

## JRC TECHNICAL REPORTS

# The JRC statistical audit of the Restrictiveness Index for seven regulated professions

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2018



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JRC113454

EUR 29407 EN

PDF ISBN 978-92-79-96746-7 ISSN 1831-9424 doi:10.2760/209047

Luxembourg: Publications Office of the European Union, 2018

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How to cite this report: Alvarez-Díaz, Marcos, Del Sorbo, Maria, Saisana, Michaela, *The JRC statistical audit of the Restrictiveness Index for seven regulated professions*, EUR 29407 EN, Publications Office of the European Union, Luxembourg, 2018, ISBN 978-92-79-96746-7, doi:10.2760/209047, JRC113454.

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## **Abstract**

The European Commission highlights the role of regulation in creating obstacles to the functioning of the single market and holding back the potential for growth and job creation in the EU economies. Removing such barriers opens up opportunities and has a positive impact on the productivity and competitiveness of the EU economy. In this context, the Directorate-General for Internal Market, Industry, Entrepreneurship and SMEs has developed the Restrictiveness Index, which aims to measure the intensity of the national regulations in the 28 Member States of the European Union with regard to entering and exercising seven professions: accountant, architect, civil engineer, lawyer, patent agent, real estate agent and tourist guide. In so doing, it raises some conceptual and practical challenges, which are discussed in the Restrictiveness Index report. The goal of this Joint Research Centre audit report is to assess the statistical coherence of the Restrictiveness Index and the impact of its modelling assumptions. These analyses lead to the following key findings.

First, the statistical coherence of the Restrictiveness Index is confirmed. The more the conceptual framework embraces the statistical structure, the greater the reliability of the indicator will be. In our case, different degrees of alignment are identified between the conceptual framework and the statistical framework, with the greatest alignment for the profession of real estate agent, and the least alignment for the profession of lawyer.

Second, the Restrictiveness Index's country rankings and scores are relatively robust to methodological assumptions. Hence, it is not sensitive to perturbations in the weights and in the aggregation formula.

Third, exclusive or shared reserved activities, educational requirements and title protection have high impacts on the Restrictiveness Index.

Fourth, quantitative restrictions seem to be the least restricted indicator given that it provides the least information in terms of regulation intensity. In addition, it records the least influence on the indicator framework and the weakest association with it.

Future editions of the Restrictiveness Index should carefully reconsider the profession of lawyer, because the restrictions related to compulsory registration in professional bodies are negatively associated with the overall index. This shows that it moves in the opposite direction within the conceptual and statistical framework.

