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Women Underrepresentation in R&I: A Sector Program Assessment of the Contribution of Gender Equality Policies in Research and Innovation

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ABSTRACT

Despite decades of efforts to achieve gender equality in research and innovation (R&I), all EU member states still face remarkable difficulties in driving forward the development of their innovation system while at the same time improving gender equality by using all the available research potential. In this paper we focus on the development of the share of women researchers in four national innovation systems, i.e. in Austria, Denmark, Hungary and Spain in the time period 2005-2015. The four selected cases represent countries with significant differences in their innovation capacity, gender regimes and progress of gender equality in R&I. A qualitative comparative analysis (QCA) is carried out to conduct a sector program evaluation based on statistical data and qualitative studies to understand the dynamic development of the proportion of women researchers. The study aims to provide insights into the aggregated gender equality interventions and policies implemented in the four countries studied and their contributions to the development of the proportion of women scientists at the structural level. The analysis reveals that the development of the share of women researchers during the studied period has been particularly influenced by contextual factors, namely the relative size of the business enterprise sector and the share of women among holders of tertiary education. While this is the case, it is found that gender equality interventions need to be more widespread and more effectively designed to be a strong contributing factor to an increasing representation of women in R&I.

1. Research investment intensity and women in R&I

Despite decades of efforts to achieve gender equality in research and innovation, all European Union (EU) member states are still facing remarkable difficulties in driving forward the development of their innovation system while at the same time improving gender equality. This paper examines the driving factors for the development of the proportion of women among the scientific workforce between 2005 and 2015 from a structural perspective. A qualitative comparative analysis (QCA) is used to discuss the extent to which the aggregated gender equality programs in Austria, Denmark, Hungary and Spain have contributed to the representation of women among research personnel.

Abbreviations: BES, Business Enterprise Sector; BERD, Gross domestic spending on Research and Development of the Business Enterprise Sector; EC, European Commission; ECCTI, Spanish Strategy of Science, Technology and Innovation; EFFORTI, Evaluation Framework for Promoting Gender Equality in Research and Innovation; ERA, European Research Area; EU, European Union; FEMtech, Women in Research and Technology; GDP, Gross Domestic Product; GERD, Gross domestic spending on Research and Development; GOV, Government Sector; HES, Higher Education Sector; ICT, Information and Communication Technology Sector; ISCED, International Standard Classification of Education; LCTI, Law of Science, Technology and Innovation; NACE, Nomenclature Générale des Activités Économiques dans les Communautés Européennes; NGO, Non-Governmental Organization; OECD, Organisation for Economic Co-operation and Development; PECTI, Plan for the Spanish Strategy of Science, Technology and Innovation; PRAGES, Practising Gender Equality in Science; QCA, Qualitative Comparative Analysis; R&D, Research and Development; R&I, Research and Innovation; RPO, Research Performing Organization; STAGES, Structural Transformation to Achieve Gender Equality in Science; STEM, Science, Technology, Engineering and Mathematics

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The EFFORTI project's analysis of the national context for gender equality programs in R&I in different EU countries (see Reidl et al. in this issue) demonstrates the high context dependence of the representation of women among scientists. In the same vein, a research group entrusted by the European Commission (EC) showed a negative correlation between research investment intensity[1] and the proportion of women in R&I personnel using data until 2004 (European Commission (EC), 2008). So-called innovation leaders, like United Kingdom, Denmark and Sweden, and innovation followers, such as Austria, France or Netherlands, were almost consequently characterized by a lower representation of women in R&I than the groups of the moderate or modest innovators, like Hungary, the Czech Republic and Spain.

The high context dependence of the share of women researchers also continued in the subsequent decade from 2005 to 2015. The four countries studied represent innovation systems with large differences in their capacity and gender regimes as well as different developments regarding gender equality in R&I. The four countries differ significantly in their positioning compared to the EU28 average in the period from 2010 to 2015 (Fig. 1). Accordingly, Denmark had the highest expenditure per researcher with an average of 136,670 EUR, followed by Austria with 129,989. Spain invested 62,781 EUR per researcher and Hungary the lowest with 35,290. In terms of gender equality, Spain demonstrates the highest share of women among researchers i.e. 39.1% while Denmark had a share of 35.4%, Hungary of 31.0% and Austria of 29.4%.

In relation to the EU average (2005-2015), Denmark was able to develop from a country with high per capita research expenditure and a below-average proportion of women to a country with high investment in innovation and above-average female participation among the four countries surveyed. Hungary, on the other hand, still has a comparatively low level of investment and is now also a low performer in terms of gender equality. The dynamic development between the periods of 2005 to 2009 and 2010 to 2015 shows the high context dependence of the share of women researchers: none of the countries achieved progress regarding the proportion of women researchers while also significantly increasing its per capita investment per researcher. In terms of per capita investment per researcher, only Hungary shows a marked increase of about one fifth, while the proportion of female researchers decreased by 2.1 percentage points.

Furthermore, the above mentioned EC study from 2008 showed that the negative correlation between R&I investment intensity and gender equality was moderated by the relative size of the business enterprise R &I sector and the overall participation of women in the labor market in the age group between 25 and 50. This implied that the smaller the share of business enterprise R&I and the higher the overall female labor market participation, the lower the expenditures per researcher and the higher the share of women researchers in the national R&I system.[2] These strong dependencies of the representation of women researchers in R&I on the sectoral structure of the national research system and on women representation in the general labor market lead to the question addressed herewith:

> Did the aggregated gender equality interventions and policies implemented in the four countries studied have the expected contributing effects of increasing the proportion of women scientists at the structural level?

The assessment carried out here is structured as follows. In the next section the evaluation approach and methods are presented (2.1) and the case selection is explained in more detail (2.2). The current state-of-the-art in the field of evaluation of gender equality measures in R&I is presented and it is discussed, how this study follows on from it (2.3). A logic model of the relationship between gender equality programs, their context and their output is discussed[3] (2.4). The following section explains in detail the gender equality measures in R&I implemented by the four countries surveyed (3.1) and the influence of the business enterprise sectors (3.2) and the female labor market as relevant context factors (3.3). A qualitative comparative analysis is conducted to structure the comparison of the contribution of the three factors in the four countries studied and to assess the relative relevance of the contribution of gender equality measures to the development of the proportion of women among researchers in the studied period (4).

2. Methods

Cross-national comparative research on women´s representation in R&I is complex and poses a range of methodological challenges (Oyen, 1990; Ragin, 1991), in particular in relation to women's occupation and advancement (Crompton, 2006; Le Feuvre, 2010). The lack of comparative studies of the "gender regimes" to analyse how women are making decisions about careers jeopardizes the quality of research in this field (Le Feuvre, 2010). According to Caprile et al. (Caprile et al., 2012) a lot choices) and fails to address systemic and structural factors. The evaluation approach presented herewith addresses these factors by focusing on the contribution of GE policies to R&I by considering "gender regimes" and systemic factors. This section presents the evaluation approach and case selection.

2.1. Evaluation Approach

This study is designed as a sector program evaluation. A sector program evaluation is an evaluation of a cluster of interventions in a sector within one country or across countries, all of which contribute to the achievement of a specific goal (OECD, 2010). Accordingly, this study examines the aggregate effect of all organizational and legislative/administrative interventions to increase the proportion of women researchers in positions, teams and organizations in the R&I sector. The study focuses on the effectiveness of the aggregated measures in their narrower sense, i.e. to which degree the gender equality interventions and policies as a whole contributed to their overall goal of increasing the proportion of women scientists at the structural level.

A qualitative comparison of four national innovation systems and gender regimes is conducted, and is complemented with statistical analysis, where possible. Within the time period studied (2005-2015), similarities and divergences are traced for key indicators and policies regarding gender equality in the R&I organizations of Austria, Denmark, Hungary and Spain. The comparison is carried out using a simple crisp-set QCA procedure. A crisp-set QCA is an analytical procedure combining both quantitative (for example, regression analysis) and qualitative (for example, content analysis) elements (Ragin, 1987; Schneider and Wagemann, 2007). Its purpose is to find logically consistent associations in a complex data set. The conclusions of QCA are not based on statistical correlations but on the logics of Boolean comparison (for a summary, see Ragin, 1987).

