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Segregation of EU13 Countries in EU Framework Programmes Illuminates Important Challenges for Cohesion Policy[1]

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INTRODUCTION

The broader discussion over the synergies of the aims and funds of cohesion policy and the framework programmes (FPs) has been on the agenda on the European level for several years. As far as the EU13 country group[2] is concerned, the most striking problem is the divide compared to the EU15. The trend is still prevalent in the framework of *Horizon 2020* (hereinafter H2020) and is a persistant problem, despite heavy criticism of the issue in the academic debate in the context of FP7 (Rauch and Sommer-Ulrich 2012; Schuch 2014; MIRRIS 2014) and its recent prominence in policy debates.[3]

Previous analyses highlight science excellence, the level of R&D financing, and networking and learning effects (including previous experience and management skills) as the most important structural features for successful participation in FP (Rauch and Sommer-Ulrich 2012; Schuch 2014). In this context, the low participation of the EU13 country group is surprising, despite the growing research capabilities in those countries and simultaneous increases in co-publication rates with EU old members (Makkonen and Mitze 2015). The main reasons have been identified as static network patterns (Okubo and Zitt 2004; Tijssen 2008), as well as geographical, cultural, institutional and technological barriers (Scherngell and Lata 2011). The lower quality of proposals submitted by the EU13 organisations is also highlighted, and derived from the information, knowledge and language barriers that continue to prevail (including the limited understanding of FP, practice in project management and transnational cooperation in general), but also insufficient motivation to participate in FPs. The previous is exemplified by the lack of necessary complementarity for building R&D capabilities and for their exploitation at the national level.

[1] This article is based on the applied research reports (Ukrainski *et al.* 2017 and 2018) funded by Interreg and the Estonian Ministry of Education and Research as well as ERDF and the Estonian Research Council.

[2] Under EU13 we mean the following countries and abbreviations throughout the paper: BG – Bulgaria, CZ – Czech Republic, CY – Cyprus, EE – Estonia, HR – Croatia, HU – Hungary, LT – Lithuania, LV – Latvia MT – Malta, PL – Poland, RO – Romania, SI – Slovenia, and SK – Slovakia. Under EU15 group, the rest of EU countries is considered.

[3] See Ex-Post-Evaluation of the 7th EU Framework Programme 2007–2013 (2015); European Commission (2016b and 2017a).

In fact, the EU13 country group finances 22–24 percent and the EU15 country group 1–13 percent of R&D expenditure from abroad (and within the funding-from-abroad category, H2020 plays a varying role and is more significant in Southern, Northern and smaller member states as well as in EU13 countries) – see Ukrainski *et al.* (2017). While FP funding seems to substitute for the resources from other (mainly national) funding sources in old member states, in Central and Eastern European (CEE) countries, it primarily tends to compensate for less developed (knowledge) infrastructures. Hence, it has been argued that FP research subsidies are only a viable option for increasing regional innovativeness in combination with other policies (Varga and Sebestyén 2016b).

The general strategy for small countries is to build their scientific excellence *via* international networks to avoid insulation in increasingly specialised fields of science (Luukkonen *et al.* 1992). Therefore, small nations often try to integrate into a broader range of international cooperation networks, which, however, can compromise the depth of integration. As many EU13 nations are small, integration patterns compared to isolation patterns remain relevant in their research policy agenda. As not all EU13 countries are affected by the same problems and to similar extents; the dichotomy of EU13 *versus* EU15 may somewhat simplify the reality of the situation. Comparing participation patterns between EU13 *versus* EU15 is nevertheless useful to understand progress towards widening of European Research Area (ERA), as well as the performance of national policies encouraging international research collaboration, as well as the more general aims of cohesion policy in research and innovation.

This article aims to evaluate how segregated (separated) or integrated (homogenously distributed) EU13 participants are across projects in FP7 and H2020; and how this segregation has changed over time. The strategy for empirical study is to measure the degree to which a group (EU13) is concentrated in particular projects ('*evenness*' of the distribution); the extent to which one group dominates or shares particular projects ('*exposure*' to participants from other groups); and, the probability (or degree) of contact between members of different groups as a result of their mutual segregation ('*clustering*') – see also Morrill (2016). The article first discusses the changing context of FP7 and H2020 from the cohesion policy perspective, and subsequently presents the empirical standpoints, and discusses these results.

