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Article

Universities of applied sciences' EU research project participation through the lens of differentiation

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Abstract

In European universities of applied sciences (UASs), the intensity of research activities and the level of differentiation from universities vary across countries. We investigate whether the differentiation in the research function of UASs is reflected in their participation in the European Union Framework Programs for Research and Innovation (EU-FPs). We focus on the current and former UASs in four higher education systems with distinct levels of differentiation—the UK, Norway, Switzerland, and the Netherlands. Our results show significant cross-country differences in the intensity and type of EU-FP projects acquired. The former UASs in the UK and Norway had a participation profile similar to that of universities. In more differentiated higher education systems, Swiss and Dutch UASs were more geared toward applied projects. Variations both across and within countries emphasize the importance of research capacities. Our results carry implications for how national and European authorities can foster UAS participation in EU-FPs.

Key words: universities of applied sciences; differentiation; EU Framework Programs; science policy; public research funding; academic drift.

1. Introduction

Universities of applied sciences (UASs)—a broad term for second-tier higher education institutions (HEIs) (De Wit et al. 2015), such as Hochschulen für Angewandte Wissenschaften or Fachhochschulen (Germany and Switzerland), Hogescholen (Belgium and the Netherlands), colleges (Norway), or polytechnics (Finland and Portugal)—represent an important component of European higher education and account for more than one-third of the enrolled bachelor's degree students in countries such as Denmark, Ireland, the Netherlands, Portugal, and Switzerland. While created as teaching-only institutions, over time, several UASs have acquired an official research mandate.

As such, there has been scholarly debate surrounding whether the research activities of UASs imply that they are becoming similar to universities (referred to as academic drift or soft differentiation) or whether they are developing a specific mission oriented toward applied research and regional development (known as hard differentiation) (Burgess 1972; Kyvik and Lepori 2010; Neave 1979). Comparative research has shown important cross-country differences in this respect (Kyvik and Lepori 2010; Vossensteyn and De Weert 2013).

This paper investigates how the heterogeneity of the European UAS landscape is reflected in the participation of UASs in European Union Framework Programmes for Research (EU-FPs). UAS participation in European Union (EU) funded projects has increased overall in the last two completed EU-FPs although their level of participation was rather marginal compared to that of universities (Lepori et al. 2015). There is, however, a growing interest among many UASs in strengthening their international positioning, notably through the acquisition of competitive research and development (R&D) funding (Leifgen and Burkhart 2019).

We consider the current and former UASs in four higher education systems with varying degrees of differentiation. We have a purposeful sample including a country where differentiation was abolished (the UK), one where we observe blurring (Norway), and two with strong distinction but more or less focus on research (Switzerland and the Netherlands). We investigate whether the intensity and mode of EU-FP participation of these current and former UASs are linked to their positioning in higher education systems and/or organizational characteristics. Despite the abolition of legal differentiation in 1992, the former UASs in the UK still have a different profile than pre-1992 universities (Carpentier 2021). We consider a set of variables identified in the literature as being associated with higher EU-FP participation intensity: size; research output; and science, technology, engineering, and mathematics (STEM) orientation. To analyze variations across the types of EU-FP projects, we consider participation in different Horizon 2020 (H2020) funding schemes covering the whole continuum from basic to applied research, namely, the European Research Council (ERC) grants, Marie Skłodowska-Curie Actions (MSCAs), Research and Innovation Actions (RIAs), and Innovation Actions (IAs).

This paper contributes to the literature on EU R&D project participation by focusing on a specific type of HEI and provides insights for policymakers on how to enhance further UAS participation. It is embedded in the context of the European Commission's goal to strengthen Europe's innovation landscape (K4I Forum in the European Parliament 2021). Several UASs are developing strategies to increase their participation in EU-FPs not only at an institutional but also at national and European levels with the creation of UAS interest groups, such as UAS4Europe.

2. Background

2.1 A heterogeneous sector between 'academic drift' and differentiation

From the 1960s onwards, certain countries in Europe have been developing binary and multi-type higher education systems, with the integration of sectors geared toward applied and practice-oriented education (Teichler 2008). This began with the establishment of UK polytechnics and German Fachhochschulen in the 1960s, followed by Norwegian regional colleges and Irish institutes of technology in the 1970s, Dutch colleges and Portuguese polytechnics in the 1980s, and Finnish polytechnics and Swiss UASs in the 1990s (Vaira 2009). These sectors were mostly generated by upgrading professional schools at the tertiary and sometimes even secondary levels (Kyvik 2004).

The development of UASs within national higher education systems differed across countries, contributing to the heterogeneity of the sector at the European level. A survey conducted by Camilleri et al. (2014) showed a lack of common ground among EU higher education stakeholders regarding the definition and nature of UASs. Noticeable cross-country differences could also be found in terms of the positioning of UASs at the national level. The proportion of registered bachelor's and master's degree students to those attending UASs varies considerably between the countries. For example, in the Netherlands, this proportion amounts to two-thirds (De Boer 2016), while in Austria, it is about 15 per cent (Schüll 2019).

In the past decades, an increasing number of UASs have developed research activities. This growing interest in research was likely enhanced by the willingness of UAS leadership to raise their status in a competitive higher education market (Christensen and Newberry 2015), UAS staff comparing themselves to their peers in universities, and increasing student demand for higher degrees (Kyvik and Lepori 2010). Policy demands at a national level included the strengthening of the role of UASs as regional knowledge providers (Jongbloed 2010) and the improvement of the scientific basis of professional practices, for which universities did not provide training (Heggen et al. 2010). At the international and European levels, the Organization for Economic Co-operation and Development (OECD 1998) recommended an enhancement of the research culture at all types of HEIs in 1998, while in 2017, a communication from the European Commission emphasized the need for more research activities in UASs to help professionals address the increasing complexity of the knowledge required in their profession (European Commission 2017). A wide variety of national or state policies providing direct and/or indirect support measures were designed to enhance research in UASs. For example, the Dutch government created the position of lector in the early 2000s and set up a targeted research funding instrument, the knowledge circulation grants in 2005 (De Boer 2016). Despite the generalized demand for more research at UASs, the resources allocated to research activities vary greatly by country (Hazelkorn and Moynihan 2010).

UASs' emulation of university characteristics is often associated with the term academic drift (Burgess 1972; Neave 1979) or research drift when solely focusing on an increase in research activities (Kyvik and Lepori 2010). The establishment of unitary higher education systems, such as in the UK in 1992 (Brennan and Williams 2008; Fulton 1996), has been widely debated, especially in view of the Bologna Process and the introduction of the bachelor's–master's structure in both universities and UASs (Teichler 2008). Witte et al. (2008) concluded that the Bologna Process blurred the boundaries between university and non-university higher education in Germany, the Netherlands, and France. However, most countries with UASs officially retained their binary systems although with varying degrees of differentiation between universities and UASs.