In this study, a QCA with three conditions was thus carried out on the basis of four cases. The four cases cover three of eight mathematically possible constellations. The transferability of the results to

[1] Research investment intensity is indicated by the ratio of the national gross domestic expenditure on research and development (GERD) and total R&D personnel.

[2] All statistical data have been extracted from the Eurostat database, unless otherwise indicated. An overview of all the indicators used, their descriptions and a link to the corresponding website can be downloaded from the website of this article.

[3] Other factors appeared to have no significant impact: e.g., the proportion of women international standard classification of education (ISCED) 6 graduates (post-docs), the gender pay gap, or the R&D expenditure per research personnel (ibid., p. 27).

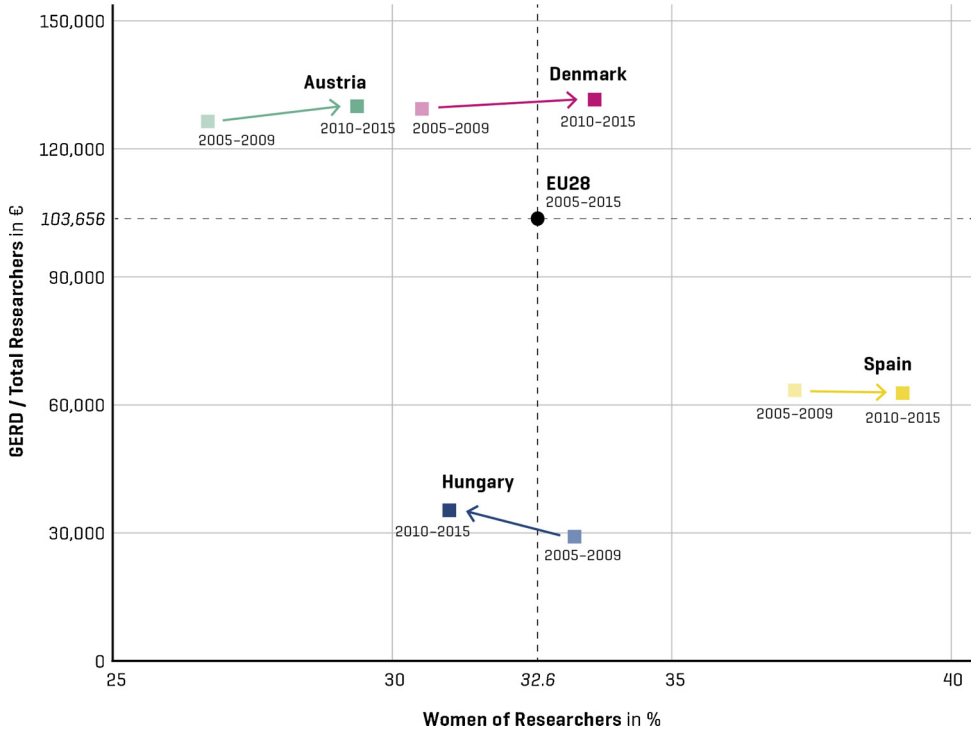

Fig. 1. GERD/Researchers (in 1,000 Euro) in Relation to Proportion of Women Researchers from 2005-2009 and from 2010-2015.
Source: Own calculations based on Eurostat, 2018[11]; percentages of women in R&I personnel are head counts.

countries not included in the comparison and the general validity could be improved by adding further comparison countries covering additional constellations of the conditions used. However, the method here is only understood as a tool for structuring the qualitative case comparison in a logical coherent way. In conventional qualitative research as well as in qualitative evaluation practice, it is common practice to examine a number of cases that are comparable but differ from one another on the basis of a number of characteristics, and allow to derive relevant insights into the phenomenon under study (theoretical sampling). Instead of aiming at a general transferability of results, the focus then lies on the question under which conditions the results of a case comparison are transferable to other cases, which show similar contextual conditions.

To mitigate the sometimes large annual fluctuations in the observed key factors, arithmetic means were calculated for two periods, one from 2005 to 2009 and one from 2010 to 2015.

2.2. Selection of Case Studies

The four selected cases represent countries with large differences in their innovation capacity. Denmark is considered an innovation leader with a total value of 0.67 on the European Innovation Scoreboard Index, Austria a strong innovator with 0.58, while Spain (0.40) and Hungary (0.33) are moderate innovators (European Union (EU), 2018).

Furthermore, the countries represent different gender regimes with different progress level as to gender equality in R&I. The concept of gender regime applied herewith is one of the most fruitful and complex notions regarding structural gender inequalities. According to Walby, a gender regime is a concept to explain the "[…] systematic relations between elements of a system […]" (Walby, 2004, p. 8) which have an effect on gender equality in a broad sense. Gender regimes are both preconditions and consequences of existing welfare regimes. In Walby's (2009) conception of gender regimes one of the main distinctions made is between 'domestic' and 'public' gender regimes (Lombardo, 2017). The more domestic form is characterized by the restriction of women to the private sphere, and exclusions in the economic and political spheres, i.e. access to and participation in the labor market and political representation. In public gender regimes – women are better represented in both the labor market and political life although vertical segregation is persistent pushing women into less powerful and influential roles (ibid). Pascall and Lewis summarize: 'Gender regimes are seen as the key policy logics of welfare states in relation to gender.' (Pascall and Lewis, 2004, p. 373). As exemplary indicators of the gender regime, the female employment rate, the part-time rate among women and the enrollment rate of children aged 2 are compared below.

According to Walby's dichotomy, Denmark stands for a public regime, even if it has fewer binding gender equality initiatives and policies compared to the other Nordic countries. The country's high female employment rate is facilitated by high quality, accessible and affordable childcare facilities. The enrolment rate of small children (aged 2) in childcare reached 90.6% in 2015. The part-time rate among women was 31,2% in 2015, taking thus a position in the middle of the compared countries. The state supports female employment and work-life balance, but does not explicitly encourage a role distribution among parents as it is indicated by the relatively high part-time share of women taking parental leave (31.4% in 2017, respectively 12.4% among men).

In Spain, only half of women aged 20 to 64 are in employment and of these, every fourth women is working part time which is lower than in Denmark (Fig. 2). Half of children aged 2 (55.54%) were enrolled in early childhood education, which is a moderate value among the countries compared. However, from the mid-1980s to the mid-1990s Spain experienced a rapid development in health care and education (Lombardo, 2017, p. 22). Taking into consideration both of these trends, Walby (2009) characterizes Spain as "in the middle of a continuum between a domestic and a public gender regime, albeit closer to a public regime" (Lombardo, 2017, p. 23).

The Austrian gender regime has a female employment rate of between that of Denmark and Spain/Hungary, and the highest part-time rate among working women within the comparison group (Fig. 2). The country has for a long time been characterized by the male breadwinner model belonging to the corporatist welfare regime. This system has

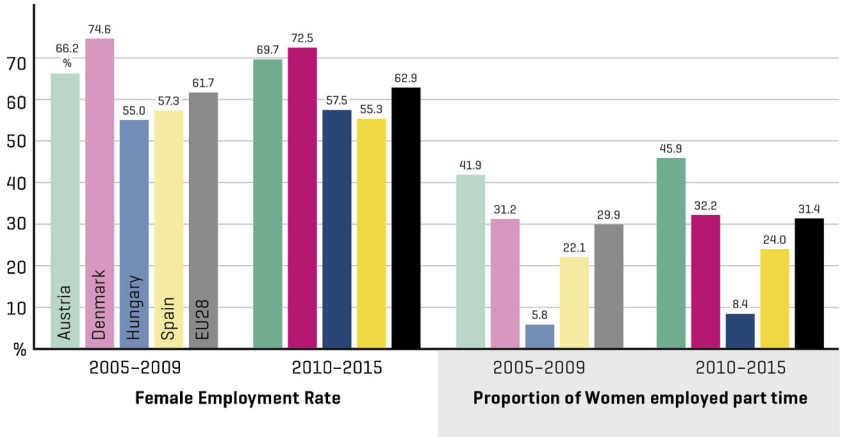

Fig. 2. Proportion of Women in Labor Force and Proportion of Women Employed Part Time, from 2005 to 2009 and 2010 to 2015.
Source: Eurostat, 2018.

changed to some extent due to an increased female employment rate and the gender regime incorporating numerous institutional guarantees. Austria has a clear commitment to the development of gender equality in the labor market, and to the reconciliation of work and private life. However, women's rising participation in the labor market does not impact the traditional division of labor considerably. In 2015, 38.8% of children aged 2 were enrolled in early childhood education, which is a lower moderate value within the comparison group. Paid parental leave can be taken until the second birthday of the child. As Austrian experts notice, the gender regime 'comprises conflicting elements of a male breadwinner model as well as of an adult worker model' (Reidl et al., 2018, p. 40). We consider this case as an example of modernizing domestic regime.