## 1. Introduction

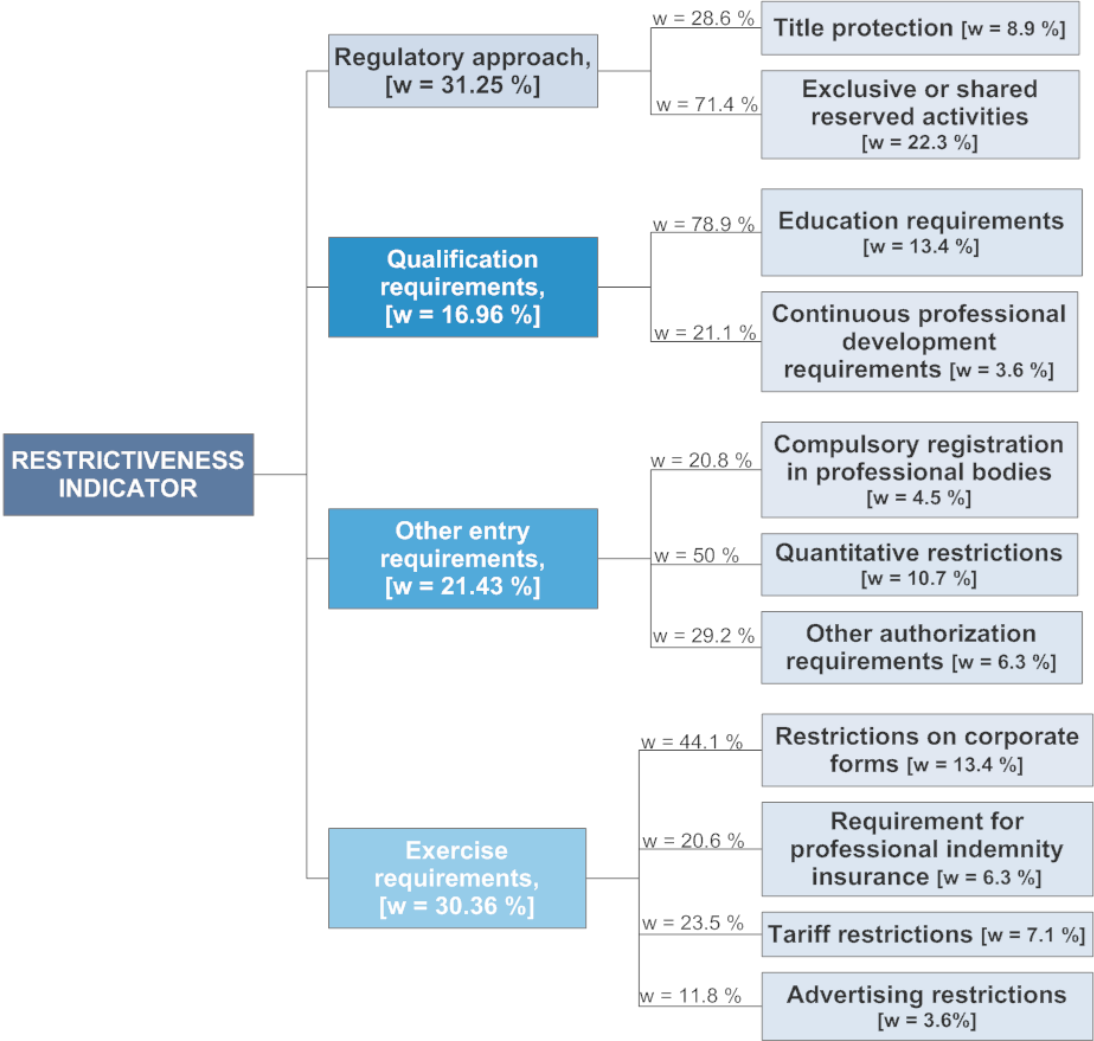
Unit E/5, Professional Qualifications and Skills, of the Directorate-General (DG) for Internal Market, Industry, Entrepreneurship and SMEs has invited the Joint Research Centre (JRC) to perform the audit of the Restrictiveness Index for the second year. This composite indicator was developed by the European Commission services as part of the initiative 'Guidance on reform needs for Member States in regulated professions', which was announced in the single market strategy adopted in October 2015. Regulation creates obstacles for the functioning of the single market and holds back the potential for growth and job creation in the EU economies. Removing such barriers opens up opportunities and has a positive impact on the productivity and competitiveness of the EU economy. Hence, the role of the Restrictiveness Index becomes crucial in monitoring progress and to guide Member States on reforms of seven regulated professions: accountant, architect, civil engineer, lawyer, patent agent, real estate agent and tourist guide. As stated in the communication of the European Commission on the reform recommendations for regulation in professional services, the rationale for the selection of these seven professions is that they belong to four key economic sectors: business services, construction, real estate and tourism <sup>(1)</sup>. Therefore, the Restrictiveness Index captures how restrictive regulation is in each of the EU-28 with regard to entering and practising the seven professions. The higher the score, the more restrictive the regulation, and vice versa, the lower the score, the less restrictive the regulation.

The added value of the Restrictiveness Index lies in its ability to condense different aspects of the national regulations of the seven professions in a more efficient and parsimonious manner than is possible with the indicators and categories taken separately. In fact, the overall country ranking by category varies from zero to three positions in this year's version of the index. Figure 1 shows the framework of the Restrictiveness Index, its 4 categories and 11 indicators with the nominal weights by category, within category and by indicator. The selection and relevance of the 11 indicators, their grouping into the 4 categories and their weights are rooted in experts' opinions based on the mutual evaluations of regulated professions by Member States.

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<sup>(1)</sup> The communication was directed to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, SWD (2016) 436 final.

**Figure 1.** Conceptual framework of the Restrictiveness Index for seven professions



NB: w, weight. The nominal weight of each indicator/category is shown inside its own box (e.g. title protection weight is 8.9 %); the weight within the category is that standing outside the box (e.g. title protection weight is 28.6 % within the category regulatory approach).

Source: European Commission, Joint Research Centre, 2018.



This audit represents the second analysis performed by the European Commission's Competence Centre on Composite Indicators and Scoreboards (COIN) at the JRC. The present JRC assessment of the Restrictiveness Index focuses on two main goals. First, the statistical coherence is assessed by means of (i) correlation analysis, (ii) impact of the indicators on the Restrictiveness Index score and (iii) impact on the country ordering when one indicator at a time is omitted. Second, the robustness of the Restrictiveness Index is assessed using sensitivity and uncertainty analyses. These analyses explore the robustness of the overall index to perturbations in the weights and/or changes in the aggregation formula.

The main findings can be summarised as follows.

