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Consumers' views on egg quality and preferences for responsible production

– Results from nine European countries

Abstract

Purpose – The purpose of this study is to provide information on how citizens in nine countries across Europe perceive egg product quality and what the importance is of a product's sustainability attributes (animal welfare, country of origin, production method) in egg purchases.

Design/methodology/approach – The data was gathered in 2021 via an online survey in nine European countries (Finland, the United Kingdom, France, Italy, Belgium, Germany, the Netherlands, Romania, Denmark). A total of 3,601 responses were collected. As methods of analysis, exploratory factor analysis, independent samples t test, paired samples t-test, and one-way analysis of variance (ANOVA) were conducted when investigating the quality dimensions of egg products and the differences amongst the sociodemographic groups.

Findings – Citizens in European countries considered animal welfare aspects, production method, and country of origin important when purchasing egg products. Citizens' perceived quality of egg products were related to two dimensions (i.e. product properties, responsible production), and there were differences in perceptions by sociodemographic groups (i.e. age, gender, education, country of residence). Responsible production was most valued by younger women with higher education. Also, in the Netherlands and Romania, citizens had stronger preferences for product properties compared to responsible production, while in Germany, responsible production was appreciated more than product properties.

Originality/value – The study provides new information on citizens' perceived egg product quality and the role of a product's sustainability attributes in egg purchases. Furthermore, the results bring novel insights on the differences in perceptions amongst citizens living in nine European countries.

Keywords – Egg consumption, Food quality, Sustainability attributes, Responsible production

Paper type – Research paper

1. Introduction

Consumers are paying increasing attention to the sustainability attributes of food products. The egg industry in particular has faced several challenges due to rising consumer expectations for animal welfare, responsible food production, and human health and food security in connection to egg consumption (Rondoni *et al.,* 2020). In the coming decades, more efficient animal production is required (Godfray, 2014) but at the same time consumers are more concerned about the welfare of farm animals (e.g. European Commission, 2015). Animal welfare is one key issue in poultry production that is covered by EU legislation, and it is closely related to the production system (Parrott *et al.,* 2016). There is a strong consumer demand for animal products (i.e. egg products) that consider animal welfare and sustainability, which has led to the egg sector introducing new production methods (Gautron *et al.,* 2021), and a large variety of new eggs (i.e. organic, free-range, and enriched eggs) (e.g. Brankob *et al.,* 2020). To meet consumer expectations, producers and retailers must have better knowledge of the market conditions (Goddard *et al.,* 2007) and a deeper understanding of consumer behaviour related to egg products (Rondoni *et al.,* 2020).

In general, consumers' environmental concern, intentions to engage with sustainable consumption, and pro-environmental behaviour have been studied to be influenced by sociodemographic characteristics, such as age, gender, education, income, and country of residence (Olofsson and Öhman, 2006; Brécard *et al.,* 2009; Sánchez *et al.,* 2015; Zhao *et al.,* 2021). Compared to other sociodemographic characteristics, country of residence is affected by local cultures that may reflect in their styles to respond in surveys (i.e. prominence to express more or less extreme opinions) (e.g. van Herk *et al.,* 2004; Kankaraš and Moors, 2011). In the case of egg products, socio-cultural factors in addition to product properties have been found to affect consumers' egg purchases (Rondoni *et al.,* 2020). Specifically, both intrinsic (i.e. appearance) and extrinsic quality characteristics (i.e. price,

packaging, brand name) are factors affecting consumers' perceptions of egg products (e.g. Andersen, 2011; Bejaei *et al.,* 2011; Gracia *et al.,* 2014; Wardy *et al.,* 2015; Baba *et al.,* 2017; Zakowska-Biemans and Tekién, 2017; Rondoni *et al.,* 2020; Van Loo *et al.,* 2021).

In addition, sustainability attributes have been found to influence consumer behaviour regarding egg products. These attributes include aspects such as environmental issues (Bejaei *et al.,* 2011; Rahmani *et al.,* 2019; Rondoni *et al.,* 2020), animal welfare (Andersen, 2011; Bejaei *et al.,* 2011; Clark *et al.,* 2017, 2019), production method (Andersen, 2011; Bejaei *et al.,* 2011; Gracia *et al.,* 2014; Baba *et al.,* 2017; Rondoni *et al.,* 2020; Van Loo *et al.,* 2021), and country of origin (Gracia *et al.,* 2014; Baba *et al.,* 2017; Rondoni *et al.,* 2020). For example, according to Gracia *et al.* (2014), consumers are willing to pay a premium for an enhanced method of production (i.e. barn, free-range and/or organic vs. conventional) and for the proximity of production (i.e. local, regional and national vs. foreign origin). Furthermore, the results by Bejaei *et al.* (2011) show that especially buyers of free-range eggs appreciate health, nutritional value, environmental sustainability, and animal welfare when choosing eggs. In contrast, Andersen (2011) has suggested that animal welfare plays a minor role in the demand for egg products. Due to the inconsistent results regarding consumers' preferences for sustainability attributes of egg products, better knowledge on consumers' egg purchase behaviour is needed.

More information on consumers' egg purchase behaviour is required especially in the European context. The poultry industry in EU has dealt with issues related to, for example, changing legislation, competition from low-cost producing countries, and increasing animal feed prices, and as a result, the industry has become more market focused, which requires producers and retailers to have better knowledge of consumers' needs (Parrott *et al.,* 2016). In the EU, it is mandatory to indicate the method of production of eggs sold on the market. Alternative (cage-free) eggs are widely available in the EU egg market. In 2022, 39.7% of laying hens in the EU were kept in enriched cages, 37.8%

in barns, and 15.5% were free-range and 7.1% organic hens. While organic hens represent less than one percent of the hen population in nine member states, cage-free forms of production are marginal in one member state only (European Commission, 2023). Furthermore, according to the EU's market situation report (European Commission, 2023), while almost a third of the laying hens in Denmark were organic, in Romania and Italy only 2.4% and 4.9%, respectively, were organic. In contrast, free-range represented almost 25% of farming methods in Germany and the Netherlands, but only 3.0% in Romania and 3.9% in Finland. These differences suggest that research to better understand how citizens value the various properties of egg products and what role, for example, production methods play in their purchasing behaviour in different member states of the common market is required.