Hungary took some ambiguous steps in the opposite direction, however remained close to the public gender regime. After 1989, the socialist countries experienced huge cuts of state subsidies, and adopted western paradigms, i.e. less state support for care work, however, with a significantly lower average household income. The collapse of the public care infrastructure, e.g., for children below the age of 3, is also an explanation for the 'retraditionalization' of social values and gender roles after 1989 in almost all post socialist countries (Pascall & Lewis, 2004). The result of Hungary's weakened position is the low, but increasing participation of children in childcare, and the relatively low female employment rate of mothers staying on long paid parental leave (Fodor & Kispeter, 2014). In 2015, only 12.7% of children aged 2 were enrolled in early childhood education. The country's gender regime is an interrupted dual-earner model, where most women work full-time. Hungary has a female employment rate comparable to that of Spain and has the lowest part-time share among the countries studied (Fig. 2). The country has a weak gender equality machinery (Füleki, Groó, Kleinheincz, & Paksi, 2018), and thus can be characterized as an *ambiguous public regime*.

Table 1 provides an overview of the case selection. Accordingly, Denmark was chosen for the study as a country with a relatively high degree of equality and a high innovation capacity, and Hungary as a country with decreasing, ambiguous equality and a low capacity for innovation. Austria and Spain both demonstrate traditionally domestic regimes with an increasingly progressive gender equality policy, the 'modernizing domestic regime', while representing strong and moderate innovators respectively.

2.3. Evaluation of Gender Equality Programs in R&I: State-of-the-Art

The EC study form 2008 (EC, 2008) showed a one-sided link between the maturity of an innovation system and the proportion of women researchers: the less attractive research jobs appear to be (prestige, income), the higher the share of women pursuing a research career. However, the current discourse in the research literature advocates for a clear rationale of gender equality programs. The beneficial effects of gender equality programs for the R&I system have been described in the literature:

- more effective group processes, because of higher collective intelligence and better group climate (Bear & Woolley, 2011; Woolley et al., 2010);
- gendered innovations that tie up to current niches of supply and demand and result in products and services more attractive to women users (Schiebinger & Schraudner, 2011);
- a higher research capacity due to a higher general participation of women among research professions (European Institute for Gender Equality (EIGE), 2017, p. 35).

As the benefits of diversity become increasingly evident, most countries nowadays are implementing different measures and policies to address gender equality (Pollitzer, Smith, & Vinkenburg, 2018). However, these measures should not stand alone but are in high need for evidence of their effectiveness and impact (EIGE, 2016). Therefore, the evaluation of gender equality measures is an upcoming and indispensable task, in particular as regards the R&I sector (Caprile et al., 2012). The nature, goals and approaches of evaluations can differ widely (Mark, Greene, & Shaw, 2006), but in its core any evaluation can be defined as "the process of determining the worth or significance of an activity, policy, programme or plan" (Espinosa et al., 2016, p. 4). Hence, evaluations should not solely be technical processes limiting their views to the simple outcome of a measure but follow the goal of providing information about the social–worth and meaning of both the

Table 1
Overview of the coverage of different innovation capacity types and gender regimes by the cases examined.

	Innovation leader	Strong innovator	Moderate innovators
Public regime	DK		
Ambiguous public regime			HU
Modernizing domestic regime		AT	ES

measures' outcome and process, using the lessons learned for future improvements (Espinosa et al., 2016; Caprile et al., 2012).

The literature reveals that the relationship between gender in R&I and evaluation has traditionally been studied by researchers from the evaluation field while gender-sensitive evaluations in R&I have been more limited (Espinosa, 2013; Seigart & Brisolara 2002). In addition, scholars also point out that the gender equality policy literature stems from the evaluation field and not from the gender studies field (Bustelo, 2017; Podems, 2010). The gender-sensitive evaluation approach underlines the importance of bearing in mind that inequality is systemic, and that evaluation is a political activity (Seigart & Brisolara, 2002). According to Bustelo (Bustelo, 2017) in order to understand structural aspects, we need to do evaluation from a gender perspective, using a reflective and critical standpoint as well as methodological diversity. The approach adopted in this study is consistent with the gender-sensitive evaluation approach in its effort to contribute to GE policy development in R&I using a critical standpoint and a combination of quantitative and qualitative methods.

Furthermore, literature shows that the majority of evaluation approaches in gender equality today concern the impact of certain (short-term) measures on the individual level. For example measuring the self-esteem of female employees before and after a career training intervention or assessing gender attitudes of employees before and after a gender sensitivity coaching. These evaluation surveys or interviews are short and simple to carry out (Caprile et al., 2012). Other evaluations focus on separate aspects, for example critically reviewing an organisations' communication tool or recruitment processing (Cacace, 2009; Van den Brink, Benshop, & Jansen, 2010). It was also found that a high proportion of evaluations carried out focus on women's access to leadership positions (Cacace, 2009). The main tools used for evaluations of gender equality measures are statistical analysis of data, documentary analysis of national legal and policy documents and organisational documents, as well as the application of checklists and standardized measures (Cacace, 2009; EIGE, 2016). However, as stated before the vast majority of evaluations seem to be rather small-scale. Comprehensive, large-scale evaluations that look at structural changes are seemingly much more difficult to carry out, as they require more financial resources and methodological complexity (Caprile et al., 2012).

One key issue when carrying out gender equality evaluations is that often only single indicators are used, such as the proportional participation of women in science and research, despite the fact that gender equality is a much more complex and multi-layered issue (Caprile et al., 2012; Kalpazidou Schmidt & Graversen, 2019). Gender equality is a socially constructed concept, embedded in a wider social context, which implies that interventions require a structural change approach. These structural changes however are difficult to evaluate because of their slow and scarcely visible nature (Caprile et al., 2012). Consequently, only few evaluations address underlying causes and preconditions like gender stereotypes or the inherent gender bias in research and innovation. Another issue we currently face in gender equality evaluation in R&I is the missing connectivity and information exchange between the different stakeholders conducting evaluations in the fields of education, research and innovation. Hence, there is a lack of systematic evaluation of the effectiveness and sustainability of the measures and policies implemented (Pollitzer et al., 2018). Overall, we can see that conducting comprehensive evaluations of gender equality is a challenging task that requires many resources (Adam, Vincke, & Dubois-Shaik, 2016).

There is thus a clear need to go beyond the often isolated local and specific evaluations and to consider the interdependence of the measures and the context factors (Caprile et al., 2012; Kalpazidou Schmidt & Cacace, 2017). The goal should be to strive for more inclusive, wide-ranging and thought-out evaluations that follow strategic and long-term goals (Adam et al., 2016; Caprile et al., 2012; Pollitzer et al., 2018). With our macro-level approach of a sector program evaluation, we aim to contribute to strengthening comprehensive evaluation strategies at system level. In this study, we propose to use the QCA method to organize and analyze complex macro-structural relationships in a transparent, logically coherent and systematic way (cf. Espinosa et al., 2016).