Lepori and Kyvik (2010) distinguished between soft and hard differentiation. Soft differentiation implies a high degree of convergence for a range of factors, such as funding, careers, and accreditation, while maintaining (at least officially) a binary divide. In Norway, UASs can be accredited as universities if they fulfill certain criteria (Elken and Frølich 2016). In Ireland, the binary divide is losing ground, notably through mergers of UASs into technological universities under certain conditions, such as the academic qualifications of the research staff (Highman 2020). Most UASs in Norway and Ireland can deliver doctoral degrees, overstepping one of the main distinctions from universities since UASs usually only offer bachelor's and master's programs. Conversely, hard differentiation is characterized by the development of a specific research mission for UASs that justifies the establishment of different rules and funding mechanisms. In countries such as Finland, Germany, Switzerland, and the Netherlands, UASs strive for differentiation from universities by specializing in more applied research, regional cooperation, and/or cooperation with industry.

Lepori's (2022) categorization of European HEIs further reflects the high degree of heterogeneity of the UAS sector in Europe. This categorization showed that UASs had different profiles when it came to subject specialization and research intensity. Some had a similar profile to universities, while others were more focused on applied research or education.

2.2 UAS participation in EU-FP projects

Since 1984, EU-FPs have been the main EU instrument for supporting R&D activities. This support consists of the provision of grants for purposes ranging from basic to applied research.

Existing research shows that participation of UASs in EU-FPs remains fairly limited. Lepori et al. (2015) estimated that the overall participation of UASs in EU-FPs accounted for only 1 per cent of total HEI participation despite covering more than half of the sample. Following a series of interviews with UAS representatives, Kleger (2016) identified four gaps that potentially hamper EU-FP participation: a lack of incentives to engage internationally due to a large number of collaborations at the local and regional levels, a lack of an international or EU strategy, the need for administrative support for grant applications, and lower centrality in research networks. Furthermore, the participation of UASs in EU-FP projects may be hindered by the participation of large companies and small- and medium-sized enterprises (SMEs), which can conduct applied research and have more intrinsic motives to bring project results to market. Wanzenboeck et al. (2020) showed that application-oriented consortia with a higher share of non-HEI partners, including industry and applied research organizations, are more likely to acquire H2020 funding than consortia predominantly composed of HEIs.

The highly skewed nature of project participation was alluded to in the first work on EU-FPs (see Geuna 1996), generating what some scholars have referred to as oligarchic networks (Breschi and Cusmano 2004) or closed clubs of regular participants, mostly composed of universities and research organizations (Enger 2018). The reputation of HEIs, along with the size of the HEI in terms of academic staff, has also proven to be strongly correlated with the acquisition of EU-FP grants (Lepori et al. 2015; Wanzenboeck et al. 2020). Therefore, the integration to EU-FP networks takes time, as it seems to be heavily reliant on the building of a scientific reputation and networks. This is particularly challenging for UASs, as they only began conducting research activities more recently, often with fewer resources and less orientation toward academic output than universities.

The subject specialization of HEIs can also influence their participation level in the EU-FPs. Lepori et al. (2015) showed that the number of EU-FP projects acquired per HEI was strongly associated with their orientation toward natural and technical sciences at the expense of HEIs, with higher student shares in humanities, social sciences, business, and law. This can particularly benefit countries with more UASs oriented toward natural and technical sciences, such as Switzerland.

We expect these patterns to be reflected in the participation of UASs. Given the heterogeneity of that particular type of HEI in terms of research activities and focus, we should consider the diversity of EU-FP projects acquired, as we can distinguish funding schemes targeting basic and applied research.

EU-FPs include different funding schemes resulting from different rationales and policy goals, from scientific excellence to economic competitiveness to societal challenges (Ulnicane 2023). ERC grants support investigator-driven frontier research based on scientific excellence (Robitaille et al. 2015). MSCAs promote the mobility of PhD holders and more experienced researchers within Europe to strengthen the European Research Area. RIAs are consortium-led projects ranging from basic research and technology development to the testing of prototypes in relevant environments. IAs consist of consortium-led demonstrations or pilot projects aimed at validating products or services in an operational setting. We expect that UASs' modes of EU-FP participation vary according to the level of differentiation in their higher education systems. For example, given their focus on basic research and support of early-stage researchers and post-docs, the former UASs that acquired the university status and the current UASs that can award PhD degrees should benefit more from ERC and MSCA funding schemes. In contrast, we expect IAs to be of advantage to UASs that are highly focused on applied science and that have closer ties to industry.

3. Methodology

3.1 Datasets and sample

Data on participation in H2020, ERC grants, MSCAs, RIAs, and IAs were obtained from CORDIS' publicly available datasets, accessed through the EU Open Data Portal (www.data.europa.eu).

Data on the organizational characteristics of UASs were retrieved from the European Tertiary Education Register (ETER; Lepori et al. 2023), which covers 3,439 HEIs in forty-one countries for the period 2011–9 and provides information on HEIs and their basic characteristics, geographical position, educational activities, staff, finances, and research performance. From ETER, we used a set of potential explanatory variables covering organizational characteristics such as the legal status of the HEIs (university status) and their size in terms of full-time-equivalent academic staff. To measure the organizational focus on STEM disciplines, we included the variable 'STEM orientation', i.e. the proportion of students registered in natural science, information and communications technology (ICT), and engineering at the five to seven levels of the International Standard Classification of Education (ISCED). The indicator 'Education intensity' measures the importance of educational activities, as it consists of the number of ISCED five to seven graduates per academic staff.

We extracted the number of publications per organization from the CWTS Leiden Ranking database (Waltman et al. 2012). Data on patents were derived from the RISIS PATENT dataset (Laurens et al. 2015), which covers close to 16,500,000 priority patents. Data on participation in FP1–FP7 projects originated from EUPRO (Heller-Schuh et al. 2021). As HEIs, which were potentially recognized as UASs, may have ceased to exist since 1984 (FP1), we used the OrgReg database (www.risis2.eu/orgreg-access) to trace any demographic events, such as mergers, takeovers, and closures.

In Table 1, we summarize the list of variables and their origin. We considered institutions recognized as the current and former UASs in four countries selected to represent distinct degrees of differentiation, from a case where differentiation was abolished (UK) to binary higher education systems where UASs have distinct roles (Switzerland and the Netherlands). This led to a sample of sixty-six current and thirty-nine former UASs Table 2 Twenty-two of the current UASs in the sample can award PhD degrees. To compare participation patterns with other HEI categories, we also considered sixty-seven pre-1992 universities in the UK, four universities in Norway, nine in Switzerland, and seventeen in the Netherlands. In the years of H2020 (2014–20), we observed the following UAS mergers: in 2017, the Bergen, the Sogn og Fjordane, and the Stord/Haugesund university colleges merged into the Western Norway UAS, while the Hedmark and Lillehammer university colleges merged into the Inland Norway UAS in 2017; the Stenden and Noordelijke Hogeschool Leeuwarden (NHL) UASs in the Netherlands merged into the NHL Stenden UAS in 2018. In our article, H2020 participations of the merging HEIs are included in the new mergers. The complete dataset of former and current UASs and their characteristics can be found in Zenodo (Cavallaro 2023), while descriptive statistics of each variable are shown in Table A.1.