DEVELOPMENT OF FP TOWARD COHESION POLICY AIMS: MAIN CHALLENGES

As mentioned already, FP and cohesion policy are distinct, but complementary policy instruments (programmes) facing the main challenges of general

fragmentation, but particularly of weak coordination and strategic alignment between different policy levels (European, national, regional). Better interoperability, mutual enforcement, and synergies have therefore been seen as essential in forming a common frame-work for research and innovation (Van Vught *et al.* 2011).

Over time, the policy rationales behind the FPs have become more oriented towards overcoming existing structural differences and creating the integrated ERA (see Nedeva 2013). However, the ambivalence of the European 'research, development and innovation' (RDI) policy in terms of strengthening the competitiveness of its leading parts and improving the conditions of those performing poorly in the same institutional and policy frame-work arguably exacerbates the existing structural problems of ERA (Young 2015; Lepori *et al.* 2015; Karo and Kattel 2018) and thus contradicts cohesion policy aims too.

The specific aim of the H2020 was to introduce a break with the past by making major changes in the distribution mechanisms of FPs (primarily aimed at covering the entire innovation cycle together with orientation towards closer-to-market applications and significant societal challenges) – see Table 1.

As this shift has been pursued in the politico-economic conditions still hampered by the last economic crisis (see European Commission 2017b; Karo *et al.* 2017; Young 2015), it has had a two-fold impact on participation patterns in H2020. On the one hand, all national governments across Europe have made participation in EU research funding schemes a central focus in their R&D policy agendas, particularly to compensate for cuts in investments in R&D at a national level (Enger 2017; Enger and Castellaci 2017). On the other hand, the submission of applications by private players grew by over 130 percent between FP7 and H2020 (European Commission 2017b). As the competition for H2020 funds has become fiercer and vastly outstripped supply, the considerable problems of oversubscription and dissatisfaction have emerged (European Commission 2017b). Here, according to the evaluations by European University Association (EUA 2016), R&D institutions perceive themselves as the group hit the hardest by the aforementioned changes in H2020 (and particularly the limited funding devoted to basic and disruptive research).

In view of this situation, analysing the factors affecting participation in the ERA is full of complexities. Firstly, different types of players (such as nation-level actors, independent organizations, individuals) may have different incentives and capacities for participating in FP projects and other EU (including cohesion policy) instruments (for example, Åström *et al.* 2012; EUA 2016; European Commission 2016a).

Table 1

Key Changes from FP7 to H2020 towards Cohesion Policy Aims

Recommendations from FP7 *ex-post* evaluation	H2020 goals and changes towards cohesion policy aims
Focus on critical challenges and opportunities in the global context	• focus on major societal challenges • boost private sector participation including SMEs • maximise synergies between different areas of research and innovation and new digital technologies
Align research and innovation instruments and agendas in Europe	• support the alignment of national research strategies • better coordinate with EU regional funding • help the EU countries reform their research and innovation strategies • identify obstacles to research and innovation • ensure that research proposals support innovation
Integrate different sections of research funding programmes more effectively	• focus on better consistency across the funding programme • ensure cross-cutting issues are considered • simplify access to research and innovation funding • apply a single set of rules consistently • efficiently coordinate across the Commission in managing the funding
Bring science closer to citizens	• better communicate with the general public on science issues in general and Horizon 2020 in particular • strengthen open access to research publications and data • involve citizens in research strategy and topics
Establish strategic programme monitoring and evaluation	• better monitor and evaluates funding and socioeconomic impacts • improve feedback loop from project results to policy making

Source: European Commission (2017b).

Secondly, given that FPs have evolved over 30 years and through complex and cumulative political compromises, the instruments of FPs cover different policy rationales – see e.g. Bach *et al.* (2014); Reale *et al.* (2013); European Commission (2017b). This implies that not all policy instruments should be of equal importance and suitable for different nations (given the differences in development stages), or specific research fields, organisations, and individuals (given their missions and interests).