Espinosa et al. (Espinosa et al., 2016) outline six basic steps for systematically implementing successful evaluations. The first step is to determine the concrete prevailing gender equality issue. This is in line with other research which shows that it is crucial to set concrete targets and to monitor and evaluate processes based on the attainment of those targets (EIGE, 2016; Kalpazidou Schmidt & Graversen, 2019). This is done in the following section. For the next step, it is important to include different stakeholders in the evaluation plan to ensure their ownership and engagement into the process. In the case of this study, the descriptions of gender equality policies in R&I (section 3.1) are based on the assessment of national gender equality experts in the countries studied and the EFFORTI country reports, in which comprehensive statistical material, literature analyses and expert opinions were compiled to assess progress in the countries studied (see also the following section). Step three is to develop specific questions to be answered by the evaluation. Our sub-questions are derived from the logic model of this evaluation and are described in the next section. The fourth step is the creation of an evaluation strategy (Espinosa et al., 2016). Many authors suggest mixed-method approaches using both qualitative data, to include people's judgement and perceptions of a subject, and quantitative data for statistic comparisons (Espinosa et al., 2016; EIGE, 2019; Genova, De Micheli, Zucco, Grasso, & Magri, 2014). In this study, we also put high value on including both qualitative and quantitative data for conducting a wide-ranging evaluation. Furthermore, Espinosa and colleagues (Espinosa et al., 2016) suggest the design of the evaluation to be creative and realistic. This study triangulates different data sources, especially statistical material and expert views and is realistic in its approach because it focuses on the influence of structural contextual factors on the effectiveness of gender equality policies in R&I and how they affect the proportion of women among researchers (Kalpazidou Schmidt & Graversen, 2019). The fifth step of a successful gender equality evaluation is the analysis of the data according to the evaluation questions which is done here by the means of a QCA. The last step concerns the reflection and communication of the findings and learnings. Evaluations should be made publicly available in order to build confidence between the organisation and the target group and include a discussion of the relevance, efficiency, effectiveness impact and sustainability of the implemented measures (EIGE, 2019; Kalpazidou Schmidt & Cacace, 2017).

2.4. Logic model and evaluation questions

This sector program evaluation is structured on the basis of a simple logic model. The logic model is based on the already mentioned EC study of 2008, which did not identify the gender equality policy of the EU member states, but the relative size of their business enterprise sector (BES) R&D in relation to that of the higher education sector (HES) and the governmental sector (GOV) as well as the women's labor market participation as important determining factors for the proportion of women among the researchers (European Commission (EC), 2008).

The logic model is shown in Fig. 3. The analysis of the political approaches to increase gender equality, the "input", is based on statistics on the dissemination of gender equality measures in RPOs, in particular gender equality plans. This quantitative indicator is supplemented by descriptions of the policies implemented in the four compared countries between 2005 and 2015 to increase the proportion of women researchers. These descriptions are too abstract to allow conclusions to be drawn about the effectiveness of the individual policies - but they allow a classification to be made of the four countries studied with regard to their gender equality efforts. Output is represented by the proportion of women researchers.

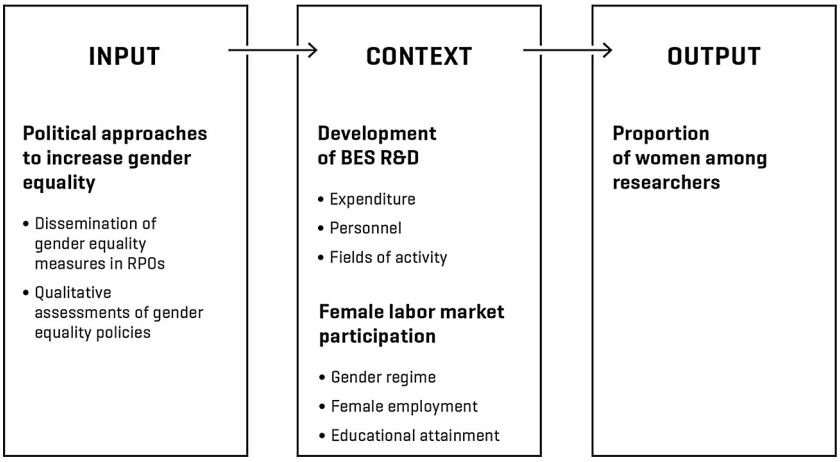

Fig. 3. Logic Model with Factors Decisive for the Development of Women Representation among Researchers in R&I.

The first context condition, the development of the BES, is discussed on the basis of the relative expenditure on BES R&D, the relative share of BES staff and the development of the share of women researchers in relation to HES and GOV. The female labor market participation is discussed as a second context condition based on the proportion of women in the labor force and the part-time quota of women as well as the proportion of women with higher education degrees.

According to the central question of this study, whether the aggregated gender equality interventions and policies in the R&I sector from 2005 to 2015 could contribute to the development of the proportion of women among researchers, the following sub-questions can be derived from the logic model:

- Were the aggregated measures in the individual countries designed with regard to their distribution and scope in such a way that they could have a structural effect on the proportion of women among the researchers?
- Has BES R&D gained in relative importance (in terms of expenditure and personnel) in the studied countries and are there actually fewer women active in BES R&D than in HES and GOV?
- Has female labor market participation increased relatively, especially among highly educated women?
- What are the relevant factors if one takes them into account in their actual dynamic interplay?

An overview of all the indicators which were used for the country comparisons and to calculate the main indicators in Fig. 3 can be found in the appendices. All quantitative indicators were compiled from the Eurostat database except those from the policy approach section which are based on She Figures (2015) data.

The policy descriptions and the main indicators are based on seven country reports produced within the H2020 project EFFORTI[4], including the four countries of this study. The country reports provide a detailed statistical overview and qualitative assessment of (1) the structure and performance of national research and innovation system, (2) gender equality policies in the labor market and welfare policies related to reproductive work and childcare, (3) the governance and existing policies of gender equality in research and innovation and (4) the evaluation culture and policy especially in the field of gender equality in research and innovation (Reidl et al., 2018, p. 7). The country reports offer a broad overview of the national gender equality policy approaches.

3. Results

The following section provides an overview of the gender equality policies in R&I in the four countries examined in the period from 2005 to 2015, and discusses their impact potential, based on the scope of the policies. On this basis, an initial assessment of the contribution of R&I gender equality policy to the development of the proportion of women in R&I is provided. Subsequently, the extent to which the context factors, i.e. the development of BES and female labor market participation contribute to explaining the proportion of women among scientists will be discussed.

3.1. Policy Measures to Increase Gender Equality among Research Personnel

Data from the European Research Area (ERA) Survey make it possible to compare the take-up and adoption of equality plans and different equality policies among RPOs of the four countries in 2013 (European Commission (EC), 2015). It can be seen that equality plans were most widespread in Austria (Table 2). Nine out of ten researchers of RPOs which replied to the ERA survey worked in an RPO that had an equality plan. In contrast, gender equality plans covered six out of ten researchers in Spain, five out of ten in Denmark and four out of ten in Hungary.

Specific individual gender equality measures are also most widespread in Austria (Table 3): support programs for leadership development and targets for gender balance in recruitment committees were found more frequently in Austria than in the other countries. The picture for the other countries is more diffuse. Of the four countries, Hungary has the lowest frequency of gender equality plans. With regard to individual measures, Hungary had lagging needs in support programs for leadership development and targets to ensure gender balance in recruitment committees and other measures, but was already well positioned with regard to work-life balance measures, recruitment and promotion measures and in enabling flexible career trajectories. In Spain, equality plans were more widespread than in Denmark, but the concrete individual measures were generally not as widespread as in Austria.

Austria's leading role among the compared countries is reflected in the government's policy to promote equality in R&I. Over the time period Austria has developed a quite differentiated policy mix aiming at promoting gender equality in R&I. The implemented measures address gender inequalities at different stages of a research career starting

[4] In this article we focus on the development of the numbers of women researchers in a sector at the aggregate level. However, gender equality is much more than increasing the numbers of women researchers and counting heads, i.e. it is about changing institutions, structures, incorporating the gender dimension in research and education, etc.

Table 2
Proportion (%) of research and development (R&D) personnel working in research performing organizations (RPOs) who adopted gender equality plans, 2013. Source: European Commission, 2015, p. 121.

	Share of R&D Personnel working in an RPO with a Gender Equality Plan	Total number of respondent RPOs	Total number of R&D Personnel in respondent RPOs	Total number of RPOs who adopted Plans	Total number of personnel covered by Plans
AT	89.8%	89	26,781	34	24,036
ES	61.4%	124	40,902	42	25,130
DK	45.2%	25	18,907	4	8,545
HU	39.1%	22	4,731	11	1,852

Table 3
Proportions of responding RPOs having implemented one of the mentioned gender equality measures, 2013. Source: European Commission, 2015, p. 118.