The present study provides new information on European citizens' evaluations of egg product quality with a focus on product's sustainability attributes. The overall purpose of this study is to examine how Europeans perceive egg product quality and what the importance of different sustainability attributes (i.e. animal welfare, country of origin, and production method) is in egg purchases. The study has two sub-aims: The first sub-aim is to investigate European citizens' perceptions of egg product quality, identify the relevant quality dimensions in the purchase situation and analyse how different sustainability attributes connect with citizens' quality perceptions. The second sub-aim is to examine differences in citizens' perceptions of the egg product quality dimensions in nine European countries. Data from a citizen survey serves as the basis for the material of the study, which are analysed quantitatively with multivariate methods.

2. Conceptual framework

For decades, the perceived quality of food products has been of major interest for research (e.g. Zeithaml, 1988; Steenkamp, 1989; Steenkamp, 1990; Oude Ophuis and Van Trijp, 1995; Grunert,

1995, 1997; Issanchou, 1996; Bredahl *et al.,* 1998; Brunsø *et al.,* 2002; Papanagiotou *et al.,* 2012; Magnier *et al.,* 2016; Hidalgo-Baz *et al.,* 2017). Zeithaml (1988) defined perceived quality as "*the consumer's judgment about a product's overall excellence or superiority"*. Perceived quality is considered a multidimensional construct, consisting of abstract quality dimensions that comprise various specific attributes (e.g. Zeithaml, 1988; Brucks *et al.,* 2000), and is influenced by personal and situational variables (Steenkamp, 1989). For example, Brucks *et al.* (2000) examined the role of quality dimensions in the case of consumer durables. In their work, they suggested that instead of overall quality, the quality dimensions form a better basis for understanding the significant connections involved in consumers' judgment and choice.

The quality of egg products is defined by the characteristics of an egg that influence the consumer acceptance and preferences (Hisasaga *et al.,* 2020), and consumers' perceptions of egg quality may vary depending on the intended use (Gerber, 2006). The existing research on egg product quality has been focused mostly on physical characteristics of eggs (e.g. Gerber, 2006; Jibir *et al.,* 2012; Jibir *et al.,* 2013; Hisasaga *et al.,* 2020). From consumers' perspectives, the quality attributes of egg products include, for example, egg size, colour, weight, cleanliness, freshness, shape, uniformity in the tray, and shell texture (Jibir *et al.,* 2012; Jibir *et al.,* 2013). Gerber (2006) has suggested that egg quality is influenced by factors related to external (shell) quality (shell integrity, texture, shape, colour, cleanliness) and internal egg quality (yolk quality, overall quality). According to Hisasaga *et al.* (2020), egg quality can be evaluated with parameters of shell cleanliness, strength, texture, and shape, the relative viscosity of the albumen, and the shape and firmness of the yolk.

In addition to physical characteristics, also various extrinsic quality characteristics (i.e. date laid or best before date, price, packaging, brand name) (e.g. Wardy *et al.,* 2015; Parrott *et al.,* 2016; Berkhoff *et al.,* 2020; Rondoni *et al.,* 2020; Van Loo *et al.,* 2021) have been found to influence consumers'

perceptions of egg products. Wardy *et al.* (2015) examined the quality attributes of egg products. In addition to intrinsic and aesthetic attributes, they included packaging type, sale price, egg size, product band, egg grade, and availability as expedient quality attributes, and freshness, packaging/best-before-date, and absence of visible cracks as wholesome quality attributes. According to their results, wholesome quality is most valued by consumers. Furthermore, according to Parrott *et al.* (2016), best before date (in addition to production system) is one of the most important factors in consumers' purchase decisions for eggs in the United Kingdom. However, their results also showed that packaging and brand name are the least important for consumers. Results of a recent study also showed price and size to be the determining factors for consumers in egg purchases (Berkhoff *et al.*, 2020), while according to Mitrovic *et al.* (2020) consumers appreciate most shelf life, type of production, egg size, and shell appearance.

The product properties addressing sustainability issues can be considered a product's sustainability attributes (e.g. Bangsa and Schlegelmilch, 2020). The recent studies on egg products have focused on sustainability issues, such as animal welfare and production methods (e.g., Doyon *et al.*, 2016; Parrott *et al.*, 2016; Pettersson *et al.*, 2016; Hörisch, 2018; Ochs *et al.*, 2018; Busse *et al.*, 2019; Mitrovic *et al.*, 2020; Rondoni *et al.*, 2020; Gautron *et al.*, 2022). These issues are interlinked, as the central part of animal welfare in poultry production is the system used to produce meat end eggs (Parrott *et al.*, 2016).

The existing results suggest that consumers are willing to pay a premium for eggs produced in an enhanced housing system (e.g., Doyon *et al.*, 2016). Furthermore, production system has been considered as one of the most significant factors influencing consumers' purchase decisions for egg products in the UK (Parrott *et al.*, 2016) and in Serbia (Mitrovic *et al.*, 2020). Also, evidence also exists on consumers' willingness to pay higher prices for adding objects in barn systems, such as

perches and nesting boxes (Doyon *et al.,* 2016) and removing the beak trimming practice from production (Ochs et *al.,* 2018). In addition, Gautron *et al.* (2022) found the housing system to be importantly affect the use-value and image properties of egg products. Animal welfare and production methods also connect with egg product safety (Ochs *et al.,* 2018; Rondoni *et al.,* 2020) and taste (Pettersson *et al.,* 2016). According to Ochs *et al.* (2018), consumers considered eggs produced with higher animal welfare standards as safer to eat. Also, in a study by Pettersson *et al.* (2016), consumers considered free-range eggs to taste better.

In addition, country of origin is influencing consumers' purchases of egg products (Lopez-Galan *et al.,* 2013; Gracia *et al.,* 2014; Parrott *et al.,* 2016; Baba *et al.,* 2017; Rondoni *et al.,* 2020). The results by Lopez-Galan *et al.* (2013) suggested that consumers appreciate the local and regional origin abreast with the free-range and organic method of production. Similar results were obtained by Gracia *et al.* (2014) showing consumers' willingness to pay a premium for the proximity of production (i.e. local, regional and national vs. foreign origin). Baba *et al.* (2017) examined consumers' preferences with results showing origin to be the third most important factor after egg type and size determining consumer preferences for omega-3 enriched eggs.