In the following, we try to evaluate the overall participation outcome indicating the degree of the success of broader integration of EU13 countries in ERA. Key areas for policy intervention are discussed on the basis of this analysis.

MEASUREMENT FRAMEWORK FOR EU13 SEGREGATION IN FP

Here we use the indices of segregation that are commonly used quantitative measures describing social separation. "People get separated along many lines and in many ways. There is segregation by sex, age, language, religion, colour, taste, comparative advantage and the accidents of historical location. Some segregation results from the practices of organisations; some is deliberately organised; and some results from the interplay of individual choices that discriminate. Some of it results from specialised communication systems, like different languages" (Schelling 1971, 143).

In our article, segregation is an outcome of the individual choices of researchers, which are affected by the individual, organisational (university, company), national or system level factors (availability of alternative funding sources, interactions with other players etc.) – see Enger and Castellaci (2017). The limitations of the use of such segregation indexes are related to the fact that the underlying segregation processes are not revealed, for example the extent to which these general trends are attributable to lower investment in R&D (personnel, infrastructures), less efficient R&D systems and policies, closed networks, and brain drain problems due to salary gaps (Galsworthy and McKee 2013).

In short, the segregation measurement framework can be described as follows. The total number of participations is noted with T; and M represents the participations from the EU13 country group, hence 0 < M < T. The overall fraction of EU13 country participations is P = M/T. In case there are n projects, $p_i = m_i/t_i$ is the fraction of EU13 participants in the particular project i. EU13 can be considered in the analysis as a minority group comprising 13 percent from EU28 by HRST ('human resources in science and technology') indicator, which is relatively stable across the years under analysis 2007–2016.[4]

[4] The data of H2020 participation have the cut-off date of 28 February 2017.

The share of EU13 participations is $P_{FP7} = 0.0798$ and $P_{H2020} = 0.0845$.

Firsty, we calculate the index of dissimilarity (D) originating from Duncan and Duncan (1955), but in this version adopted from Baroni and Ruggieri (2015)

$$(1) \quad D = \frac{1}{2P(1-P)} \sum_{i=1}^{n} \frac{t_i}{T} |p_i - P|$$

where 2P(1 – P) is a normalisation factor to place the index in the range between 0 and 1. The dissimilarity index would be at its minimum when the distribution of participants from EU13 countries is uniform over all projects. D measures the 'concentration' or 'evenness' of the distribution, hence it is interpreted as the proportion of the minority group that would have to 'move' for all projects to have the same average proportion. (The similar measures of the Theil and Gini indexes could be calculated here, too – see Duncan and Duncan (1955)).

Secondly, we calculate the isolation index, which is defined as the likelihood of a participant from EU13 countries being exposed to another member of the same country group in a project. For the particular project i, this is estimated as the product of the likelihood that a member of the EU13 countries is in the project (m_i/M) divided by the likelihood that she is exposed to another EU13 participant in the unit (m_i/t_i, or p_i), assuming that the two events are independent:

$$(2) \quad \mathrm{I} = \frac{1}{\mathrm{M}} \cdot \sum_{\mathrm{i}=1}^{\mathrm{n}} \mathrm{m_i} \cdot \mathrm{p_i}$$

The isolation index runs over the range from P (overall fraction of minority group participation) to 1, whereby higher values denote higher segregation. Again, the minimum value is achieveded where $p_i = P$; the maximum value is reached where there is only k, such that $m_k = t_k = M$, which means the unit contains all EU15 members and no EU13 member, therefore I measures the 'clustering' of the minority group.

A complementary measure is the interaction (or exposure) index, or the likelihood that a member of the minority group is exposed to a member of the majority group in a unit, which is the following:

$$(3) \quad \mathrm{Int} = \frac{1}{\mathrm{M}} \cdot \sum_{\mathrm{i}=1}^{\mathrm{n}} \mathrm{m_i} \cdot (1 - \mathrm{p_i})$$

The index of interaction measures how the majority group dominates (or shares, if the index value is lower) the project participations; it runs from P – 1 to 0, where higher values show higher domination. It is clear from (2) and (3) that I + Int = 1. As the totals of T and M cannot be so easily detected from the data, but also participants can join several projects, we use here $T = \sum_{i=1}^{n} t_i$ and $M = \sum_{i=1}^{n} m_i$, thus the size of the total population of participations is by definition the sum of the sizes of the unit (project) populations,

Table 2

Segregation Index Values for EU13 Participations in Framework Programmes (FP7 and H2020)

	Index of dissimilarity (D)	Index of isolation (I)	Index of interaction (Int)
FP7	0.61	0.32	0.68
H2020	0.64	0.37	0.63

Note: Total number of projects in FP7 is 25205, and H2020 is 10,966.
Source: Author's calculations based on eCORDA.

and similarly for the minority group (Baroni and Ruggieri 2015).