	Flexible career trajectory	Recruitment and promotion measures	Support for leadership development	Targets for gender balance in recruitment committees	Work–life balance measures	Other measures	Total number of respondent organizations
DK	24.0%	24.0%	16.0%	20.0%	52.0%	36.0%	25
ES	35.5%	25.8%	12.1%	21.0%	60.5%	26.6%	124
HU	45.5%	45.5%	0.0%	13.6%	63.6%	9.1%	22
AT	50.6%	41.6%	38.2%	41.6%	71.9%	30.3%	89

e.g. provisions for career interruptions, returning schemes after career breaks, gender-aware conditions, provisions on dual careers.
e.g. mentoring or networking opportunities for women researchers.
e.g. parental leave, flexible working arrangements.

already in schools, e.g., by raising the interest of girls in science and technology and promoting atypical educational choices. Furthermore, other measures are targeting the HES and the BES and try to promote careers of female researchers, initiate organizational change process in R&I organizations towards more gender equality and are also focusing on including a gender dimension into R&I projects. Since 2009 a quota system for university collegiate bodies has been introduced. This has raised the number of women in decision making committees and boards significantly (Österreichisches Bundesministerium Bildung, Wissenschaft und Forschung, 2015). In 2013, Austria introduced gender budgeting within its framework of outcome-oriented budgeting, impact-oriented assessment of policy measures and impact controlling. All three federal ministries tasked with promoting R&I have defined specific targets within this framework to increase the share of women researchers in different R&D sectors. The latest development of gender equality policies in R&I in Austria can be labelled as mainstreaming. This means that gender equality measures have been included in main funding programs for applied as well as basic research in Austria but were also included into performance agreements between the Austrian Federal Ministry of Education, Science and Research and Austrian universities. Through mainstreaming gender equality measures more research performing organizations and R&I companies become involved in such activities.

In **Spain**, the policy framework for gender equality in R&I (that covers the HES and GOV sectors) is also sophisticated and comprehensive on paper. There are three main strategies to cover gender equality in R&I, which intend to strengthen studies and research with a gender perspective, increase women's participation in information and communication technology sector (ICT), and increase their presence on corporate board positions. The Law of Science, Technology and Innovation (LCTI) (Spanish Government, 2011), the Spanish Strategy of Science, Technology and Innovation 2013-2020 (EECTI) passed in February 2013 and the Spanish State Plan for Scientific and Technical Research and Innovation (PECTI) for its implementation, support positive changes regarding gender equality and mainstreaming in research. The strategy establishes the rationale, objectives and indicators of the Spanish R&I policy for the period 2013-2020. Regarding gender equality the LCTI introduced a provision in which public research bodies should adopt 'gender balance' plans within two years – and be subject to annual monitoring (European Commission (EC), 2014, p. 591). Gender balance in selection committees in the realms of R&I is also regulated by the 14/2011 law on Science, Technology and Innovation – which states that gender balance must be reached in the composition of selection committees in university appointments for permanent professor positions (Lombardo, 2016, p. 13). The LCTI affects all public and private bodies 'in charge of financing, executing and coordinating, as well as, all actions that are taken to promote research development and innovation policies regardless of the economic and social sectors' (Art 3.1) (Fernández-Zubieta and Zacharewicz, 2016, p. 70).

In comparison, **Hungary** had an under-developed policy to promote women researchers in R&I in the studied period. In Hungary, in order to support young parents, female researchers with children under ten years are granted two extra years when they apply for grants, i.e. they are allowed to submit their applications even if they are beyond the age limit. Although the National Strategy for the Promotion of Gender Equality was adopted in 2010, it has never been implemented. Although some papers have been published on gender imbalance in R&I, and also some initiatives and projects led by non-governmental organizations (NGOs) have been implemented (e.g. Girls' Day) in Hungary, they mostly remained connected to a few non-profit organizations. There have not been policies or concrete initiatives from governmental side, however. Moreover, the government banned the running gender studies MA programme as of 2019. All actions connected to the development of gender equality policy are erratic, and remain on the organizational level ordered by external actors. For example these actions are often connected to the obligatory equal opportunity plans in public organizations prescribed by the Act on Equal Opportunity and Equal Treatment, or the guidelines of the European Commission, EU-conform specifications of calls and requirements for grants, or to the business-driven regulations of headquarters at multinational companies. However, while the equal rights of women are hardly systematically promoted, initiatives and policies connected to family friendliness are in the focus of governmental interest.

In **Denmark**, the promotion of gender equality in the HES mainly focusses on talent development, productivity, excellence, and resource optimization (Kalpazidou Schmidt et al., 2017). Moreover, the common perception in Denmark is that no gender discrimination is present, and structural bias is hence often overlooked. Therefore, although gender mainstreaming has a long tradition in Denmark, direct gender equality initiatives in R&I have been scarce and fragmented (Kalpazidou Schmidt et al., 2017). In addition, such initiatives have been met with resistance and debate about their legitimacy. Nonetheless, while the share of female PhD's in Denmark is almost 50%, only approximately

20% of full professors are women (Nielsen, 2016). As regards the BES, while some European countries, e.g. Austria, are assessing and promoting collaborations between female researchers and the BES, no such initiatives are found in the Danish context (Danmarks Forsknings- og Innovationspolitiske Råd, 2015). However, a policy for measurable targets was implemented in 2013 to increase the share of women in top management positions in the largest Danish companies. In 2015 more than four in five companies had not reached the target of at least 40% of the underrepresented sex (women) in managerial bodies (Larsen et al., 2016).

Although Austria; Denmark and Spain are characterized by a more progressive gender equality policy for R&I than Hungary, three major weaknesses apply to the policy approaches of all four countries: firstly, these measures have to be considered as weak as non-compliance is not really sanctioned. For instance, the Spanish PECTI lacks indicators to measure gender balance and is vague in its application of 'gender equality' and the 'gender dimension in research' (Fernández-Zubieta and Zacharewicz, 2016, p. 70). Secondly, the resources spent for mainstreaming and promoting gender equality in R&I are very low compared to the total R&I expenditures. This can be exemplified by the Austrian FEMtech research project program which was allocated 2.2 million EUR in 2014 whereas the whole funding budget of the Austrian Research Promotion Agency added up to 617 million EUR in the same year (Wroblewski, 2016, p. 4). Thirdly, compared to the size of the BES, this sector is not adequately targeted compared to the HES.

3.1.1. Interim Conclusion

The available data allow a limited assessment of the impact potential of gender equality policies with regard to their take-up and adoption. In Austria and Spain, thanks to accompanying legislative measures, equality plans are the most legally binding and have the highest levels of adoption. In Hungary, there is a legislative commitment for state-owned organization to prepare a general equal opportunity plan, however, it has not been implemented and monitored systematically while the situation in Denmark is questionable if one considers the pace of the implementation of mainstreaming and the take-up of equality plans in R&I.

Austria, Denmark and Spain had the most progressive GE policy in R&I during the time period researched. Whereas Hungary followed a much more conservative policy according to qualitative assessment and statistics. Compared to Austria, Denmark and Spain lagged behind in implementing ambitious policies.

Considering that only in Austria almost all researchers were working in RPOs with gender equality plans (among those that replied to ERA survey), that the gender equality policies of all countries were mainly limited to HES and GOV (and thus targeted only a part of the research personnel), that in all countries only small amounts of resources were invested, and that the gender equality plans and similar measures were often implemented without binding force, a limited potential impact of the implemented measures can be assumed.