Even though there is considerable amount of academic literature addressing consumers' perceptions of egg products and their properties at general level, specific knowledge on consumers' perspectives on the quality dimensions of egg products remain lacking. Furthermore, the information on the role of sustainability attributes in egg product quality is limited. In the present study, we investigate the sustainability attributes of animal welfare, production method, and country of origin, along with other product attributes, as factors influencing egg product quality. In accordance with the existing academic literature on perceived quality, the construct of egg product quality is the result of consumers' evaluation of various quality dimensions, consisting of different quality attributes (i.e.

sustainability attributes, other product attributes), and influenced by personal and situational variables (e.g., Zeithaml, 1988; Steenkamp, 1989; Brucks *et al.*, 2000). Figure 1 presents the conceptual framework of this study. As an exception, this study does not examine the connections between situational variables and egg product quality (illustrated in dashed lines in the model).

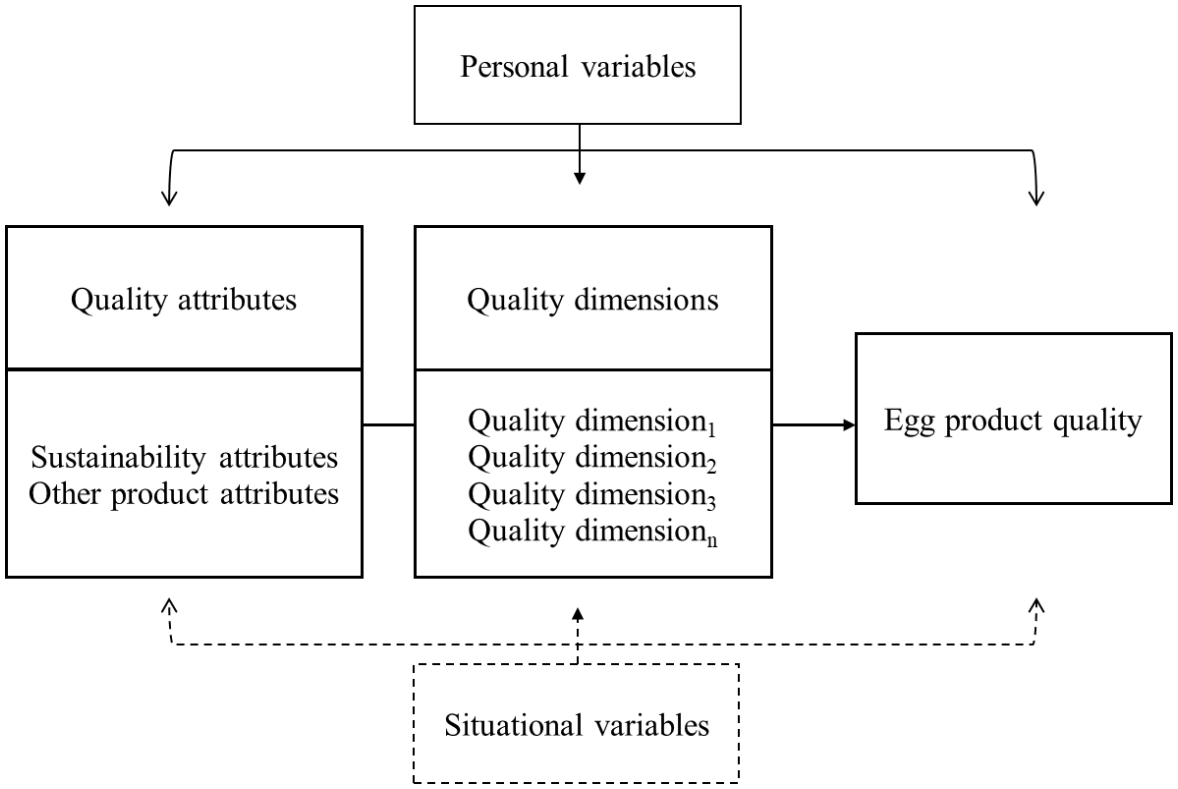

Figure 1. The conceptual framework of this study.

3. Material and methods

The data for this study were gathered in February 2021 via an online survey in nine European countries (i.e. Finland, the United Kingdom, France, Italy, Belgium, Germany, the Netherlands, Romania, and Denmark) in PPILOW project funded by the European Union (grant agreement N°816172). The overall purpose of the data gathering was to examine citizens' reactions to new approaches to pig and poultry production, with special attention to animal welfare-related measures.

The questionnaire asked about themes related to consumption and purchase decisions of pig and poultry products (i.e. chicken, eggs, pork) and views on farming methods (i.e. conventional indoor, organic, non-organic outdoor or free-range, low-input animal production) and welfare issues. In accordance with the objectives of this study, we employed questions connected to purchase decisions of egg products and information on the sociodemographic background of the respondents (i.e. gender, age, education, income, country of residence) (Appendix 1).

The questionnaire was developed in English. The instrument was piloted by researchers working for the partner organizations and by a few external persons. Their feedback was taken into account when finalizing the instrument. The final version of the instrument was first translated into local languages and then back-translated into English and compared to the original version in English to ensure the consistency across different language versions. Data collection was contracted to a market research agency that had an online panel. The sample was representative of each country's adult population (18-70 years of age). The representativeness was checked for gender, income, and geographical distribution of the respondents within each country. Altogether, 3,601 responses from nine countries were gathered.

In the survey development, a measurement scale was produced to investigate the respondents' perceptions of egg product quality. In accordance with the existing literature, the construct of egg product quality is the result of consumers' evaluation of various quality dimensions, consisting of different quality attributes (i.e. sustainability attributes, other product attributes). The selection of relevant quality attributes to the measurement scale was based on a review of peer-reviewed journal articles related to different aspects of egg consumption (see Table I). The final question to assess the importance of different quality aspects for citizens when they purchase egg products comprised altogether ten quality attributes, which were assessed with a six-point Likert scale (1 = Not Important,

2 = Slightly Important, 3 = Moderately important, 4 = Very important, 5 = Extremely important, 6 = I don't know).

Table I. Quality attributes used to assess citizens' egg purchasing decisions and examples on the literature used to operationalize the variables

The data were analysed with IBM SPSS Statistics 25.0 software. In the first stage of analysis, the relevant quality dimensions for citizens' egg purchases were identified with an exploratory factor analysis (EFA) with Kaiser normalization, Maximum Likelihood Estimation, and Varimax rotation. In the EFA, "I don't know" responses were treated as missing values since they did not provide any information on respondents' views on quality attribute variables in egg purchasing behaviour. EFA is a multivariate analysis method that aims to decrease the size of a dataset by reducing the variables to a smaller number of underlying dimensions (also called latent variables or factors) (Janssens *et al.*, 2008). In this study, latent variables (i.e. factors) derived from EFA illustrate groups of attributes, which describe the respondents' views on egg product quality dimensions.