3.2 Methods

The present work focuses on the former and current UASs from four countries, namely the UK, Norway, Switzerland, and the Netherlands. The case studies selected reflect the diversity in terms of the positioning of the former and current UASs in national higher education systems. In the UK, all UASs obtained the university status; in Norway, some UASs also became universities, while others remained UASs; in Switzerland and the Netherlands, there is a clear differentiation from universities, but the role of UASs differs as Swiss UASs have a

Table 1. List of variables.

Variables	Definition	Source
Dependent variables		
H2020	Number of projects acquired in H2020	CORDIS
ERC	Number of European Research Council grants	CORDIS
MSCA	Number of Marie Skłodowska-Curie Actions projects acquired in H2020	CORDIS
RIA	Number of H2020 Research and Innovation Actions acquired in H2020	CORDIS
IA	Number of H2020 Innovation Actions acquired in H2020	CORDIS
Independent variables		
Size	Number of academic staff in full-time equivalent (2019)	ETER
Uni status	Dummy variable equals 1 if the UAS has the university status or 0 otherwise	ETER
STEM orientation	Number of ISCED five to seven students in natural sciences, ICT, and engineering, divided by the total number of ISCED five to seven students (2019; 2016 for the UK)	ETER
Education intensity	Total students ISCED five to seven, divided by size (2019)	ETER
Publication intensity	Number of publications, divided by size (2019)	CWTS, ETER
Patent intensity	Number of priority patents, divided by size (2010–2014)	RISIS Patent, ETER

Table 2. Sample description.

Country	*N*	Current UAS	Former UAS	PhD award	Universities
Switzerland	17	8	0	0	9
Netherlands	54	37	0	0	17
Norway	31	21	6	23	4
UK	100	0	33	33	67
Totals	202	66	39	56	97

higher focus on applied research, while Dutch UASs are more oriented toward practice-based training.

To analyze the level and mode of EU-FP participation among the former and current UASs, we adopted a mixed-method design, using both quantitative and qualitative approaches (Schoonenboom and Johnson 2017). The analysis is divided into four parts.

First, we provided an overview of the four cases based on the literature and official documents describing the history and specific aspects of each of the four higher education systems, with a focus on the former and/or current UASs.

Second, we compared the intensity and evolution of the former and current UAS participation across countries. We investigated the participation intensity in H2020 overall and per type of projects, along with the evolution of the share of UAS projects in relation to HEI participation from FP1 to H2020.

Third, to examine the relationship between H2020 participation and organizational variables, we used hurdle negative binomial models (Gurmu 1998) as our dependent variables, i.e. the number of participations in H2020 and most project types (MSCA, RIA, and IA) are count variables that follow a negative binomial distribution and include a high number of zeros. Furthermore, this method allowed us to distinguish patterns between non-participants and participants and among participants. First, we studied the correlation between participation and organizational variables. Second, we added country dummies and consider their influence over correlations with organizational characteristics. In the case of the ERC, we used a logit model, given the high share of non-participating UASs and ex-UASs (79 out of 105) and that most of the organizations with ERC grants acquired only one (seventeen out of twenty-six). Correlations between variables can be found in Table A.2.

Fourth, we inquired about the heterogeneity in H2020 participation within the countries. To assess the distribution of H2020 projects within each country, we use Lorenz curves and the Gini coefficient (Gastwirth 1972). We also analyzed the mode of participation of the former and current UASs within the respective national contexts and considered other categories of HEIs. In the UK, we distinguished universities from the Russell Group, a self-selected association of twenty-four universities that accounts for more than 75 per cent of competitive funding in the UK, pre-1992 universities that are not part of the Russell Group, and the ex-UASs that are also referred to as new universities or ex-polytechnics. For Norway, we considered the four historical universities, six ex-UASs or new universities, and the UASs that include both university colleges and specialized university colleges. In the case of Switzerland, we compared UAS participation with that of the Federal Institutes of Technology in Lausanne and Zürich and the cantonal universities. For the Netherlands, we differentiated the participation of the technical universities (TU Delft and TU Eindhoven), universities, and UASs.

4. Results

4.1 Case study background

The UAS category followed different trajectories in the four countries selected, notably in terms of their relation to universities, their role in the higher education system, the support provided by the government for research activities, and their research outputs.

The UK case represents a unitary but hierarchized higher education system (Bleiklie 2005). Most UASs, referred to as polytechnics, were established in the 1960s and primarily focused on applied science and engineering education. They all automatically obtained the status of the university through the Further and Higher Education Act of 1992. However, the UK higher education system remains stratified in terms of prestige, research production, and funding, with the former UK polytechnics regularly classified in the lowest tier in the Research Assessment Exercise, a research quality evaluation system through which the UK government allocates funding for research (Elton 2002). The crises in 2006 and 2008 further widened the gap, especially with Russell Group member universities (Carpentier 2021). Through an analysis of the university income structure, Carpentier (2018) showed that the former UASs were heavily reliant on fees, in contrast to old universities, for which income mainly came from public research funding.

The Norwegian case represents one of soft differentiation, in which the higher education system grants UASs the opportunity to obtain university status, either individually or through mergers, and under certain conditions linked notably to infrastructure, the level of research activities, and their integration into national and international academic networks (Elken and Frølich 2016). This led to the establishment of six new universities, including the Norwegian University of Life Sciences (NMBU) and the University of Stavanger in 2005, the University of Agder in 2007, the University of Nordland in 2010, and the Oslo Metropolitan University and the University of South-Eastern Norway in 2018. New universities and UASs highly differ in terms of academic staff, student numbers, STEM orientation, and research production. This can be partly explained by the fact that some of these new universities were the result of UAS mergers and that obtaining the university status is subject to certain criteria in terms of research outcomes and capacity. UASs, like the other categories of HEIs, can receive core funding for research based on performance indicators. With regard to competitive national grants, UASs compete with universities in the various funding opportunities offered by the Research Council of Norway (RCN). However, since 2010, Norwegian UASs have accounted for less than 8 per cent of the total participation in RCN funding schemes.

The Swiss higher education system is highly differentiated, with a specific policy mandate for UASs. The case of Swiss UASs is rather unique if we consider that they have had a research mandate since their establishment in 1995. This research mandate differed from the one conferred to universities, with a focus on applied research and knowledge transfer to companies (Kyvik and Lepori 2010). A longitudinal study on the Swiss HEI system concluded that the binary divide around distinctive features of universities and UASs (research for universities vs. knowledge transfer for UASs) was reinforced from 2000 to 2008 (Lepori et al. 2014). The Swiss government set up specific support measures to promote research in UASs via the Swiss Innovation Agency in the early development phase (Lepori et al. 2014). Differences in terms of funding sources illustrate the relatively high level of differentiation, as UASs account for more than 50 per cent of the participation in Innosuisse innovation projects (the main funding scheme of the Swiss Innovation Agency) and only 3 per cent of the funding provided by the Swiss National Science Foundation, which primarily funds basic research (Innosuisse 2019). Some UASs offer cooperative doctoral programs with universities, where PhD students can conduct some research at the UAS and receive their doctoral degree from a university (Lepori et al. 2014).