3.2. Development of the Business Enterprise Sector

In line with the assumption to be investigated here that the proportion of women among researchers follows essentially the size of the BES of a country, Fig. 4 looks at the simultaneous development of gross domestic spending on Research and Development of the Business Enterprise Sector (BERD) in relation to GDP and overall gross domestic spending on R&D in relation to GDP (GERD). The diagram shows the largely parallel development of BERD and GERD in all countries. In Hungary alone, the BERD has increased significantly in relation to the GERD. While the share of BERD in GERD was 44.5% from 2005 to 2009, it was 47.8% from 2010 to 2015. This means that the lower proportion of female researchers in Hungary could be linked to an increase in the importance of BES. In Austria and Spain, in turn, the increased proportion of women among researchers cannot be explained by a loss of BES investments. In Denmark, the size of BERD even decreased from 60.84% for 2005 to 2009 to 59.81% for 2010 to 2015. However, more decisive for gender equality than the R&I expenditure is the development of the number of research staff in the research sector.

Fig. 5 illustrates the evolution of the total number of researchers working in the national innovation systems, as well as for the entrepreneurial sector only. Even when looking at the number of staff, it can be noted that the number of BES researchers in relation to the total number of researchers has hardly changed in the two periods studied in Austria and Spain. In Hungary, on the other hand, two out of five researchers now work at BES, compared with only one out of five in 2005-2009. A less pronounced but nevertheless relevant change is evident for Denmark: the share of BES researchers among total researchers decreased from 56,4% for the period 2005-2009 to 50,0% for the period 2010-2015.

The next step is to examine how the proportion of women in the individual research sectors has developed. Fig. 6 shows the mean values of the proportions of women among researchers in BES, the HES and GOV for the periods 2005-2009 and 2010-2015. Austria and Denmark were able to increase the proportion of women in all three sectors, especially in the GOV and slightly in the BES. Spain achieved a slight increase in the proportion of women in all three sectors. In Hungary, the proportion of women among researchers in GOV and HES also increased slightly. In the Hungarian BES, however, the proportion of women fell by 2.7 percentage points. The Hungarian development is an expression of the increased importance of the automotive industry. The number of people employed in the "Manufacture of transport equipment" rose from 85.2 thousand in 2008 to 144.4 thousand in 2015 (Hungarian Central Statistical Office, 2018). The proportion of women researchers was about 30% in 2015.

The following picture emerges from the comparison of the average values for the periods 2005-2009 and 2010-2015:[5] the share of female BES researchers in manufacturing has remained constant in Austria, slightly increased by about 3 percentage points in Denmark and Spain, and decreased by 3.8 percentage points in Hungary. In the service sector of BES, the proportion of women researchers in Austria grew by 4 percentage points. In all other countries, the proportion of women in this sector fell slightly: in Denmark by 2.2 percentage points, in Hungary by 1.6 and in Spain by 0.8 percentage points.

3.2.1. Interim Conclusion

In Austria and Spain, the relative importance of the BES, measured by BERD and number of researchers, remained constant, in Hungary a very clear increase has been noticed while the development in Denmark shows a slight decrease. In all countries, the proportion of women in the research staff of the HES and GOV increased, in some cases significantly, the lowest in Hungary. In Austria, Denmark and Spain the proportion of women in the BES increased at the same time. This share decreased only in Hungary. In Austria, the higher proportion of female BES researchers is reflected in the service sector, in Spain and Denmark in the manufacturing sector.

3.3. Development of Female Labor Market Participation

Political measures undertaken (or omitted) in the individual countries have had little effect on the actual distribution of roles within the family. With the exception of Spain, there have been no significant[6]

[5] www.efforti.eu.

[6] While industrial change has a clear impact on the proportion of women researchers in Hungarian R&I, it is hardly possible to make clear statements for the other countries in how far the developments within the BES are decisive for the slight increase in the proportion of women. Due to a restructuring of the so-called Nomenclature Générale des Activités Économiques dans les Communautés Européennes (NACE) classification, the statistical classification

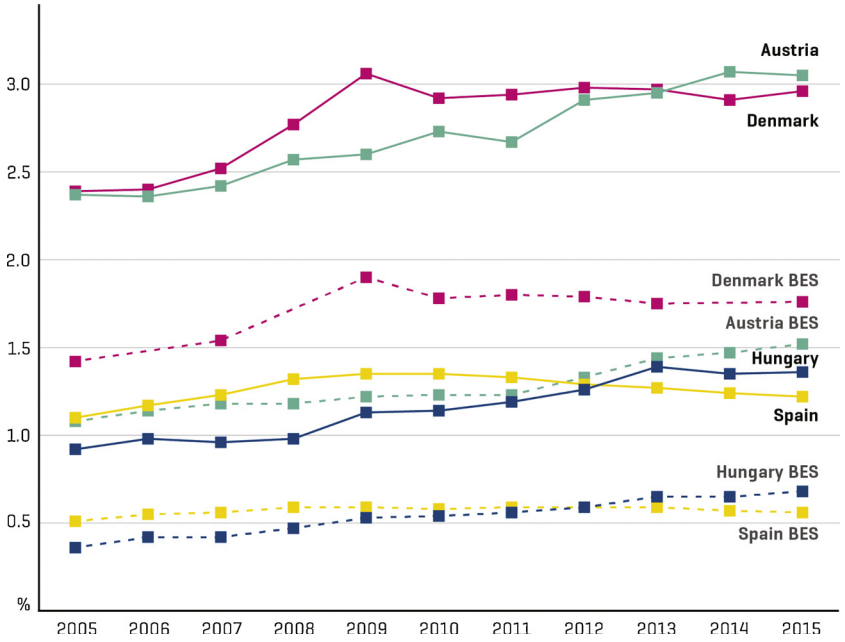

Fig. 4. Gross Domestic Expenditure on R&D for All Sectors and for BES in Percentage of GDP from 2005 to 2015. Source: Eurostat, 2018.

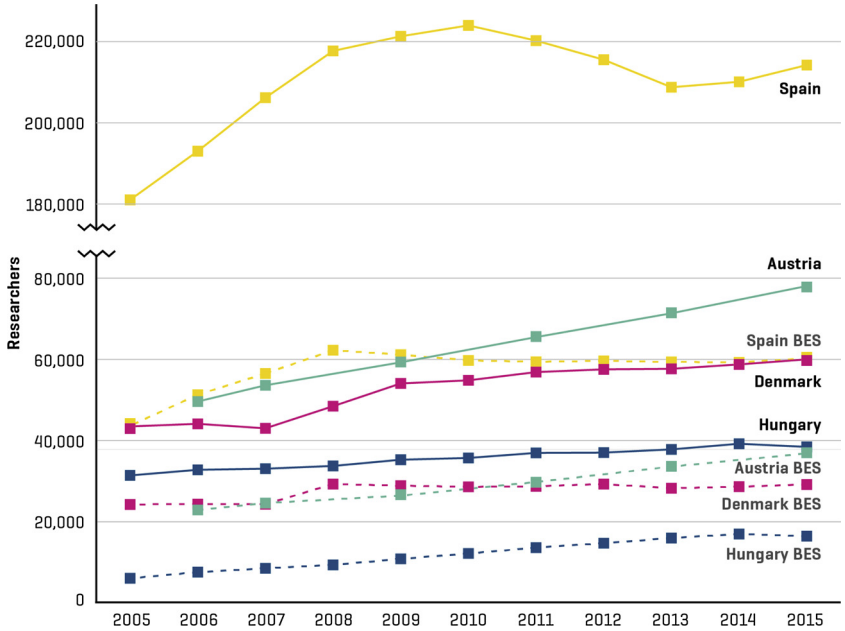

Fig. 5. R&D Personnel (Researchers) for All Sectors and for BES in Absolute Numbers from 2005 to 2015. Source: Eurostat, 2018; number of researchers are head counts.

changes in the participation of women in the labor market in the comparison countries. Spain has experienced an increase of 2.9 percentage points in the participation of women in the labor market and is now at the same level as the other three studied countries.

However, female employment rates show a slightly different dynamic (Fig. 2): thus, Austria experienced a significant increase in the proportion of women in employment from 66.2% between 2005 and 2009 to 69.7% between 2010 and 2015. In Hungary, an increase can also be observed, from 55% to 57.5%. In Denmark the rate fell from 74.6% to 72.5% and in Spain from 57.3% to 55.3%. The part-time quota of women in employment is also meaningful (Fig. 2). The Austrian part-time quota, which has grown by 4 percentage points, can be interpreted as an expression of a still strongly anchored distribution of family roles and a high level of decommodification due to a well-developed welfare state. The low Hungarian part-time rate rose by 2.6 percentage points and the Spanish rate by 1.8 percentage points, while the relatively high Danish rate remained constant.