EU13 PARTICIPATIONS IN FP EVALUATED BY SEGREGATION INDICES

Here we use the segregation indices and their dynamics to assess whether the EU13 countries have achieved wider integration within ERA science cooperation (which they are aiming at) or not. The empirical results show that the segregation of EU13 in the H2020 programme has increased compared to FP7 – the dissimilarity index has increased from 0.61 to 0.64 (Table 2). As the dissimilarity index measures the 'evenness' of the distribution, showing that the degree to which EU13 countries have concentrated in particular projects, has increased.[5] Paradoxically, this growth of segregation has emerged while the overall participation of EU13 members in FP has grown a little – in FP7, the share of this group was 7.98 percent and, respectively, in H2020 8.45 percent of all participations. Thus, one can conclude that while EU13 has managed to gain more participation (and funding) from FP, this has not necessarily increased the integration of these countries within ERA.

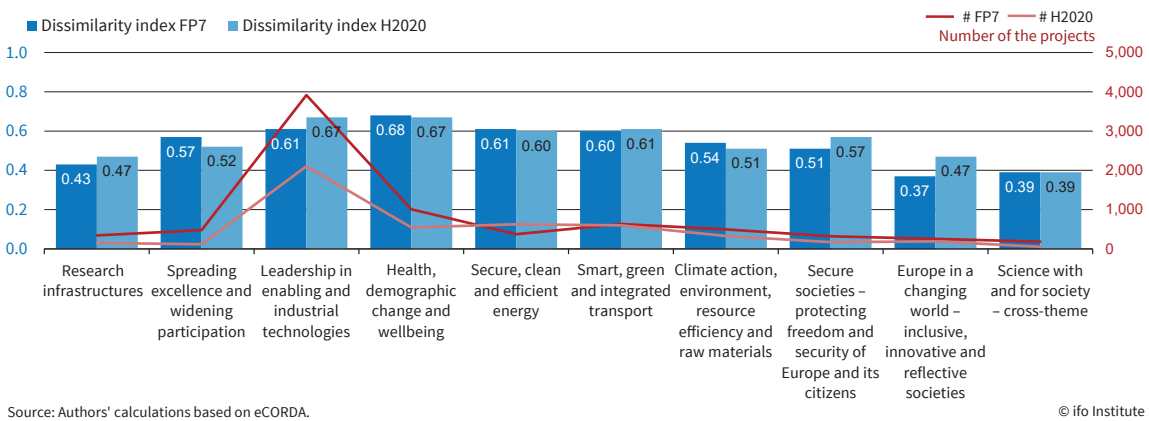
Similar results are also shown by the indices of isolation and interaction. The index of isolation expresses the probability of meeting another member of the EU13 within the cooperation project. It has grown between FP7 and H2020 and shows that the EU13 members have clustered into certain projects, as opposed to widening participation across all types of projects or becoming critical mass members in projects they participate in. The index of interaction shows the probability of meeting (or being exposed to) another member of the majority group (EU15 member, respectively). The dynamics of the index support our claims of H2020 being much more complex in terms of the governance forms of instruments, requiring greater relational proximity, which, in turn, limits the wider participation of EU13 countries. However, smaller projects and the single/small number of participants involved also lower the probability of having other EU13 partners in the project.