In the second stage of analysis, independent samples t test and one-way analysis of variance (ANOVA) were executed to test the relationships between the respondents' sociodemographic variables (Table II) and the latent variables derived from the EFA (i.e. egg product quality dimensions). Both independent samples t-test and ANOVA enable examining statistically significant differences among the group means (Ross and Wilson, 2017; Woodward and Elliot, 2006). We employed independent samples t test for using two-category group comparisons (i.e. gender) and ANOVA for group comparisons with more than two categories (i.e. age, education, income, country of residence). Furthermore, to gain insights on how different sociodemographic groups value the

different egg product quality dimensions, the average factor scores were calculated by sociodemographic groups of respondents (see Table VI and Appendix 2).

Table II. Descriptive sociodemographic information on the sample by country (n=3,601)

In addition, when investigating the country-wise differences, paired samples t-test was used to examine whether the average factor scores were statistically different from each other by pairs of countries. This paired t-test is applicable for data where the two samples are paired in some way (Woodward and Elliot, 2006).

4. Results

4.1 Respondents' preferences for egg quality attributes

Table III summarizes the variables used to evaluate the respondents' perceptions of quality attributes of egg products. Based on Table III, the least important quality attributes for the respondents were brand, packaging (size, material, etc.), and retail outlet. In contrast, the most important attributes were date laid or best before date, country or region of origin, and production method (e.g. organic, free-range, intensive).

Table III. The quality attributes of egg products addressed in the questionnaire and the proportions of respondents with different views on their importance. The least valued variables are underlined, and the most valued variables are bolded

4.2 Factor solutions for respondents' perceptions of egg quality

EFA resulted in a two-factor solution on the quality dimensions for egg products. The final EFA solution comprised 9 of ten original egg quality attributes used in the questionnaire explaining approximately 55% of the total variance of our data (Table IV). During the EFA modelling, the variable of price was omitted from the final factor solution due to low communality value (<0.2). The Kaiser-Meyer-Olkin measure of factorability for the results was 0.868, which supports the applicability of the data for use in EFA. Bartlett's test of sphericity rejected the null hypothesis that no correlation among the original variables existed (p=0.000).

Table IV. Results of the final rotated two-factor solution on the variables describing respondents' perceptions on egg product quality. Bolded values are the highest factor loadings in absolute values

Two underlying quality dimensions of egg products were revealed, and the respondents' perceptions of egg quality attributes were grouped into two factors: Factor 1, "Product properties", and Factor 2, "Responsible production". The first factor "Product properties" includes the quality attributes related to intrinsic and extrinsic characteristics of egg products, such as date laid or best before date, appearance, brand, packaging, intended use of product, and retail outlet, while the second factor "Responsible production" factor consists of sustainability issues related to the production, such as animal welfare assurance, production method, and country or region of origin. These factors can be considered the underlying quality dimensions of egg products.

4.3 Respondents' perceptions of egg product quality dimensions by gender, age, and education groups

Independent samples t test results and one-way analysis of variance (ANOVA) results on sociodemographic groups (i.e. gender, age, education) are presented in Table V. Apart from income, all other sociodemographic variables showed signs of being statistically significantly related to respondent views on the quality dimensions of egg products. Respondents' views on "Product properties" were especially related to gender ($p<0.001$), age (for all age groups $p=0.034$), and education (for all education groups $p<0.001$). In comparison, for opinions on "Responsible production", statistical evidence was found for a relationship with gender ($p<0.001$), age (for all age groups $p=0.044$), and education (for all education groups $p<0.001$).

Table V. T test and ANOVA results on statistically significant differences in perceived egg product quality dimensions by sociodemographic groups

Furthermore, the average factor scores for "Product properties" and "Responsible production" were calculated by sociodemographic groups of respondents (Appendix 2). For "Product properties," the higher average factor scores were given by male respondents than female respondents, while for "Responsible production," the average scores were higher in the group of females than males. For both "Product properties" and "Responsible production," the higher average factor scores were given by respondents aged 18-34 years, while respondents aged 60 or older gave the lowest ratings.

In the case of education, "Product properties" were more highly rated by respondents with primary education, while respondents with secondary education gave the lowest factor scores. In contrast, "Responsible production" was most valued by those respondents with master's degree or equivalent, or doctorate or equivalent and was least valued by the respondents with primary education.

4.4 Country-wise differences in perceived egg quality dimensions

One-way analysis of variance (ANOVA) was conducted to investigate evidence on the statistically significant differences amongst the respondents in nine European countries in how they perceive the egg quality dimensions "Product properties" and "Responsible production" (i.e. factors derived from EFA). According to the results, differences exist by countries both in "Product properties" (Factor 1) and "Responsible production (Factor 2). Appendix 3 presents the detailed information the results by individual countries.

Table VI and Figure 2 present the average factor scores for "Product properties" and "Responsible production" for the respondents living in nine European countries. To investigate whether the average factor scores were statistically different from each other in different countries, paired samples t-tests were conducted. In Table VI, a larger average factor score indicates a stronger preference for the factor, while a smaller average score suggests a weaker preference. Based on the average factor scores, neither "Product properties" nor "Responsible production" were strongly appreciated in Finland, the Netherlands, Denmark, and Belgium while both were valued in Italy, France, and United Kingdom. "Responsible production" was in Germany valued more than "Product properties", while the situation was other way around in the Netherlands and Romania. The results for Germany and Romania were statistically significant. Furthermore, respondents from Denmark and Belgium valued "Responsible production" numerically more than "Product properties", but the differences were minor and not statistically significant.