- The version of the Restrictiveness Index presented by the developers is coherent, well balanced and robust, displaying strong associations between the underlying indicators and the Restrictiveness Index categories, especially for the professions of real estate agent and accountant, and hence offers a sound basis for policy interpretations.
- The more the conceptual framework embraces the statistical structure, the higher the reliability of the indicator will be. In our specific case, different degrees of alignment are identified between the theoretical and statistical frameworks, with the greatest alignment for the profession of real estate agent, and the least alignment for the profession of lawyer.
- Some indicators, most significantly exclusive or shared reserved activities and then title protection, have a high impact on the Restrictiveness Index.
- Advertising restrictions, quantitative restrictions and tariff restrictions — in descending order — seem to have less influence on the indicator framework. The findings also confirm the robustness of the proposed weights and the suitability of the arithmetic average as a formula for aggregating the individual indicators.
- In order to enhance the soundness of the Restrictiveness Index, some minor issues outlined in this report are also recommended for examination in the next version of this index.

Overall, this JRC audit concluded that the Restrictiveness Index is robust, with a statistically coherent and balanced two-level structure. The analysis has been performed in order to ensure the transparency and the coherence of the Restrictiveness Index and thus to enable policymakers to derive more accurate and meaningful conclusions, and to potentially guide their choices on priority setting and policy formulation.

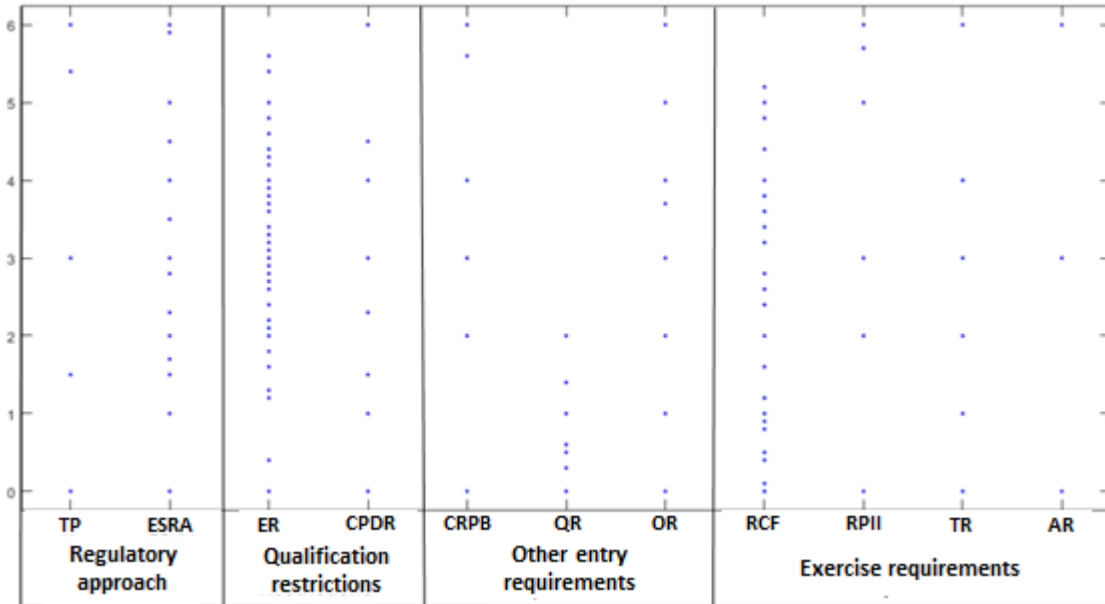
## **2. Statistical coherence in the Restrictiveness Index framework**

An initial assessment of the Restrictiveness Index (RI) was performed by the JRC in June 2017, when a pre-audit was carried out for the profession of accountant. This preliminary report determined the statistical tools and the steps to be followed in the final version of the audit. No critical issues were identified during this preliminary phase of the audit. The current assessment of the statistical coherence in this final version is based on the steps specified in the previous pre-audit, detailed in the following sections.