According to the latest data, the total share of funding allocated to the EU13 remains relatively low and has increased only slightly from 4.2 percent in FP7 to 4.4 percent in H2020 (as of 1 January 2017); while the success rate of applications from EU13 has fallen from 18.0 percent to 11.1 percent (European Commission 2017b). Whereas previous analyses of FP7 have highlighted the limited participation rates of EU13 in particularly well-financed FP areas (e.g. Rauch and Sommer-Ulrich 2012; European Commission 2016b), the central issue today concerns their limited range of participation in the different types of FP instruments. Here the success of the EU13 country group is argued to rely heavily on bottom-up or horizontal instruments like SME promotion, RIA (research and innovation actions) and CSA (coordination and support actions). These instruments, together with more complex and top-

[5] There are no common rules on how to judge or interpret more broadly these indices, e.g. Marcińczak *et al.* (2015) suggest adapting commonly used thresholds in ethnic segregation (D < 30 indicating low and D > 60 high segregation) to a lower level in case of socio-economic segregation, thus D < 20 indicating low and D > 40 high segregation.

Figure 1

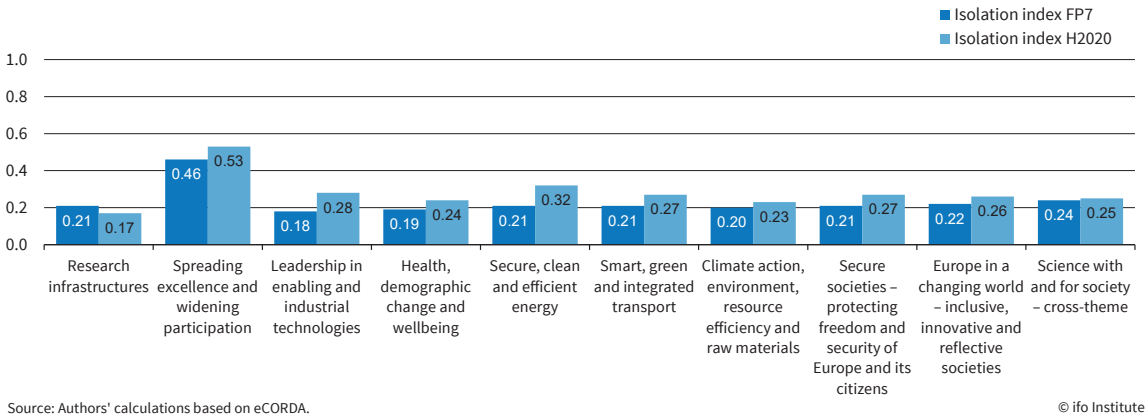
Value of Dissimilarity Index by Thematic Priorities



Source: Authors' calculations based on eCORDA.

Figure 2

Value of Isolation Index by Thematic Priorities



Source: Authors' calculations based on eCORDA.

down governance structures, remain out-of-reach (Ukrainski *et al.* 2018). The failure at the governmental level to provide the necessary commitment and symbolic leadership required for participation in FP may become a crucial barrier from a long-term perspective. At the national level, the relatively higher share of SMEs in contrast to larger companies involved in FPs has also been highlighted.

On the project level, it is found that the EU13 countries are involved in H2020 projects where the average contribution per participant and per coordinator is lower. They mostly participate in consortia led by other countries, rather than acting as coordinators (Ukrainski *et al.* 2017). Nevertheless, some smaller EU13 countries (Slovenia, Cyprus, Estonia) are said to outperform the EU15 averages (FP contributions in comparison to the size of the population, the number of researchers and national investments in R&D) – see also European Commission (2017b). Here the variations in wages and reimbursement rates between EU15 and EU13 need to be considered, arguably accounting for up to 80 percent of the total variation in financial returns from FP (Council of European Union 2011). The low salary level of EU13 is also a major reason for low motivation to take up the role of the coordinator in H2020 (European Commission 2017a).