Table VI. The country-wise average factor scores for "Product properties" and "Responsible production" and the t-test results on the differences between the average factor scores by country

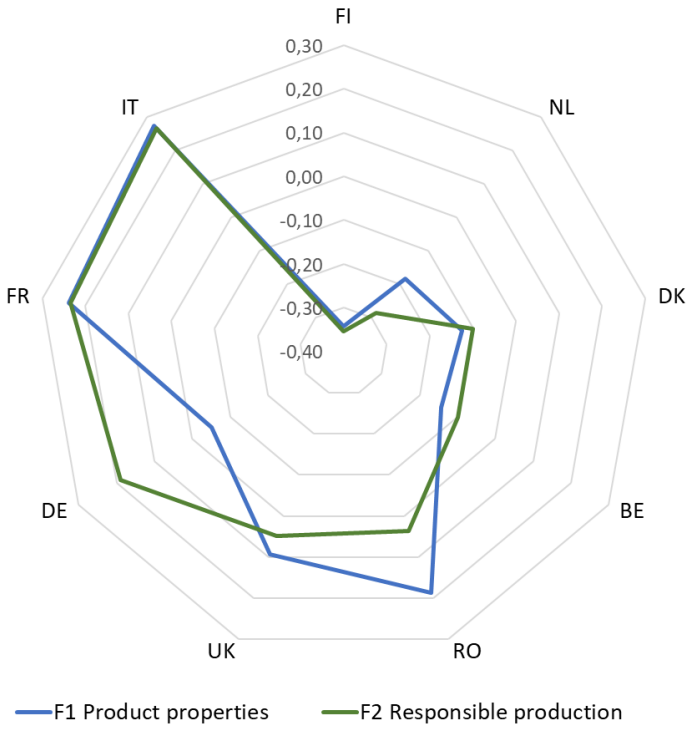

Figure 2. The average factor scores for "Product properties" and "Responsible production" by country[1].

[1] FI=Finland, UK=United Kingdom, FR=France, IT=Italy, BE=Belgium, DE=Germany, NL=the Netherlands, RO=Romania, DK=Denmark.

5. Discussion

The purpose of this study was to examine how Europeans perceive egg product quality and the importance of different sustainability attributes (i.e. animal welfare, country of origin, and production method) in egg purchases. In addition, we assessed the differences in perceptions of egg quality dimensions amongst the citizens in nine European countries.

Our results show that the quality attribute describing date laid or best before date was the most important individual attribute for citizens when purchasing egg products. Earlier, similar results have been gained among consumers' egg purchases in the United Kingdom (e.g. Parrott *et al.*, 2016). In

our study, also sustainability attributes (i.e. country of origin, production method, and animal welfare assurance) were important for European citizens when purchasing egg products. The result is in line with previous studies on consumer egg purchases (e.g. Andersen, 2011; Bejaei *et al.,* 2011; Mesias *et al.,* 2011; Parrott *et al.,* 2016; Teixeira *et al.,* 2018; Güney and Giraldo, 2020). Yet, in all, scientific information on consumers' perceptions of these sustainability attributes by European countries is scarce and thus our results provide new insights on the issue.

Regarding animal welfare, our results are in line with European commission's (2016) market report: over 90% of EU citizens considered protecting the welfare of farmed animals as important in 2015. According to Clark *et al.* (2019), animal welfare assurance schemes are also among the most trusted stakeholders to provide accurate information on production diseases, which typically challenge farm animal welfare. Moreover, the availability and contents of animal welfare assurance(s) available in each country can vary substantially (see, for example, Heinola *et al*., 2021; Niemi *et al*., 2021; Stygar *et al*., 2022). In countries such as the United Kingdom, France and the Netherlands, animal welfare assurance markets are generally more developed than in countries such as Romania or Finland. Hence, the availability and visibility of welfare-assured products in shopping situations may also influence consumers' valuations regarding sustainability attributes. For example, in the Netherlands, the animal welfare label Beter Leven provides animal welfare information for consumers (Heinola *et al.,* 2021). Furthermore, the role of animal welfare in consumers' purchase behaviour is influenced by culture, religion, and income (Parrott *et al.,* 2016).

Based on the EFA results, "Product properties" and "Responsible production" are the two underlying quality dimensions of egg products used by consumers in their evaluations. "Product properties" includes appearance as an example of an intrinsic quality attribute, but also many extrinsic product properties related to the product packaging (i.e. date laid or best before date, brand) and purchasing

and consumption phase (i.e. retail outlet, intended use of product). “Responsible production” consists of only product’s sustainability attributes: animal welfare assurance, production method, and country or region of origin.

Our results reveal perceptions on egg product quality to be affected by consumers’ age, gender, education, and country of residence. The results suggest sustainable product properties to be most valued by younger, well-educated females that is in line with earlier studies on sustainable products. For example, Zhao *et al.* (2021) found that women are more positive towards green consumption and make more frequent purchases of eco-friendly products. Also, younger age and higher education have been linked with intentions to engage with pro-environmental behavior and sustainable food consumption in earlier studies (e.g., Sánchez *et al.,* 2015; Brécard *et al.,* 2009). Contrastingly, our results did not indicate earnings to affect the evaluations of the egg product quality dimensions. This may be caused by the fact that by countries survey participants represented very different types of income levels: For example, over 30% of Romanian respondents earned less than 50% of the national median income, while over 20% of respondents in Finland and Denmark had at least twice the national median income.

When comparing citizens’ preferences for revealed egg quality dimensions (i.e. product properties and responsible production), certain differences were found amongst the European countries. Citizens living in Italy, France, and United Kingdom valued both responsible production (i.e. animal welfare assurance, production method, origin) and the general product properties (i.e. date laid or best before date, brand, retail outlet, intended use of product). In comparison, citizens living in Finland, Denmark, and Belgium did not have any strong preferences for either general product properties or properties related to responsible production. In addition to actual differences in the appreciation of egg quality dimensions by countries, the higher and lower country-wise results on the valuation of both egg

quality dimensions may be affected by cultural differences in response styles (i.e. propensity to give less or more extreme answers) between European countries (e.g. van Herk *et al.,* 2004; Kankaraš and Moors, 2011).

Regarding country-wise preferences for either of the egg quality dimensions, the results suggest that German citizens appreciate especially the sustainability aspects, such as animal welfare, production method, and origin, when choosing egg products. For egg producers, this is an opportunity to innovate higher-quality systems. Previous research results have also shown German consumers to be attentive to farm animal welfare issues (Schulze *et al.,* 2008). Regarding egg production systems, Germany has decided to end the use of cages for laying hens (Gautron *et al.,* 2021) and can be considered a front runner in cage free systems which might relate to consumer preferences for egg product sustainability.