As to R&I positions, the employment rate is more decisive than the participation rate in the general labor force. One explanation for the increase in the proportion of women researchers in Austria and in the Hungarian GOV and HES during the period under study is in part due to the increase in women's employment rate overall. But as this has declined in Denmark and Spain, this factor alone cannot be sufficient to explain the development of the proportion of women researchers.

(*footnote continued*)
of economic activities in the EU, the data on the proportion of women among researchers should be treated with caution.

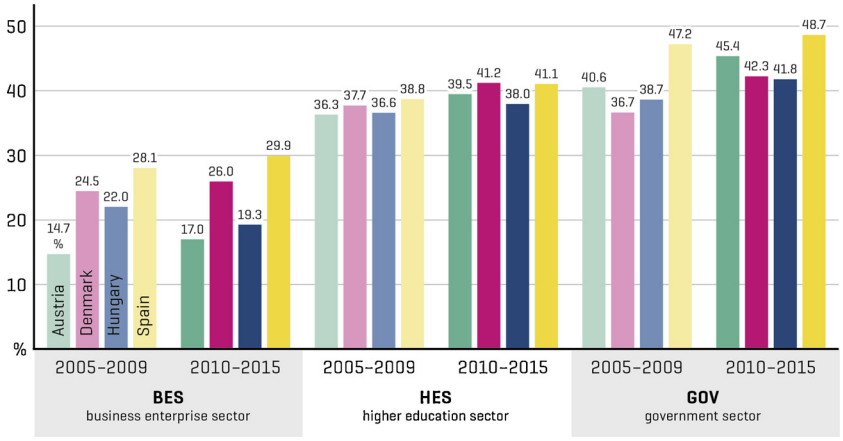

Fig. 6. Proportion of Female R&D Personnel (Researchers) for BES, HES and GOV from 2005 to 2009 and 2010 to 2015.
Source: Eurostat, 2018; number of researchers are head counts.

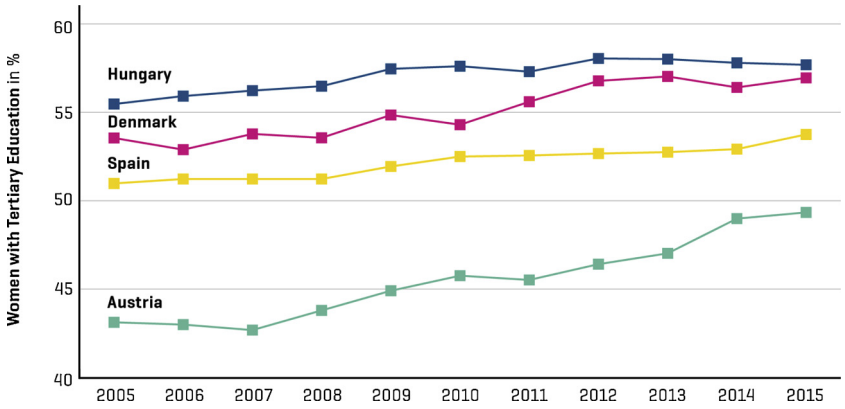

Fig. 7. Proportion of Women with Tertiary Education (ISCED5-8) among Total Population from 15 to 64 years with Tertiary Education.[12]
Source: Eurostat, 2018.

Despite a constant or decreasing employment rate of women, it is also possible that the supply of highly qualified female labor has improved significantly, which has led to more women researchers. Fig. 7 shows the proportion of women with tertiary education. In the period under study, all countries achieved an increase in this aspect. In Denmark, the proportion of women with tertiary education among all persons with tertiary education in 2015 is 3.4 percentage points higher than in 2005, in Hungary 2.2 percentage points higher and in Spain 2.7 percentage points higher. In Austria, in 2005 women accounted for just 43.1% of all holders of tertiary education which increased to 47.3% in 2013[7] .While the development of the proportion of women with tertiary educational qualifications is slow but steady in almost all countries surveyed. The situation in Hungary has stagnated since 2009 due to a reform of higher education in 2012.

3.3.1. Interim Conclusion

In Austria and Hungary, the female employment rate increased slightly over the period, while a slight decrease is noticed in Denmark and Spain. In all countries, the part-time employment rate of women increased slightly. The proportion of highly qualified women has increased in all countries from 2005 to 2015.

4. Discussion

Within the group of compared countries, Denmark can be seen as having the best outcome: while the country was able to hold its R&I investment intensity at a constant (already high) level, the proportion of women among researchers in total notably increased. Austria shows a similar pattern, but had a slightly lower increase of women's share among research personnel in the same period, i.e. 2005 to 2015. Spain shows a slight decrease of R&I investment intensity followed by a slight increase of the share of women among researchers. Hungary on the other hand increased the per capita expenses on researchers but shows a decreasing level of representation of women in R&I. Thus a differentiated pattern emerges as regards the factors that shaped the development of the share of women researchers in the four countries surveyed under the studied period.

4.1. Country Patterns

In Denmark, a traditionally progressive gender regime, based on gender mainstreaming, meets high investments in R&I. However, the relative size of the BES decreased during the studied period both in terms of investments and personnel compared to global R&D expenditure and research personnel. In parallel, the already high female employment rate decreased (Fig. 2), while the proportion of women with tertiary education in the population increased. The proportion of women has risen, especially among researchers in the HES (and GOV, in the first studied period), but it is questionable whether this is due to better regulation of this sector through targeted equality plans and a corresponding public funding policy.

In Austria, too, the higher proportion of women is mainly due to HES and GOV. The number of highly qualified women in Austria as well

[7] Significant means here no change higher than +/- 1 percentage point between the two comparison periods.

as the female employment rate has increased. It should be emphasized that of the countries compared, Austria has achieved the highest increase in the proportion of women among BES researchers. There is at least a slight shift of the traditionally 'male' framed private-sector research in Austria – while the BES is hardly covered by gender equality policy just like in the other comparison countries (Reidl et al., 2018, p. 58). Compared to the other R&D sectors in Austria the relative size of the BES remained constant.

In Spain, like in Denmark, the female employment rate decreased whilst the proportion of women with tertiary education has increased. There were no changes in the size relationship of BES to GDP or of BES personnel to whole research personnel. Equality policy in R&I appears to be comparable with that of Denmark and Austria.

Hungary has a former public gender regime with clear signs of 'retraditionalization' of gender roles. At the same time, the country has been able to increase its investment in research. This increase is largely due to the growth of the BES, driven in particular by a Europe-wide automotive industry. During the same period, the female employment rate and the low female part-time employment rate increased slightly. Over the entire period under study, the proportion of highly qualified women has also risen (stagnating, however, since 2012).

4.2. Truth Table

The country patterns presented above can be quantified for better comparability and presented using a so-called truth table. At first glance, a truth table (here Table 5) appears like a normal data matrix. The columns indicate the individual factors of the logic model ("conditions") and the outcome and sort the corresponding values. The main difference is that the individual rows of the truth table do not stand for individual cases, but for all logically conceivable constellations of the conditions of the logic model. The truth table enables the structuring of the country comparison on the basis of clear rules of Boolean algebra and results in a solution formula which indicates the conditions for the occurrence of the outcome which are to be considered necessary or sufficient (Ragin, 1987).

Table 4 shows the rules for the calibration of the truth table values. In general, value "1" was ascribed, when a significant increase of a variable (here set to one percentage point and higher) could be observed. Otherwise, value "0" was ascribed. An exception is the calibration of the "Gender Equality Policy for R&I" condition. Due to the assessment of the policies in Section 2.1 it is most probable that no country has a gender equality policy in R&I effective enough to show significant impact on the proportion of women researchers between 2005 and 2015. However, to simulate the assumption that at least the progressive gender equality policy of Austria may have had an effect, a calibration level for this variable was chosen that explicitly ascribes a value of 1 to Austria.

Table 5 shows the quintessence of the comparison in the truth table form. The first row outlines the conditions studied. The model is based on the following assumptions:

- An effective gender equality R&I policy has a positive impact on the proportion of female researchers.
- An increase in the relative importance of BES research has a negative impact on the proportion of female researchers.
- An increase in the proportion of women among those with tertiary education has a positive impact on the proportion of female researchers.