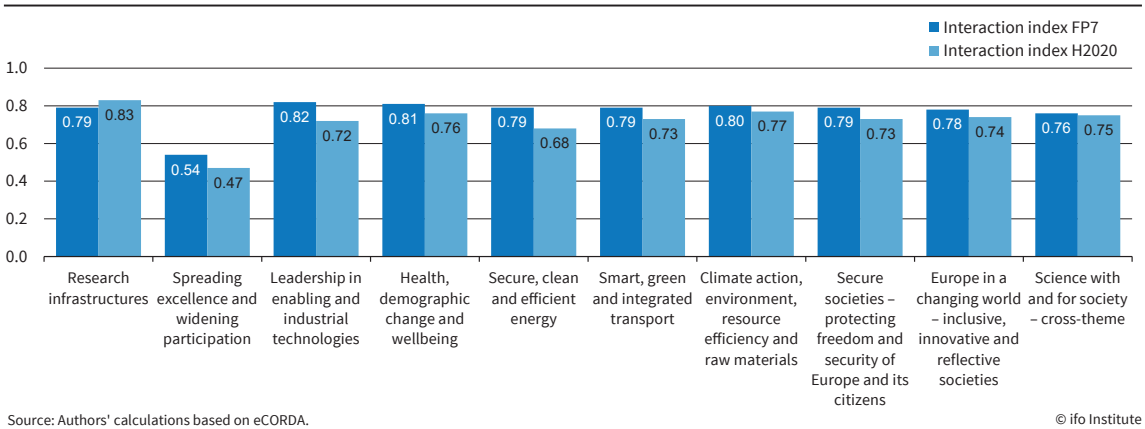
An analysis of the projects with larger numbers of EU13 participants reveals that the Teaming and Marie Curie instruments have gained relevance in H2020 with new instruments targeting wider EU13 participation. Thematically, 'leadership in enabling technologies' has lost in relevance, as it is one instrument with a relatively larger number of EU13 participations in FP7. The segregation indices by thematic fields or priorities (as far as these have been comparable between FP7 and H2020; see Figure 1) show that projects under SEWP ('spreading excellence and widening participation') have clearly reduced overall segregation, but nevertheless increased the isolation (clustering) of EU13 countries in H2020 at the same time (Figure 2).

The vast differences between EU13 and EU15 become even more evident once we look at the EU contributions across different thematic instrument groups (so-called 'Juncker's priorities'[6]). In EU13 countries, widening instruments are more visible

[6] Here, division of thematic priorities (called also thematic pillars) are constructed following the High Level Group suggestion based on priorities and budget allocations in European Commision (2017a).

Figure 3

Value of Interaction Index by Thematic Priorities



Source: Authors' calculations based on eCORDA.

and potentially compensate for overall segregation in terms of Commission's contribution. If one looks at the size of this instrument, however, it accounts for around 1.1–1.2 percent of total budget allocations (European Commission 2017a), which is clearly too small to produce a change in the overall pattern of participation. In certain cases, the success of widening instruments converges around single (large) projects in Estonia and Latvia, for example (Ukrainski *et al.* 2017).

SPECIFIC CHALLENGES TO PARTICIPATION IN H2020 FOR EU13 COUNTRIES

The specific challenges facing the EU13 countries are summarised in Table 3. It seems that the current EU funding patterns are limited in their ability to foster structural reforms at the national level in the EU13. This group of countries is under great pressure to obtain funding from H2020, but is failing to provide the requisite complementarity of national funding for R&D (Veugelers 2014) – one of the key factors incentivising R&D players to design and pursue excellent research projects at the European level and to increase their competitiveness in FPs (EUA 2016; Rauch and Sommer-Ulrich 2012; Schuch 2014). While the Estonian and Latvian success rates (higher than 16 percent), despite the declining national funding (EUA 2016), may seem to point to different arguments and conclusions, the 'success rate' here needs to be interpreted in the context of the specifically EU13 targeted 'widening' measures (see above).

Furthermore, successful participation in FPs is found to depend heavily on research capabilities (academic reputation, size of research personnel), as well as on learning and network effects gained from previous participation (Lepori *et al.* 2015). According to European Commission (2017b), the H2020 has opened up the existing 'clubs' *via* the increased participation of newcomers from industry (here the attractiveness of the SME instrument can play its role), as well as from the EU13. Nevertheless, application activity still tends to converge overwhelmingly in the hands of R&D institutions (approximately ten times higher on average than for industrial partners during the first three years of H2020) – see European Commission (2017b). In the case of EU13, even although EU accession has had a positive impact on international scientific collaboration in terms of the rising number of co-publications, it has also been found that this collaboration is more significant within EU13 than between researchers/groups from EU13 and EU15 (Makkonen and Mitze 2016). Similar proof of segregation between EU13 and EU15 countries is found in the case of region-specific Baltic Sea collaboration instruments (Ukrainski *et al.* 2017).