In contrast, citizens living in the Netherlands and Romania appreciated the general product properties more than properties related to responsible production when choosing egg products. This might be explained by the fact that, for example, in the Netherlands, the hen housing legislation is stricter than EU legislation (Mendez and Peacock, 2022) and thus the available egg products for consumers already meet the various sustainability criteria. Therefore, "Responsible production" might be found less important in the purchase situation. In addition, in Romania, citizens generally might have doubts regarding sustainable products. For example, Romanian consumers have considered ecological products too expensive, and they have a lack of trust towards sustainable labels (Strambu-Dima, 2022). Furthermore, according to Orzan et *al.* (2018), a low consumer budget and deficiencies in the availability of information were considered the main barriers when adopting sustainable behaviour and buying products with sustainable packaging among Romanian consumers. Moreover, in this

study, a large proportion of the Romanian low-income respondents might explain the results to some extent.

6. Conclusions

6.1. Theoretical implications

The study provides new information on citizens' perceived egg product quality (i.e. quality dimensions) and the role of sustainability attributes in quality perceptions. The existing research on egg product quality has been focused mostly on physical characteristics of eggs (e.g. Hisasaga *et al.*, 2020), while the results of this study show that in addition to general product properties, Europeans' perceptions of egg quality are based on properties related to responsible production (i.e. sustainability attributes). Furthermore, citizens in different European countries vary in their purchasing preferences by age, gender, education, and country of residence. In some countries, citizens value properties related to responsible production more than other product properties when purchasing eggs, while in other countries the valuations are reversed. Also, product properties related to responsible production are especially appreciated by younger, well-educated females.

6.2. Practical implications

The results lead to managerial implications for egg industry companies. For example, egg industry should utilize the sustainability attributes (i.e. animal welfare, production methods, country of origin) valued by consumers in product development and when developing marketing strategies to also benefit consumers. Through accurate, understandable, and reliable marketing communication, consumers can verify these sustainability attributes when making consumption choices. In marketing, consumers with different preferences concerning product and sustainability properties should be recognized to ensure that value propositions better compliment their preferences. Stakeholders are

also recommended to use efficient communication channels to communicate about sustainable product properties and to take efforts to enhance the informed, sustainable consumption of egg products.

6.3. Limitations and future research

One limitation of the present study is that the measurement scale of the survey did not include attributes addressing, for example, the importance of nutritional value, taste, or health aspects that previous studies have considered factors influencing egg consumption (e.g. Bejaei *et al.*, 2011; Pettersson *et al.*, 2016; Gangnat *et al.*, 2018; Rondoni *et al.*, 2020). In future studies, the measurement scale for egg product quality could be developed further to consider a wider range of sustainability and other quality attributes of egg products.

In addition, the present study did not aim to measure how consumers perceive egg products in terms of quality attributes, but rather to examine how they rate these properties in a purchasing situation. Measuring consumers' perceptions and investigating how a sociodemographic background and personal values, beliefs, and knowledge influence egg product purchasing preferences related to sustainability aspects are topics that could be investigated in follow-up studies. One of the benefits of the present study is that data were collected from many countries, although country-wise differences in responding to surveys is a challenge for making general comparisons between countries. Covering multiple countries or at least repeating studies in different countries with rich datasets (i.e. surveys and interviews) would provide opportunities for a wider generalization of research findings.

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Table I. Quality attributes used to assess citizens' egg purchasing decisions and examples on the literature used to operationalize the variables

Quality attribute	Reference
Price	Andersen, 2011; Bejaei *et al.*, 2011; Lopez-Galan *et al.*, 2013; Gracia *et al.*, 2014; Parrott *et al.*, 2016; Baba *et al.*, 2017; Zabowska-Biemans and Tekién, 2017; Ochs *et al.*, 2018; Güney and Giraldo, 2019; Van Loo *et al.*, 2021
Animal Welfare Assurance	Andersen, 2011; Bejaei *et al.*, 2011; Doyon *et al.*, 2016; Parrott *et al.*, 2016; Ochs *et al.*, 2018; Clark *et al.*, 2017, 2019
Production method (e.g. organic, free-range, intensive)	Andersen, 2011; Bejaei *et al.*, 2011; Lopez-Galan *et al.*, 2013; Gracia *et al.*, 2014; Parrott *et al.*, 2016; Doyon *et al.*, 2016; Pettersson *et al.*, 2016; Baba *et al.*, 2017; Ochs *et al.*, 2018; Güney and Giraldo, 2019; Rondoni *et al.*, 2020; Van Loo *et al.*, 2021
Country or region of origin	Lopez-Galan *et al.*, 2013; Gracia *et al.*, 2014; Parrott *et al.*, 2016; Baba *et al.*, 2017; Gangnat *et al.*, 2018; Rondoni *et al.*, 2020
Date laid or best before date	Best before date (Parrott *et al.*, 2016); Date laid (Parrott *et al.*, 2016)
Appearance	Type of egg (brown, white) (Bejaei *et al.*, 2011); Size, colour, cleanliness, uniformity, texture (Jibir *et al.*, 2012); Size, colour, cleanliness, shape (Jibir *et al.*, 2013); Egg size (Baba *et al.*, 2017); Appearance (Wardy *et al.*, 2015; Rondoni *et al.*, 2020); Colour (Güney and Giraldo, 2019)
Brand	Parrott *et al.*, 2016; Güney and Giraldo, 2019; Van Loo *et al.*, 2021
Packaging (e.g. size, material)	Parrott *et al.*, 2016; Zabowska-Biemans and Tekién, 2017; Rondoni *et al.*, 2020
Intended use	Gerber, 2006; Rondoni *et al.*, 2020
Retail outlet	Retailing store (Parrott *et al.*, 2016)

Table II. Descriptive sociodemographic information on the sample by country (n=3,601)