### **2.1. Data checks**

The most recently released data were used for each country. Data checks confirm that the data are complete and reliable and there are no outliers/problematic indicators in the dataset, as facilitated by the development team. The numerical framework behind the Restrictiveness Index is well defined and the measurement scale is clearly established. The survey design provided by DG Internal Market, Industry, Entrepreneurship and SMEs codifies the data from a minimum of 0 (no regulation) to a maximum of 6 (maximum level of regulation), allowing non-integer values. This survey design affects the data structure, which is a mixture of discrete and continuous ('hybrid data'). Figure 2 represents the pooled data for the 11 indicators across the 7 professions. Some indicators are coded by non-integer values (e.g. 'education requirements' and 'restrictions on corporate forms'), while others can score only specific values (e.g. the indicator 'advertising restrictions' can take only values 0, 3 and 6). This characteristic of the data affects the choice of the standard statistical techniques to use, such as principal component analysis (PCA), factorial analysis (FA) and Pearson's correlation analysis. These tools are based on the assumptions of continuous data, normality and linear relationships, which are not always met by the data used to calculate the Restrictiveness Index. The JRC COIN team have selected ad hoc techniques and the suitable tools taking into account the peculiarity of the data (e.g. Kendall's tau rank correlation).

**Figure 2.** Graphic representation of the pooled data



AR, advertising restrictions; CPDR, continuous professional development requirements; CRPB, compulsory registration in professional bodies; ER, education requirements; ESRA, exclusive or shared reserved activities; OR, other requirements; QR, quantitative restrictions; RCF, restrictions on corporate forms; RPII, requirements for professional indemnity insurance; TP, title protection; TR, tariff restrictions. Reading key: Figure 2 represents the values that each type of restriction can take considering the pooled data across countries. It can be concluded from this figure that, for example, advertisement restrictions takes only three values for all professions (0, 3 and 6), and tariff restrictions take only six values (0, 1, 2, 3, 4 and 6).

*Source:* European Commission, Joint Research Centre, 2018.

The statistical analysis of the data for the seven professions reveals some common patterns.

- The data have little or no variability, and they stand within a small range of values; e.g. the indicator 'quantitative restrictions' ranges from 0 to 2. Specifically, for the profession of real estate agent, this indicator records only values of 0.
- The data are highly concentrated on the tails of the empirical distribution of the indicators. For the professions of accountant and architect, the indicators 'compulsory registration in professional bodies', 'requirements for professional indemnity insurance', 'continuous professional development requirements' and 'restrictions on corporate forms' record the most of the observations lying at the lowest and highest values of the distribution: 0 (no regulation) and 6 (maximum level of regulation).

Given that all indicators of the Restrictiveness Index are measured on the same scale it is not necessary to normalise the data.

## 2.2. Statistical coherence

To be reliable, a composite indicator needs to have, among other things, a coherent conceptual framework and a coherent statistical structure. The more the conceptual framework embraces the statistical structure, the more reliable the Restrictiveness Index will be. This section presents the JRC's analysis of the statistical coherence of the Restrictiveness Index. The methods used to identify the added value of one indicator to the framework are the impact of the indicator on the Restrictiveness Index (correlation analysis), the impact of the indicator on the Restrictiveness Index's scores (pie-shares analysis) and the impact on the country ordering when the indicator or category is omitted. Given that the present statistical analysis of the Restrictiveness Index will mostly, although not exclusively, be based on correlations, the correspondence of the Restrictiveness Index to a real-world phenomenon needs to be critically addressed because correlations do not necessarily represent the real influence of the individual indicators on the phenomenon being measured.

### 2.2.1. Impact of the indicator on the Restrictiveness Index (analysis of the correlation structure)

The correlation structure is analysed at three different levels: between the Restrictiveness Index and the indicators, between the Restrictiveness Index and the categories and, finally, between the individual indicators and the categories. Given the hybrid nature of the data, the Kendall's rank correlation coefficients are used as a statistical measure to detect ordinal relationships between variables <sup>(2)</sup>.

#### ***Correlation between the Restrictiveness Index and the indicators***

Information about the statistical significance of the correlation between the Restrictiveness Index and the different indicators appears in Table 1. Annex I presents the values of the Kendall's correlation coefficients. The total number of correlations computed is 77, which results from multiplying the number of restrictions (11 indicators) by the number of professions (7 professions). Out of the 77 computed correlations, 65 % (50 out of the total) are statistically significant at the 10 % level of significance <sup>(3)</sup>. The restrictions 'exclusive or shared reserved activities' and 'educational requirements' are always correlated with the overall Restrictiveness Index. It seems that these indicators have a significant impact on the Restrictiveness Index. On the other hand, 'quantitative restrictions' is associated with the Restrictiveness Index two out of seven times, when assessing the regulatory restrictiveness of only two professions: lawyer and tourist guide. Similarly, the indicators 'advertising restrictions' and 'tariff restrictions' are correlated with the Restrictiveness Index in three out of the seven cases: real estate agent, engineer and lawyer.