While in the case of FP7 it was argued (by e.g. MIRRIS 2014) that EU13 countries were often involved in research consortia due to their 'favourable position' (geographical location, size, etc.), in the case of H2020 (and given its revised logic *vis-à-vis* FP7) the dominant role of larger and EU15 countries as consortia coordinators and members seems to be reinforced again, especially as they possess higher levels of

Table 3

Key Challenges of EU13 in Participating in FP as Derived from the Discussion on Segregation

Key challenges	National level	Organizational / project level
'Evenness' of distribution	The functional synergies between the EU research foci and R&D systems of EU13 remain limited, reflected primarily by the EU13's overwhelming participation in horizontal and bottom-up instruments in contrast to those with more top-down and complex governance structures, presuming, in turn, more active and strategic involvement by the national governments, as well as compliance with the EU strategic aims.	The potential of SEWP ('spreading excellence and widening participation') instruments to compensate for overall segregation remains unfulfilled, mainly due to the limited share devoted to the instrument in the total FP allocations, as well as its currently limited impact, while tackling the structural issue of isolation of EU13 countries in H2020.
'Exposure' to participants from other groups	The growth of segregation between EU13 and EU15 has emerged, while the overall participation of EU13 members in FP has grown a little; the segregation is evident also in the case of region-specific collaboration instruments, particularly worrisome due to certain expected geographical, relational, etc. proximity here.	The participation activity in general, as well as the submissions of successful applications, has concentrated in the hand of limited leading groups, whereas entry barriers in FP-like international research networks become higher (presuming steep learning curves) and more structural in their essence.
'Clustering'	The insufficient access of EU13 to existing so-called 'old boys' networks, relying heavily on academic reputation at the international level. The latter is particularly important in this context, where existing networks matter more in FP than existing capabilities developed in isolation.	Weakly constructed national networks that act as an important structural barrier for building consortia and engagement of participants (user-side) from own countries and beyond.

Source: Compiled by authors.

international and national (user-level) collaboration partners. Newcomers from the EU need to buy into these 'closed clubs', often without strong international and domestic networks of partners (Enger 2017; Enger and Castellaci 2016; Lepori *et al.* 2015; Council of European Union 2011). This means that for weaker performing research systems, the entry barriers in FP-like international research networks are not only high but also of a highly structural nature.

One could assume that the more active EU13 members have at least managed to increase their readiness to participate in FPs: Estonia, for example, experienced an increase of nearly 100 percent in the number of overall applications between FP7 to H2020 (European Commission 2017b). The relatively low success rates, however, indicate that the effectiveness of participation has remained limited; and it can therefore be argued that EU13 countries may have already maximised their current potential. This is primarily reflected in the convergence of participation activity in general, as well as submissions of relatively few strong applications into the hands of limited, leading groups in these countries (Ukrainski *et al.* 2017 and 2018).

We can only conjecture that, given the shifts in H2020 towards innovation and societal challenges, this may be due to imbalances in the domestic RDI system (fewer capable public sector user-level partners and large firms), as well as limited capacities to coordinate and manage the more substantial diversity of domestic and international partners required in current H2020 projects. To summarise, the EU13-specific vital barriers to participating in H2020 are related to the RDI and cooperation capabilities of different types of players within innovation systems, but also to the formal and informal institutions (such as networks, commitment, agreement on strategic aims) shaping the cooperation.

CONCLUSION

The major challenge facing EU13 countries remains the participation divide in FPs. As converging/catching-up economies, the EU13 countries seem to expect different impacts from FPs than the leading EU15 economies. Thus, debates regarding the participation of EU13 countries in FPs are by necessity more critical and emphasize the challenges (as opposed to specific opportunities) of entering and participating in FP activities. The policy reducing the segregation of EU13 needs to consider enhancing:

- the participation (especially coordination) capabilities of EU13 countries;
- mutual cooperation of EU13 members within FP projects (instead of forming even smaller thematic groups); and
- the intake of broader geographical coverage of partners to the projects.

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