The analysis of this truth table shows that the evolution of the proportion of women among researchers in the four countries studied was characterized by the relative size of the BES remaining constant or its shrinkage linked to the increase in the proportion of women among tertiary educational attainment. Since the increase in women with tertiary qualifications is a constant characteristic among the countries

Table 4
Calibration rules of the truth table.

	Gender equality policy for R&I	Increase in relative size of BES research staff	Increase of proportion of women with tertiary education	Outcome: Increase of women proportion among researchers
1	If gender equality plans were implemented broadly (=full or nearly full coverage of ERA survey respondents) among RPOs.	If an increase (higher than one percentage point) in the proportion of BES researchers among total population of researchers between the periods 2005-2009 and 2010-2015 is observed.	If an increase (higher than one percentage point) in the proportion of women with tertiary education among total population with tertiary education between the periods 2005-2009 and 2010-2015 is observed.	If an increase (higher than one percentage point) of the proportion of women among researchers between the periods 2005-2009 and 2010-2015 is observed.
0	If gender equality plans were not implemented broadly (=full or nearly full coverage of ERA survey respondents) among RPOs.	If a decrease or stagnation in the proportion of BES researchers among total population of researchers between the periods 2005-2009 and 2010-2015 is observed.	If decrease or stagnation in the proportion of women with tertiary education among total population with tertiary education between the periods 2005-2009 and 2010-2015 is observed.	If a decrease or stagnation of the proportion of women among researchers between the periods 2005-2009 and 2010-2015 is observed.

Table 5
Truth table for the different influencing factors on the development of the proportion of women among. researchers, 2005-2015 Legend: 1 means a plausible positive/negative effect; 0 means no effect plausible.

Gender equality policy for R &I	Increase in relative size of BES research staff	Increase of proportion of women with tertiary education	Outcome: Increase of women proportion among researchers	Cases
1	0	1	1	AT
0	1	1	0	HU
0	0	1	1	DK, ES

studied, this factor could even be dispensed with in order to explain the variations in the outcome. This model is based on the assumption that only the Austrian gender equality policy in R&I had real impact potential.[8]

Alternatively, it would also be conceivable that the Spanish gender equality policy in R&I, which was the most comparable of the four countries with that of Austria, also had impact potential. But this model leads to the same solution that relative BES size in combination with increase of women among holders of higher education are decisive for the development of women representation in R&I. Finally, an optimistic hypothetical model is simulated in which gender equality policy in R&I was effective enough in all countries. In this model, the increased proportion of women among researchers in Austria, Spain and Denmark would be the result of an interaction of an effective gender equality policy in R&I, the lack of relative growth (or decline) of the BES and the higher proportion of highly qualified women.[9] However, since this model works with two constant variables, the development of the BES would be the decisive variable here as well.

Given these observations, it may be argued that at least the increase in the proportion of women among HES and GOV researchers may be partly due to the aggregated gender equality measures. However, an increase in the proportion of women researchers in HES and GOV can also be observed for Hungary, which had the most moderate gender equality policy in research and development during the reporting period.

5. Conclusion

It can be assumed that the aggregated gender equality interventions in the national R&I systems have had a contributing effect on individual organizations or individuals. A structural influence on the proportion of women among researchers in HES and GOV cannot be ruled out here either.[10] However, the aggregated gender equality interventions alone cannot explain the development of the proportion of female researchers in the period under study.

It is shown that, first of all, the proportion of women among the highly educated has increased in all four countries. This implies an increase in the proportion of women among research personnel. The contribution analysis with the QCA revealed that this result is only achieved if the research of the BES does not gain in relative importance (increase in proportion of BES research staff relative to other sectors) at the same time.

But why was the structural contribution of GE policy in the period under study smaller than that of its other contextual factors, such as the relative development of the BES size? The analysis showed that gender equality interventions were generally not effectively designed: such measures were not widespread enough, not binding enough and were too fragmented. Furthermore, the measures were directed almost exclusively at HES and GOV and only to a limited degree at the BES, which has by far the greatest pent-up demand.

The contribution of the gender equality interventions take different shapes within the R&I system. Firstly, the higher proportion of women among those with tertiary educational qualifications is itself an expression of progressive gender equality regimes in society and thus of measures that already shape adolescents in earlier stages of their lives. Secondly, the research environments also experience an adjustment towards a stronger awareness for work-life balance and career development of all employees as a result of the different equality measures.

5.1. Learnings

In the period under study, the increase in the proportion of women among holders of higher educational degrees was the main driver behind the increase in the proportion of women among researchers. However, it can be assumed that this factor will lose momentum in some of the studied countries: already today, the proportion of women among the holders of higher educational qualifications is significantly higher than 50% in three of the four countries. In view of this, significantly more resources must be invested in future gender equality programs in R&I in order to increase their economies of scale. The programs should also have a strong focus on the BES and in particular on networking and institutionalizing and embedding the programs should be even more important than in the past.

5.2. Future Research

Based on the results presented herewith, a starting point for further research lies in extending the research approach used in this paper to other countries or alternative comparative constellations. In particular, the notion discussed here that the structural context of gender equality policy in R&I - namely the size and composition of the BES and the representation of women in the labor market and among holders of higher education degrees – is as influential for the long-term development of the proportion of women in R&I as fragmented gender equality measures themselves, should be further explored. This implies that gender equality policies have to be studied in the context in which they are implemented, moving beyond mono-dimensional approaches, considering multiple components to avoid oversimplification of a highly

[8] For Austria, only data until until 2013 can be analysed. See explanation in the footnote below.

[9] Data up to 2013 are based on ISCED 1997, as from 2014 ISCED 2011 is applied. The level shift break in Austria is due to the reclassification of a programme spanning levels: the qualification acquired upon successful completion of higher technical and vocational colleges is allocated in ISCED 2011 to ISCED level 5; under ISCED 1997 the same qualification was reported on ISCED level 4, but earmarked as equivalent to tertiary education (Eurostat, 2017).

[10] The analysis was performed with the software fsQCA using the Quine-McCluskey algorithm. The complex solution is: ~(increase in relative size of BES staff)*(increase of women with tertiary education). Raw coverage, unique coverage and consistency are 1. The parsimonious solution is: ~(increase in size of BES staff). Raw coverage, unique coverage and consistency are 1.

[11] The complex solution is: (effective GE policy in R&I)*~(change in size of BES staff)*(increased numbers of women with tertiary education). Raw coverage, unique coverage and consistency are 1. The parsimonious solution is: ~(change in size of BES staff). Raw coverage, unique coverage and consistency are 1.

[12] An alternative explanation for the stronger increase of the women proportion in HES and GOV compared to BES is the general increase in the proportion of women among holders of tertiary degrees and an increase in R&I spending, in combination with the less technical orientation of GOV and in particular HES.

complex issue (Kalpazidou Schmidt and Cacace, 2017). Another consideration is the identification and study of countries that have been able to reverse the negative relationship between the expansion of the BES and the resulting increase in expenditure per researcher and the decreasing proportion of women among researchers.

With this study we emphasize the importance of program sector evaluations. Obviously, it is important to evaluate the effects of gender equality measures on the individual and organisational level in order to design these measures more effectively. However, only macro-evaluations allow statements to be made as to whether the political will to strengthen equality in R&I, which stimulates and (financially) supports most of the individual measures, really achieved its objective. Against this background, the ever-improving macro-monitoring through the data collected by SheFigures or EIGE is a useful tool. The present study has shown how "pragmatic" (Striebing, Kalpazidou Schmidt, & Palmén, 2019), i.e. cost-saving, evaluations for the macro level can be carried out on the basis of this data stock in combination with well-founded qualitative analyses. Earlier studies (see European Commission (EC), 2008) provided evidence for the challenges that classical inferential statistical approaches face with program sector evaluations of gender equality interventions in R&I. With this study, we highlight the potential of using QCA, which is much more flexible in dealing with the diverse quality of the statistical data, and the complex gender equality intervention policies, and yet can deliver straightforwardly communicable results.

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