The Dutch higher education system is also highly differentiated, as the main mission of Dutch UASs is to provide practical training with a primary focus on regional and local needs. Although UASs were given the task of conducting research by law in 1986, financial support for research activities has only been provided since 2001 (Griffioen et al. 2013). Research activities in Dutch UASs are mostly practice oriented, which makes it challenging for them to attain scientific legitimacy (Hasanefendic 2018; Jongbloed 2018). Measures aimed at enhancing the research intensity of Dutch UASs include lectorates, heads of research groups establishing knowledge circles, and knowledge circulation grants to foster knowledge exchange with industry (since 2005) and the public sector (since 2006).

In Table 3, we summarize the key differences between the four cases and show the substantial cross-country differences in terms of size and education intensity. We can observe that the UASs in Switzerland and the former UASs in the UK had a remarkably higher number of academic staff than in the other countries. The level of education intensity was highest in the

Table 3. Case study overview and characteristics (N = 105, 2019).

	UK	Norway	Switzerland	Netherlands
Level of differentiation	Hierarchization	Soft differentiation	Hard differentiation	Hard differentiation
Specific mission	–	Regional education	Applied research	Practical training
University status	Obtained by all UASs	Possibility to obtain it under certain conditions	–	–
PhD programs	All	Former UASs and most current UASs deliver PhD degrees	Cooperative programs with universities	–
Specific support for research activities	–	–	Applied science funding scheme	Lectorates, knowledge circulation grants, and centers of expertise
Size (median)	980.00	217.10	1,139.29	248.00
No. of publications (median)	343	31.5	82	4
No. of patents (median)	6.00	0.00	5.50	0.00
Education intensity (median)	14.17	18.17	7.57	20.05
STEM orientation (median), %	20	1	26	0

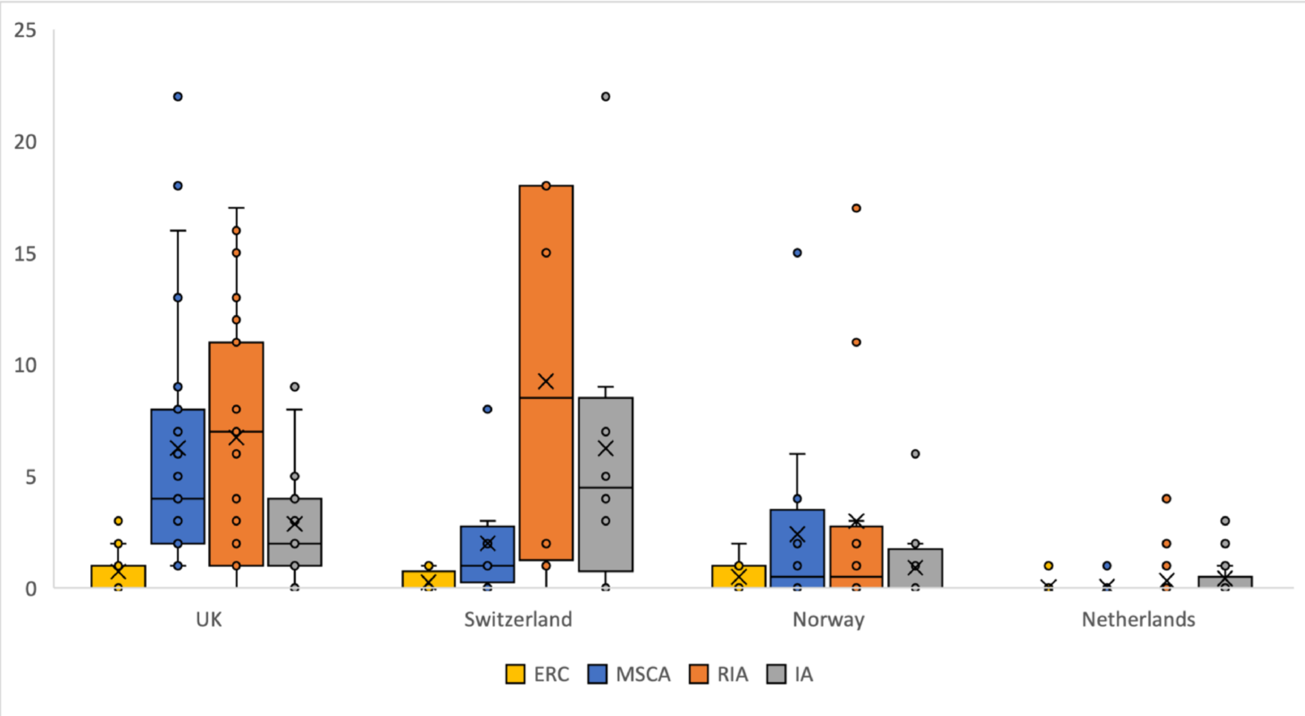

Figure 1. The current and former UAS participation in H2020 project types per country.

Netherlands and lowest in Switzerland. UK former UASs and Swiss UASs had a significantly higher median STEM orientation (45 per cent) than the other countries. Most Norwegian and Dutch UASs had little to no students in STEM disciplines. In terms of research output, UK and Norwegian former UASs counted higher numbers of publications, while Dutch and current Norwegian UASs typically had fewer publications and patents.

4.2 Participation intensity across countries

When we compared the participation intensity in H2020 across the four countries (Fig. 1), we observed that in the UK and Switzerland, where the former and current UASs have more resources for research activities and higher STEM orientation, participation levels were significantly higher than in the other two countries. The participation of Dutch UASs, which tend to have higher education intensity and therefore potentially fewer resources for research activities, was marginal.

This cross-country comparison also showed how the diversity in the positioning of the former and current UASs can correlate to different EU-FP participation tendencies. In higher education systems with little to no differentiation, like in the UK and Norway, the former UASs tended to acquire more projects in ERC and MSCA schemes than in Switzerland and the Netherlands. In these two countries, characterized by their differentiated systems, UASs acquired more RIAs and IAs than ERC and MSCA projects. Thirty out of the 105 UASs and the former UASs have coordinated RIA and IA projects at least once. Coventry University (nine) and the NMBU (five), which both acquired the university status, are the HEIs in our sample with the most coordinated projects.

Figure 2 shows the evolution of the UAS share of HEI participation at the national level. We observed significant cross-country differences.

Over time, we observed a general increase in the former and current UASs' share of HEI participation until FP7. At the national level, the former UK UASs' share remained stable throughout the years (at around 5 per cent), with a slight increase from FP3 to FP4, when they obtained the university status. The share of Swiss UASs and Norwegian UASs increased substantially from FP5 to FP7. The relatively higher share of Norwegian former and current UASs was partly explained by the relatively low number of universities (four). Despite UASs representing more than half of the HEI sample in the Netherlands, their participation remained marginal throughout the EU-FPs.

4.3 Organizational heterogeneity

Regression results associating project counts with organizational variables are reported in Table 4, while the full model with the addition of country dummy variables is shown in Table 5.[1] The two models show similar results, as the most significant correlations persisted when we considered the country dummy variables. Given that the model with country showed a higher log-likelihood than the one with organizational variables only (–212.35 vs. –224.44), we mainly describe the results obtained in the former.

