58	Maastricht University	5	5	1.0	15.9
59	Erasmus University Rotterdam	5	7	0.7	11.0
60	ETH Zurich	5	20	0.2	4.0

Notes: The efficiency scores are based on the ZINB estimations. Calculations are restricted to the cities with a predicted number of MSCA grant holders of 5 or more. University of Venice is excluded in the calculations because it received less than 5 in the previous years. Research organisations are not included in the estimations.

Table A3: Negative binomial estimations on factors affecting the number of MSCA grant holders

	Multi effects NBERG		NBERG	
	Coeff.	z-stat	Coeff.	z-stat
Research	0.033 ***	5.73	0.033 ***	3.82
Citations	0.017 ***	3.76	0.014	1.61
Industry Income	-0.006	-1.12	-0.004	-0.68
International Outlook	0.019 ***	3.05	0.015 *	1.69
ln Number of FTE students	0.340 ***	3.84	0.363 **	2.25
Number of students per staff	-0.013 *	-1.67	-0.013 **	-2.34
International Students	0.785 **	1.98	0.896 *	1.77
Constant	-5.834 ***	-5.84	-5.990 ***	-2.79
Country dummy variables	no		yes	
α	0.668 ***		0.557 ***	
Var (constant)	0.216 *	1.78		
LR test vs. negative binomial model (p-value)	0.00			
Log likelihood/Log pseudolikelihood	-600.11		-569.27	
Pseudo R ²			0.21	

Notes: Note: Research organisations are not included in the estimations. Asterisks ***, ** and * denote significance at the 1, 5 and 10 per cent levels.