	Country[1]								
	FI	UK	FR	IT	BE	DE	NL	RO	DK
N	400	400	400	400	400	400	400	401	400
Gender (%)									
Female	49.1	49.0	50.0	51.0	50.3	50.6	50.2	50.0	50.6
Male	50.9	51.0	50.0	49.0	49.7	49.4	49.8	50.0	49.4
Age (%)									
18-34 years	25.3	36.5	34.8	29.3	34.3	32.5	34.3	32.2	27.0
35-59 years	37.0	40.0	42.5	58.3	42.5	42.0	43.3	54.9	41.3
60 years or older	37.8	23.5	22.8	12.5	23.3	25.5	22.5	13.0	31.8
Education (%)									
Primary education, or lower	8.5	4.0	2.3	1.0	2.5	2.8	3.0	1.7	9.8
Secondary education (e.g. high school, vocational education)	33.5	41.0	36.0	9.5	41.8	54.8	50.0	25.7	35.3
Post-secondary education, including bachelor's degree or equivalent	36.3	40.5.	45.5	54.8	41.0	28.2	35.5	47.9	38.5
Master's degree or equivalent, or Doctorate or equivalent	21.8	14.5	16.3	34.8	14.8	14.2	11.5	24.7	16.5
Income (%)									
Less than 50% of median income[2]	9.0	8.0	14.0	12.0	9.8	14.2	7.8	36.7	7.2
>50% and ≤75% of median income[2]	10.8	13.5	18.0	16.5	11.3	12.0	9.5	16.0	6.5
>75% and ≤100% of median income[2]	11.0	13.8	15.3	19.8	16.0	12.8	14.0	7.0	12.3
>100% and ≤125% of median income[2]	8.5	11.0	15.5	16.3	13.8	16.0	14.0	8.0	12.0
>125% and ≤200% of median income[2]	26.0	24.8	19.8	15.5	18.0	19.5	22.5	9.2	20.5
>200% and ≤400% of median income[2]	20.8	15.3	8.5	4.3	8.0	14.2	13.5	8.5	21.3
More than 400% of median income[2]	2.0	2.5	1.8	0.8	0.5	1.5	2.8	2.7	7.5
I don't know	3.5	5.3	1.8	4.3	9.3	2.5	6.8	6.2	4.0
I don't wish to respond	8.5	6.0	5.5	10.8	13.5	7.2	9.3	5.7	8.8

[1] FI=Finland, UK=United Kingdom, FR=France, IT=Italy, BE=Belgium, DE=Germany, NL=the Netherlands, RO=Romania, DK=Denmark.

[2] The scale is dependent on each country's median income. Monetary boundaries between the classes vary by country.

Table III. The quality attributes of egg products addressed in the questionnaire and the proportions of respondents with different views on their importance. The least valued variables are underlined, and the most valued variables are bolded

Variable	Not important %	Slightly important %	Moderately important %	Very important %	Extremely important %	I don't' know %	Average index[1.]
Price	4.9	11.1	31.9	33.2	15.6	1.6	3.45
Animal welfare assurance	7.0	9.0	26.1	31.6	18.1	6.4	3.49
Production method (e.g. organic, free-range, intensive)	6.9	7.6	23.1	35.0	21.9	3.7	**3.61**
Country or region of origin	7.9	8.1	21.4	33.1	24.7	3.0	**3.62**
Date laid or best before date	7.4	6.6	23.2	33.8	23.4	3.8	**3.63**
Appearance	10.1	11.9	28.2	31. 5	13.1	3.3	3.27
Brand	22.0	17.3	30.2	18.1	7.3	3.2	<u>2.70</u>
Packaging (e.g. size, material)	13.9	16.5	33.8	23.3	8.3	2.5	<u>2.95</u>
Intended use of product	10.4	10.2	29.3	31.4	12.5	4.5	3.27
Retail outlet	13.3	12.8	33.9	24.9	9.2	4.2	<u>3.04</u>

[1] The last column represents an index that was obtained by calculating the average of each score.

Table IV. Results of the final rotated two-factor solution on the variables describing respondents' perceptions on egg product quality. Bolded values are the highest factor loadings in absolute values

Variables	Communalities (extracted)	F1: Product properties	F2: Responsible production
Animal welfare assurance	0.703	0.292	**0.786**
Production method	0.895	0.227	**0.918**
Country or region of origin	0.422	0.342	**0.552**
Date laid or best before date	0.336	**0.471**	0.338
Appearance	0.454	**0.635**	0.225
Brand	0.624	**0.759**	0.220
Packaging	0.554	**0.716**	0.202
Intended use of product	0.471	**0.605**	0.322
Retail outlet	0.496	**0.648**	0.278
Cronbach's alpha		0.844	0.832
Eigenvalues		4.557	1.166
Explained variance (in total 55 %)		30.597	24.458

Table V. T test and ANOVA results on statistically significant differences in perceived egg product quality dimensions by sociodemographic groups

Factor	Groups compared	*p*-value for all groups	*p*-value for groupwise comparisons
Product properties	Female vs. male	<0.001***	
Responsible production	Female vs. male	<0.001***	
Product properties	All age groups	0.034**	
	18-34 years vs. 60 years or older		0.025**
Responsible production	All age groups	0.044**	
	18-34 years vs. 60 years or older		0.072*
	35-59 years vs. 60 years or older		0.054*
Product properties	All education groups	<0.001***	
	Primary vs. secondary education		0.037**
	Secondary vs. post-secondary education, i.e. bachelor's degree or equivalent		0.012**
	Secondary vs. master's degree or equivalent, or Doctorate or equivalent		0.015**
Responsible production	All education groups	<0.001***	
	Primary vs. secondary education		0.007***
	Primary vs. post-secondary education, i.e. bachelor's degree or equivalent		<0.001***
	Primary vs. master's degree or equivalent, or Doctorate or equivalent		<0.001***
	Secondary vs. post-secondary education, i.e. bachelor's degree or equivalent		0.009***
	Secondary vs. master's degree or equivalent, or Doctorate or equivalent		<0.001***

*Suggestive evidence on statistical significance = 0.05 ≤ p-value < 0.1; **Moderate evidence on statistical significance = 0.01 ≤ p-value < 0.05; ***Very strong evidence on statistical significance = < 0.01 p-value.

Table VI. The country-wise average factor scores for "Product properties" and "Responsible production" and the t-test results on the differences between the average factor scores by country

Country[1]	F1 Product properties	F2 Responsible production	Two-sided P
FI	-0.34	-0.35	0.895
DK	-0.13	-0.10	0.715
BE	-0.14	-0.10	0.487
RO	0.19	0.04	0.004***
UK	0.09	0.05	0.536
DE	-0.05	0.19	<0.001***
NL	-0.18	-0.28	0.156
FR	0.24	0.23	0.938
IT	0.27	0.26	0.877

[1]FI=Finland, DK=Denmark, BE=Belgium, RO=Romania, UK=United Kingdom, DE=Germany, NL=the Netherlands, FR=France, IT=Italy

*Suggestive evidence on statistical significance = $0.05 \leq$ p-value < 0.1; **Moderate evidence on statistical significance = $0.01 \leq$ p-value < 0.05; ***Very strong evidence on statistical significance = < 0.01 p-value.