Overall, the hurdle negative binomial regressions showed a statistically significant positive correlation between H2020 participation and university size ($P = 0.000$). The publication intensity was highly correlated with participation magnitude (1,836; $P = 0.000$). In line with the descriptive statistics above, the location in the Netherlands was negatively associated with levels of participation (–1,552; $P = 0.000$).

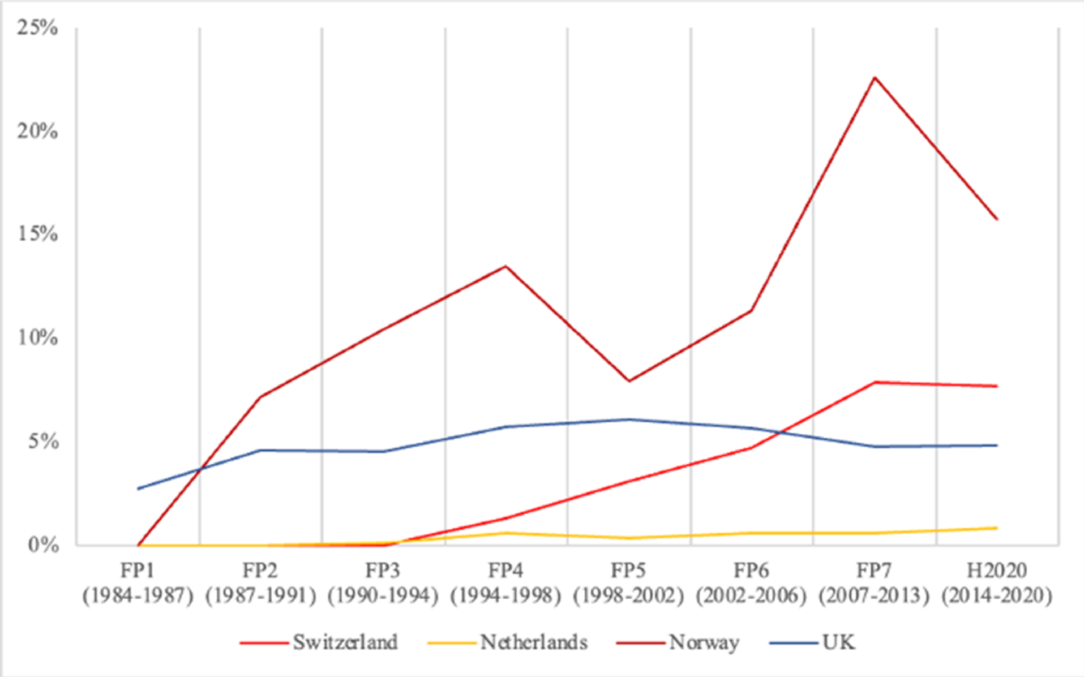

Figure 2. The share of the current and former UAS EU-FP participation within countries and across EU-FPs.

In the case of ERC grants, we observed statistically significant correlations between publication intensity and participation in both regression models. We have not found other significant correlations with other variables. With regard to MSCA grants, the university size was positively correlated with both participation and participation magnitude. Publication intensity was positively correlated with participation magnitude (2.872; $P = 0.001$).

As expected, we observed different patterns in RIAs and IAs. In the case of RIAs, the university size was strongly associated with participation and higher levels of participation. Publication intensity was positively associated with participation magnitude (1,727; $P = 0.000$ in the full model) but not with participation. The location in the Netherlands was negatively correlated with both participation (−2.966; $P = 0.031$) and participation magnitude (−1.819; $P = 0.016$).

In IAs, publication intensity was negatively correlated with higher levels of participation (−2,318; $P = 0.003$ in the full model). This is in line with the expectation that IAs, due to their applied character, attract different types of HEIs, more oriented toward applied sciences. University size was positively associated with participation ($P = 0.000$) but not with participation magnitude. STEM orientation was positively correlated with participation magnitude (5,103; $P = 0.003$ in the full model). UASs and ex-UASs participating in IAs had thus a more STEM-oriented profile. Education intensity was negatively correlated with participation magnitude (−0.126; $P = 0.006$). This may imply that researchers based in UASs with higher levels of education intensity have fewer resources to contribute to applied research projects within IAs.

In sum, the results of the regressions emphasized, in line with most of the literature on EU-FPs, the importance of organizational research capacities for participation in EU-FP projects. They also showed how being in the country in the sample where research in UASs receives the least support, i.e. the Netherlands, negatively affects participation in EU-FPs. In our study, we, therefore, suggest that both organizational characteristics and national contexts should be considered to explain variation in UAS and ex-UAS EU-FP participation.

4.4 Heterogeneity within countries

While UAS participation in EU-FPs greatly varied across countries, the Lorenz curves in Fig. 3 show different levels of variance in terms of H2020 participation within the four countries analyzed.

The country with the most unequal distribution was the Netherlands with a Gini coefficient of 0.77. This was however mostly because thirty-two of the thirty-seven UASs in the sample did not participate in H2020. Twenty-six out of these thirty-two UASs had less than 300 academic staff. Moreover, they include both practice- and training-oriented UASs and multidisciplinary UASs with high education intensity. The Dutch UAS with the highest amount of H2020 participation was NHTV Breda, with only five projects.

Norway, which had a substantially higher participation intensity than the Netherlands, had the second-highest Gini coefficient (0.6). About 75 per cent of H2020 participations in the Norwegian sample were obtained by the six new universities. More than half of the projects were acquired by NMBU, OsloMet, and the University of Stavanger, which are among the Norwegian HEIs with the highest number of academic staff and research output.

The UK and Swiss samples had the lowest Gini coefficient among the four countries, i.e. 0.38 and 0.47, respectively. In the UK, Coventry University and Manchester Metropolitan University were among the former UASs with the most H2020 project acquired (forty-one and thirty-eight, respectively). Both have also the lowest level of education intensity in the UK sample.

Table 4. Hurdle negative binomial regressions (N = 91).

	H2020		ERC	MSCA		RIA		IA	
	Logit	Trunc. negbin	Logit	Logit	Trunc. negbin	Logit	Trunc. negbin	Logit	Trunc. negbin
Uni status	2.2931	0.6307	0.6048	4.1275***	1.4714**	1.8599*	0.3625	0.7819	1.3968**
	(1.1947)	(0.3856)	(0.8017)	(1.0995)	(0.5645)	(0.7873)	(0.4911)	(0.7114)	(0.3982)
Size	0.0019**	0.0006***	0.0011	0.0012*	0.0010***	0.0016**	0.0008***	0.0023***	0.0001
	(0.0006)	(0.0002)	(0.0006)	(0.0005)	(0.0002)	(0.0005)	(0.0002)	(0.0006)	(0.0002)
Publications	1.1286	1.3260	2.7603*	1.7216	2.3031*	1.0129	1.3996*	1.000	−2.7088***
	(0.9955)	(0.7179)	(1.1361)	(1.1367)	(0.9437)	(1.0465)	(0.7148)	(0.9566)	(0.6771)
Patents	72.0618	−13.7878	125.0741	−10.5420	38.2258	120.7037	−8.6391	68.6054	5.7001
	(128.2248)	(19.5005)	(66.2795)	(64.2897)	(33.6813)	(107.548)	(12.356)	(62.3354)	(14.1605)
Edu. intensity	0.0527	−0.0392	0.0861	−0.1048	−0.0079	0.0460	−0.0309	−0.0424	−0.1144***
	(0.0433)	(0.0333)	(0.0478)	(0.0602)	(0.3031)	(0.0377)	(0.0344)	(0.0490)	(0.0337)
STEM orientation	1.6987	1.2800	−0.3561	3.0447	−4.2537*	2.9894	1.2064	0.2805	5.3211**
	(2.1422)	(1.4173)	(1.6769)	(2.2335)	(1.866)	(2.2648)	(1.3814)	(2.4621)	(1.793)

The correlation is significant at the ***0.001, **0.01, and *0.05 levels. Robust standard errors are given in parentheses.

Table 5. Hurdle negative binomial regressions with country dummies and CH as reference (N = 91).

	H2020		ERC	MSCA		RIA		IA	
	Logit	Trunc. negbin	Logit	Logit	Trunc. negbin	Logit	Trunc. negbin	Logit	Trunc. negbin
NL	−2.3294	−1.5523***	−2.2892	−3.6019*	−22.245***	−2.9664*	−1.8197**	−0.4565	−0.0258
	(1.3524)	(0.3814)	(1.4349)	(1.7169)	(0.6817)	(1.3651)	(0.6117)	(1.3051)	(0.7253)
NO	0.7460	−0.8044*	−1.5378	1.8262	0.3511	−0.5292	−0.5994	0.2998	0.9215
	(1.4900)	(0.3998)	(1.6961)	(1.695)	(0.7948)	(1.4488)	(0.5444)	(1.9648)	(0.8249)
UK	0.7906	−0.2311	−0.7811	2.5056	0.8980	−0.3423	−0.2962	−0.1252	1.4853
	(1.6221)	(0.3217)	(1.1646)	(1.548)	(0.7219)	(1.3902)	(0.4111)	(1379.61)	(0.7645)
Size	0.0025**	0.0006***	0.0009	0.0027*	0.0010***	0.0021**	0.0007***	0.0025***	−0.0001
	(0.0007)	(0.0002)	(0.0006)	(0.0011)	(0.0002)	(0.0006)	(0.0002)	(0.0006)	(0.0002)
Publications	−0.1684	1.8369***	3.0357*	0.5529	2.7194**	0.3006	1.7274*	0.8410	−2.3184**
	(1.1067)	(0.5282)	(1.5002)	(1.0924)	(0.8886)	(1.1893)	(0.6825)	(1.2529)	(0.8920)
Patents	51.1566	5.3020	112.8654	−7.0196	35.0139	87.1589	−14.3819	95.2159	1.9603
	(109.498)	(12.0248)	(65.206)	(61.2091)	(21.0937)	(92.9895)	(14.9323)	(66.7626)	(15.5080)
Edu. intensity	0.0855	−0.0214	0.1039	−0.0225	−0.0045	0.0693	−0.0146	−0.0215	−0.1263**
	(0.063)	(0.0159)	(0.0602)	(0.0429)	(0.0395)	(0.0551)	(0.0216)	(0.0442)	(0.0486)
STEM orientation	0.9354	0.5036	−0.4137	3.4033	−3.4622	2.4593	0.6402	0.1815	5.1029*
	(2.436)	(0.9812)	(3.943)	(3.3467)	(2.0641)	(2.5161)	(1.4041)	(2.490)	(2.016)

The correlation is significant at the ***0.001, **0.01, and *0.05 levels. Robust standard errors are given in parentheses. We dropped the variable 'Uni status' due to the high correlation with the UK dummy (0.8757***).

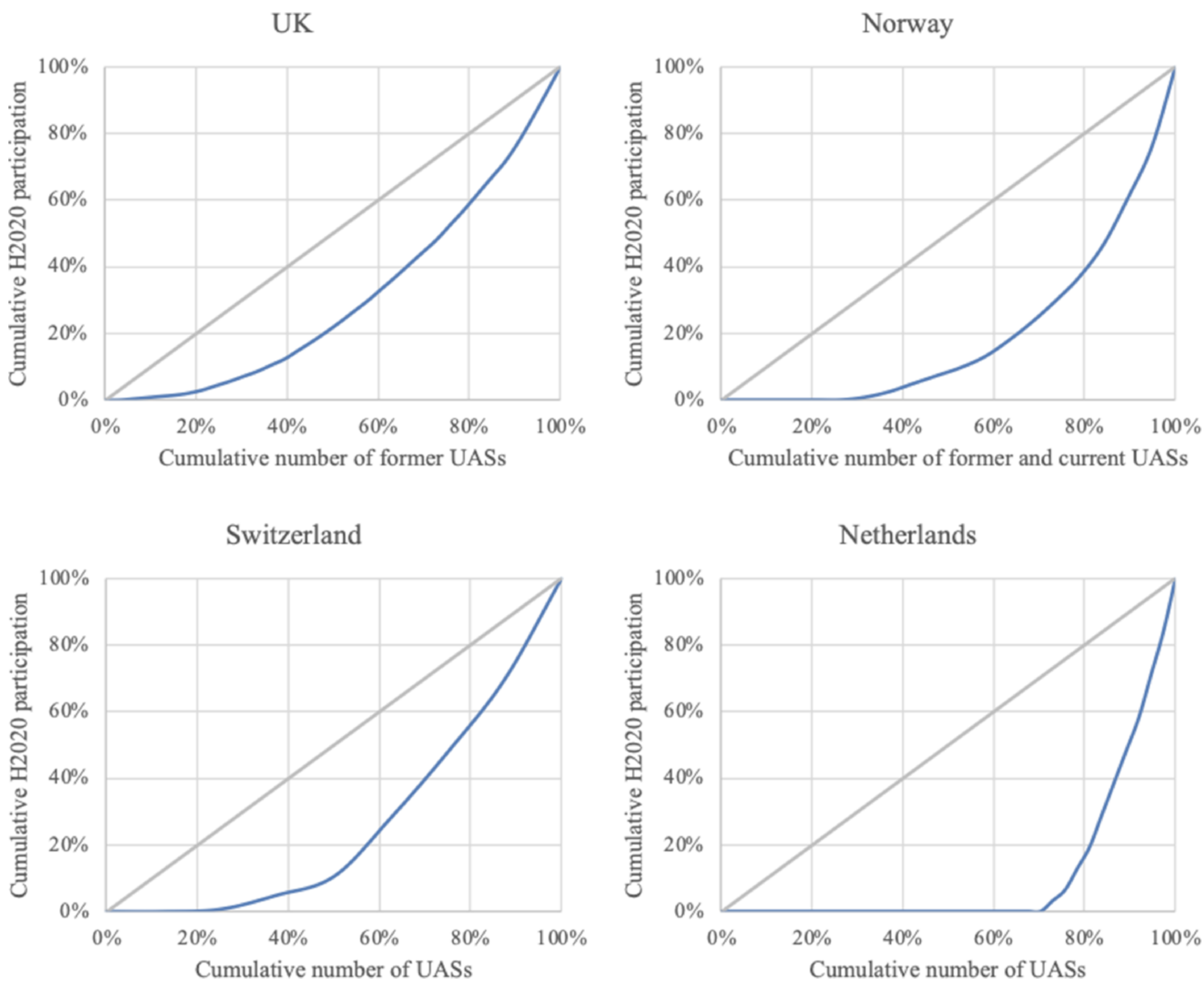

Figure 3. Lorenz curves representing the distribution of H2020 projects among the former and current UASs at the national level.