APPENDIX 1

E3. Country selection

1. Finland	2. France	3. United Kingdom	4. Belgium	5. Romania
6. The Netherlands	7. Denmark	8. Germany	9. Italy	

E1. What is your gender? (Select one option only)

Male	Female	Other	No response

E2. How old are you?

B5. The factors below have been identified as being of importance to some people when buying **eggs**. Please indicate their importance for you in egg purchasing decisions.

	1= Not Important	2 = Slightly Important	3 = Moderately important	4 = Very important	5=Extremely important	6 = I don't know
1. Price						
2. Animal Welfare Assurance						
3. Production method (e.g. organic, free-range, intensive)						
4. Country or region of origin						
5. Date laid or best before date						
6. Appearance						
7. Brand						
8. Packaging (e.g. size, material)						
9. Intended use of product						
10. Retail outlet						

E5. Which of the following best describes your highest level of education?

1. Primary education (or less)	2. Secondary education (e.g. high school, vocational education)	3. Post-secondary education, including bachelor's degree or equivalent	4. Master's degree or equivalent, or Doctorate or equivalent

E9. What is the total annual ***net income of your household*** (after taxes)?*

1. Less than £12,000
2. £12,000 – £19,000
3. £19,001 – £25,000
4. £25,001 – £31,000
5. £31,001 – £50,000
6. £50,001 – £100,000
7. More than £100,000
8. I don't know

9. I don’t wish to respond

*example from the UK survey. Country-wise responses for these questions are used to calculate the country-wise information for Table II for income of the respondents in reference to statistical information on median income by countries.

APPENDIX 2

The average factor scores for “Product properties” and “Responsible production” calculated by sociodemographic groups of respondents.

Factor	***Sociodemographic variable***	***Average factor score***
Product properties	Female	-0.058
	Male	0.057
Responsible production	Female	0.144
	male	-0.144
Product properties	18-34 years	0.047
	35-59 years	0.000
	60 years or older	-0.069
Responsible production	18-34 years	0.023
	35-59 years	0.022
	60 years or older	-0.080
Product properties	Primary education	0.148
	Secondary education	-0.081
	Post-secondary education, i.e. bachelor’s degree or equivalent	0.032
	Master’s degree or equivalent, or Doctorate or equivalent	0.056
Responsible production	Primary education	-0.366
	Secondary education	-0.079
	Post-secondary education, i.e. bachelor’s degree or equivalent	0.043
	Master’s degree or equivalent, or Doctorate or equivalent	0.138

APPENDIX 3

One-way analysis of variance (ANOVA) test results regarding statistically significant differences in respondents' preferences for egg quality dimensions (i.e., factors derived from exploratory factor analysis) by countries.

Factor	*p*-value for all groups
F1 Product properties	<0.001***
F2 Responsible production	<0.001***

One-way analysis of variance (ANOVA) test results, which showed statistically significant differences in respondents' preferences for egg quality dimensions (i.e., factors derived from exploratory factor analysis) by countries.

Factor	Country[1]	Country[1]	*p*-value for groupwise comparisons	Factor	Country[1]	Country[1]	*p*-value for groupwise comparisons
F1 Product properties	FI	DK	.038**	F2 Responsible production	FI	DK	.011**
		RO	<.001***			RO	<.001***
		UK	<.001***			UK	<.001***
		DE	<.001***			DE	<.001***
		BE	.083*			BE	.011**
		NL	.322			NL	.990
		FR	<.001***			FR	<.001***
		IT	<.001***			IT	<.001***
	DK	FI	.038**		DK	FI	.011**
		RO	<.001***			RO	.586
		UK	.035**			UK	.485
		DE	.973			DE	.001***
		BE	1.000			BE	1.000
		NL	.997			NL	.208
		FR	<.001***			FR	<.001***
		IT	<.001***			IT	<.001***
	RO	FI	<.001***		RO	FI	<.001***
		DK	<.001***			DK	.586
		UK	.903			UK	1.000
		DE	.008***			DE	.388
		BE	<.001***			BE	.616
		NL	<.001***			NL	<.001***
		FR	.997			FR	.100
		IT	.920			IT	.025**
	UK	FI	<.001***		UK	FI	<.001***

	DK	.035**
	RO	.903
	DE	.424
	BE	.016**
	NL	.002***
	FR	.447
	IT	.152
DE	FI	<.001***
	DK	.973
	RO	.008***
	UK	.424
	BE	.915
	NL	.607
	FR	<.001***
	IT	<.001***
BE	FI	.083*
	DK	1.000
	RO	<.001***
	UK	.016**
	DE	.915
	NL	1.000
	FR	<.001***
	IT	<.001***
NL	FI	.322
	DK	.997
	RO	<.001***
	UK	.002***
	DE	.607
	BE	1.000
	FR	<.001***
	IT	<.001***
FR	FI	<.001***
	DK	<.001***
	RO	.997
	UK	.447
	DE	<.001***
	BE	<.001***
	NL	<.001***
	IT	1.000
IT	FI	<.001***
	DK	<.001***
	RO	.920

	DK	.485
	RO	1.000
	DE	.557
	BE	.514
	NL	<.001***
	FR	.189
	IT	.057**
DE	FI	<.001***
	DK	.001***
	RO	.388
	UK	.557
	BE	.002***
	NL	<.001***
	FR	.999
	IT	.974
BE	FI	.011**
	DK	1.000
	RO	.616
	UK	.514
	DE	.002***
	NL	.203
	FR	<.001***
	IT	<.001***
NL	FI	.990
	DK	.208
	RO	<.001***
	UK	<.001***
	DE	<.001***
	BE	.203
	FR	<.001***
	IT	<.001***
FR	FI	<.001***
	DK	<.001***
	RO	.100*
	UK	.189
	DE	.999
	BE	<.001***
	NL	<.001***
	IT	1.000
IT	FI	<.001***
	DK	<.001***
	RO	.025**

		UK	.152			UK	.057*
		DE	<.001***			DE	.974
		BE	<.001***			BE	<.001***
		NL	<.001***			NL	<.001***
		FR	1.000			FR	1.000

[1] FI=Finland, UK=United Kingdom, FR=France, IT=Italy, BE=Belgium, DE=Germany, NL=the Netherlands, RO=Romania, DK=Denmark.

*Suggestive evidence on statistical significance = 0.05 ≤ p-value < 0.1; **Moderate evidence on statistical significance = 0.01 ≤ p-value < 0.05; ***Very strong evidence on statistical significance = < 0.01 p-value.