About 90 per cent of the projects acquired by Swiss UASs were obtained by four out of the eight in the sample, namely the Zurich UAS (ZHAW) and the UASs and Arts of Southern (SUPSI), Western (HES-SO), and Northwestern (FHNW) Switzerland. Two of them, ZHAW and HES-SO, accounted for close to 50 per cent of the total academic staff in the Swiss UAS sample.

In addition to the analysis of H2020 participation intensity, we also notice clear cross-country differences in the former and current UASs' mode of participation (Fig. 4).

In the UK, the EU-FP participation profile of the former UASs was highly similar to those of their counterparts, with slightly higher shares in IAs. Within the former UASs themselves, we found a range of EU-FP participation profiles. For example, twenty-five of the twenty-six projects at Sheffield Hallam University were RIAs and IAs, while twenty-two of the twenty-six projects acquired by Bournemouth University were MSCAs. The Sheffield Hallam University was one of the former UASs with the highest number of academic staff and FP1–FP7 projects, which is in line with the assumption that the composition of consortia in collaborative projects partly relies on social networks.

In the case of Norway, we found that the new universities' participation profile is overall similar to that of the older universities. We also observed distinct profiles within the new universities: seventeen of the twenty-one projects at the University of Stavanger were MSCAs, while the NMBU and OsloMet most frequently participated in RIAs. Compared to the other new universities, these three had more academic staff and higher research output. In line with the regression results concerning RIAs, NMBU had one of the highest shares of STEM students among the HEIs in the sample (48 per cent).

The differentiated research mandate between Swiss UASs and universities was particularly salient in terms of the types of projects acquired in H2020. In fact, UASs had a distinct participation profile from the other HEI categories, as they participated more in applied projects and rarely in the ERC and MSCA schemes. UASs accounted for more than 40 per cent of Swiss HEI participation in IAs. About half of these IAs were obtained by a single UAS (SUPSI).

Dutch UASs also clearly differed from universities in terms of H2020 participation mode, as more than half of the projects acquired were IAs.

5. Discussion

In this article, we investigated how the heterogeneity in the European UAS landscape was reflected in the intensity and

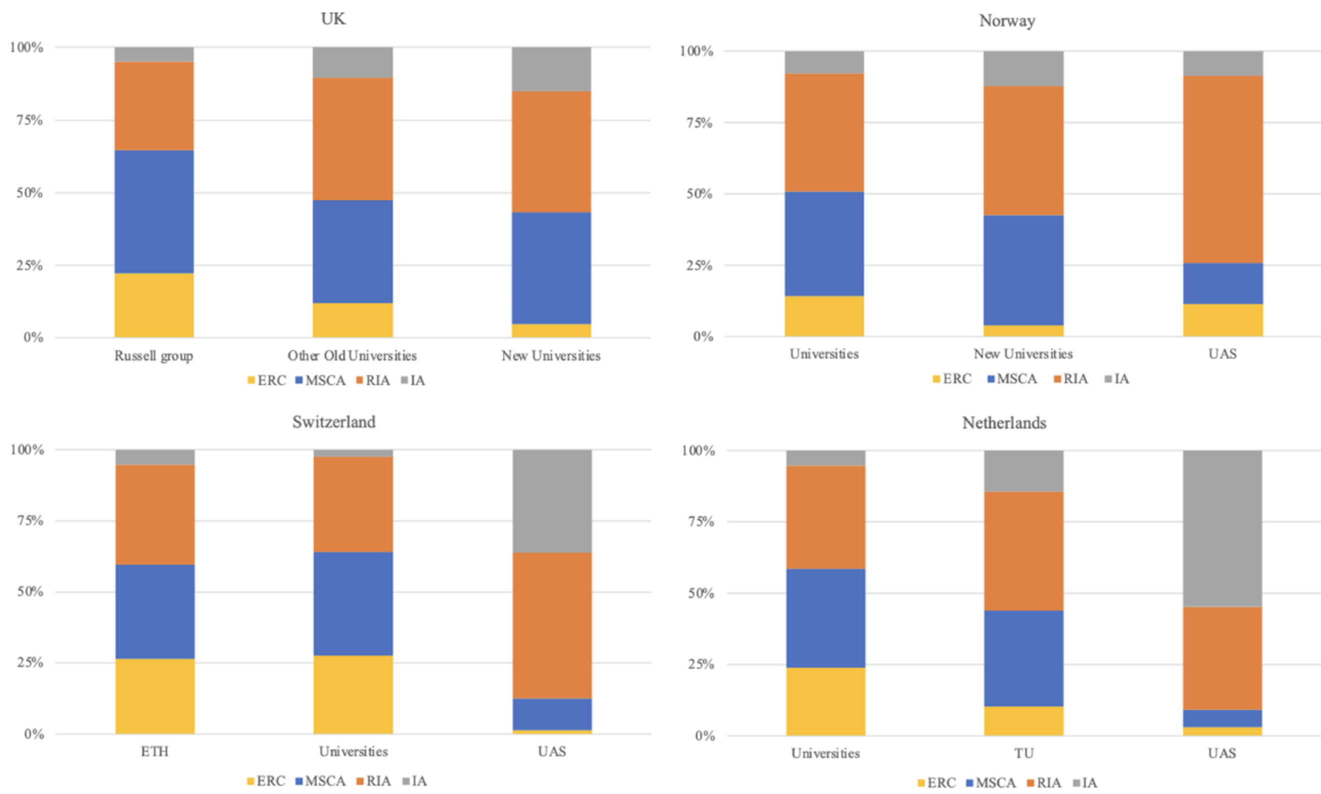

Figure 4. The EU-FP participation across types of HEIs and per project type in the UK, Norway, Switzerland, and the Netherlands.

mode of EU-FP participation among the former and current UASs in the UK, Norway, Switzerland, and the Netherlands. While the participation of universities showed similar tendencies at the European level and limited country effects (Lepori et al. 2015), the former and current UASs' EU-FP participation was influenced by their position in their respective national higher education systems and by national policies to support the development of their research. The former UK and Norwegian UASs had similar EU-FP participation profiles to that of universities, while Swiss and Dutch UASs were geared toward more applied science projects.

The case of the UK has shown that automatically conferring university status to UASs was not sufficient to reduce the gap compared to pre-1992 universities with regard to research output. The participation of the former UK UASs in EU-FPs remained marginal compared to that of pre-1992 universities. The Brexit vote in 2016 led to a series of uncertainties in the UK higher education sector, notably regarding the participation in EU-FPs (Cavallaro and Lepori 2021). Increased EU-FP participation barriers may have further widened the gap between the former UASs and pre-1992 universities, as the latter tended to have more established R&D networks and were thus more likely to join consortia despite Brexit-induced uncertainties or non-eligibility to receive EU funding.

Our regression analyses corroborated findings from the EU-FP literature, as the former and current UASs with higher research capacities tended to acquire more H2020 projects. In a highly differentiated system, the relatively high participation levels of Swiss UASs may be correlated to their larger size in terms of academic staff and higher levels of resources, notably obtained through the Innosuisse funding program for innovation, where they are the main beneficiary.

This paper adds to our understanding of EU-FPs by focusing on the participation of a specific type of institution—UASs—a category of HEI that itself is characterized by commonalities and marked differences in terms of history, levels of differentiation, and capacities. These results carry policy implications that could help tailor policies for enhancing UAS participation in competitive R&D funding at institutional, national, and European levels.

As R&D capacities were shown to be key enablers to compete for EU-FP funding, we suggest considering different measures to incentivize research in UASs and enhance their attractiveness as research-performing institutions. In the UK and Norway, governments allocate core research funding according to performance-based criteria, notably publication related, which tend to favor HEIs that already have more research capacities and established reputations at the expense of the former and current UASs. National governments could allocate a part of the core research funding based on performance criteria that are better linked to applied research and the typical contribution of UASs, e.g. cooperation with private companies and public authorities, number of graduates in professional programs, and number of graduates employed in non-academic settings. The creation of competitive funding schemes targeted at applied research, like the Innosuisse grants in Switzerland, could not only contribute to increasing UASs' R&D resources but also enable their researchers to gain experience with preparing competitive proposals and make their R&D project portfolios more attractive to grant evaluators.

The creation of UAS PhD programs like in Norway, Ireland, and certain German states (Hessia, Saxony-Anhalt, and North-Rhine Westphalia) is another measure that can increase the quantity and quality of research activities in UASs. The establishment of cooperative PhD programs between UASs and universities, like in Switzerland and Germany, could also increase the attractiveness of UASs as locations for conducting research. To support UAS–university collaboration in applied sciences, Austria created the Wissenstransferzentren. Programs designed to encourage UAS–university cooperation should be attractive to universities, which have also been requested to redesign their curricula to enhance their graduates' employability, especially in the industry sector (Dunkel and Le Mouillour 2008). Such measures should, however, primarily result from national policy debates on the desired level of distinction between universities and UASs' research activities.

At the European level, funding schemes targeted specifically to the development of research activities in UASs can contribute to EU-FP goals—e.g. the strengthening of the European Research Area and Europe's innovation capacity—and the development of a European Innovation Area, an initiative from the European Parliament and supported by the European Commission toward the establishment of a pan-European innovation ecosystem (K4I Forum in the European Parliament 2021). The integration of the European Innovation Ecosystem's scheme into Horizon Europe, the ninth EU-FP, could lead to additional funding and networking opportunities for UASs, with a mandate for regional economic development and strong connections with local industry and SMEs. However, we suggest that additional measures could be implemented to enhance UAS participation in EU-FPs. For example, the European Commission could set up an instrument for cross-border institutional cooperation between universities and UASs, similar to Horizon Europe's Twinning scheme that fosters networking activities between research institutions from lower and higher research-performing countries. To improve the skills of research or managerial staff in UASs, dedicated calls within the framework of MSCA Staff Exchanges could be another option. For example, such an instrument has been implemented in Germany with the German Academic Exchange Service's UAS.International program, which supports UAS researchers willing to carry out research visits abroad. As suggested above, at the national level, such measures may also be attractive to academic staff at universities who could gain further insights into applied science, industry, and regional cooperation.

UASs could also benefit from knowledge exchange with their peers and further promotion of UAS research at national and European levels. In the German state of Baden-Württemberg, the Centers of Applied Research were designed to improve framework conditions for research activities in local UASs and favor knowledge exchange among UAS researchers in the region. In Switzerland, UASs, like other HEI categories, are represented in the Board of the Rector's Conference and can thus defend the interests of their category at a national level. At the European level, the UAS4Europe network, which brings together 450 UASs from twenty-four European countries, was founded in 2016 to strengthen the positioning of UASs in Europe's research and innovation landscape.

This paper focused on four specific cases representing distinct levels of differentiation in higher education systems. Further studies could cover UAS participation in other European countries. With its 243 UASs and its federal structure leading to diversified support systems across the Länder, Germany alone is an interesting study subject. The mergers of UASs into technological universities in Ireland in the early 2020s and their effect on the acquisition of EU-FP projects could also represent an interesting case study, especially in comparison to the Norwegian case, which experienced similar developments. Future research can assess the effect of national and/or regional measures or the latest developments at the EU-FP level mentioned above on the integration of UASs into EU R&D networks.

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Data availability

The data underlying this article are available in Zenodo and can be accessed with the URL https://zenodo.org/record/8180506.

Note

1. For RIAs and IAs, we performed an exploratory analysis with funding volumes as a dependent variable instead of project counts to examine robustness, but the results were essentially the same. In fact, project counts and funding volumes are highly correlated (0.9001 for RIAs and 0.9433 for IAs).

Appendix

Table A.1. Descriptive statistics of variables.

	N	Mean	STDEV	Skewness	MIN	1Q	Median	3Q	MAX
H2020	105	8	10.98	1.48	0	0	3	14	43
ERC	105	0.39	0.82	2.56	0	0	0	0	4
MSCA	105	2.49	4.56	2.42	0	0	0	3	22
RIA	105	3.49	5.32	1.64	0	0	1	5	19
IA	105	1.62	3.05	3.54	0	0	0	2	22
Size	103	761.77	653.75	0.92	16	176.7	740	1,131	2,933.36
Publications	105	153.44	206.29	1.53	0	5	54	261	806
Patents	99	3.71	6.98	2.95	0	0	0	6	46
Edu. intensity	103	19.21	7.55	1.99	4.51	16.30	19.38	22.25	64.65
STEM orientation	104	0.15	0.14	1.32	0	0	0.16	0.22	0.74

Table A.2. Correlation matrix.

	Switzerland	Netherlands	Norway	UK	Uni status	Size	Publications	Patents	Edu. intensity	STEM orientation
Switzerland	1									
Netherlands	−0.2354	1								
Norway	−0.1480	−0.3876*	1							
UK	−0.2153	−0.5639*	−0.3544*	1						
Uni status	−0.2458	−0.6439*	−0.0868	0.8757*	1					
Size	0.2781	−0.2385	−0.2846	0.3200	0.3134	1				
Publications	−0.1526	−0.4926*	0.3646*	0.2908	0.4244*	0.0524	1			
Patents	0.0219	−0.3955*	−0.0927	0.4589*	0.4898*	0.1889	0.3669*	1		
Edu. intensity	−0.3532*	0.0454	0.0041	0.1558	0.0945	−0.1182	0.0142	−0.0372	1	
STEM orientation	0.2086	−0.2798	−0.110	0.2569	0.2881	0.3883*	0.1418	0.3368*	−0.2088	1

*The correlation is significant at the 0.001 level.

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