The last column of Table 1 provides the correlation between the different types of restrictions and the Restrictiveness Index for the pooled data (i.e. adding the data of all professions). The indicators 'restrictions on corporate forms', 'compulsory registration in professional bodies', 'educational requirements', 'exclusive or shared reserved activities', 'title protection' and 'requirements for professional indemnity insurance' have a relatively strong association with the Restrictiveness Index. Conversely, as expected, 'quantitative restrictions' has the weakest association with the RI, which shows its slight influence on it.

Table 1 also reveals that the profession of real estate agent shows a perfect match

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<sup>(2)</sup> The Pearson's correlations and the Spearman's rank correlations were also calculated. There were no significant differences among the different methods to detect statistical relationships. However, the results of the Kendall tau-b statistics are the only ones reported in this study, since they are more suitable given the specific characteristics of the data.

<sup>(3)</sup> This means that there is a 90 % probability that there are no mistakes or that associations exist.

with the framework, since it is the only profession where all the 11 indicators display significant correlations with the Restrictiveness Index <sup>(4)</sup>. This case is ideal, given that it fits perfectly within the theoretical framework. By contrast, for the profession of lawyer, the impact on the Restrictiveness Index is driven completely by only 4 out of the 11 restrictions: 'exclusive or shared reserved activities', 'educational requirements', 'tariff restrictions' and 'advertising restrictions'. Statistically, the remaining seven restrictions are not reflected in the final index. Moreover, for this profession, an important statistical incoherence is detected. Specifically, it is observed that 'continuous professional development requirements' is negatively associated with the RI, meaning that its higher values imply lower values of the RI; see Table 1. Figure 3 illustrates this incoherence, depicting two cases: the unexpected negative relationship observed for the profession of lawyer, and the expected positive relationship for the profession of real estate agent. As can be seen, the indicator 'continuous professional development requirements' moves inversely with respect to the RI for the profession of lawyer, while it moves in the same direction as the RI for the profession of real estate agent. The association of these requirements with the index shows an inverse logic fit within the conceptual framework for the profession of lawyer: the lower the value of the restriction, the higher the score of the Restrictiveness Index.

**Table 1.** Analysis of correlation between the Restrictiveness Index and the 11 indicators

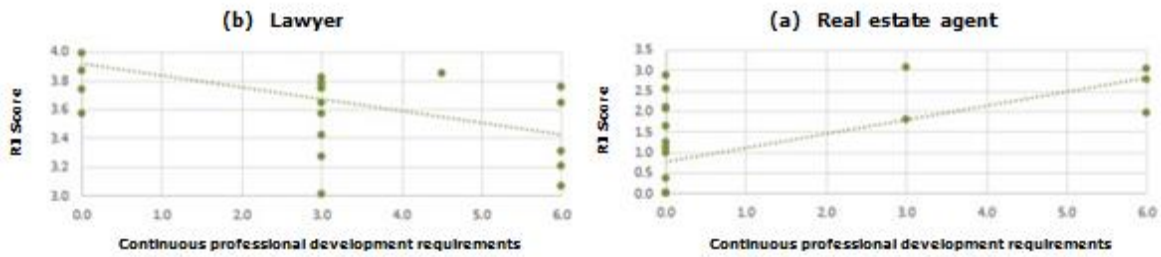
		Real estate agent	Accountant	Engineer	Tourist guide	Architect	Patent agent	Lawyer	Total number of 'N'	Correlation pooled data with the RI
Regulatory approach	TP	Y	Y	Y	Y	Y	N	N	2	0.57
	ESRA	Y	Y	Y	Y	Y	Y	Y	0	0.58
Qualification requirement	ER	Y	Y	Y	Y	Y	Y	Y	0	0.60
	CPDR	Y	Y	N	Y	N	N	Y	3	0.38
Other entry requirements	QR	Y	N	N	Y	N	N	N	5	0.06
	CRPB	Y	Y	Y	Y	Y	Y	N	1	0.65
Exercise requirement	OR	Y	Y	N	Y	N	Y	N	3	0.39
	RCF	Y	Y	Y	N	Y	Y	N	2	0.69
	RPII	Y	Y	N	N	Y	Y	N	3	0.57
	TR	Y	N	Y	N	N	N	Y	4	0.33
	AR	Y	N	Y	N	N	N	Y	4	0.37
Total number of 'N'		0	3	4	4	5	5	6	27	

The correlation analysis is based on the Kendall's correlation coefficients. The statistical significance was set at the level of 10 %. AR, advertising restrictions; CPDR, continuous professional development requirements; CRPB, compulsory registration in professional bodies; ER, education requirements; ESRA, exclusive or shared reserved activities; N, no statistically significant correlations; OR, other requirements; QR, quantitative restrictions; RCF, restrictions on corporate forms; RPII, requirements for professional indemnity insurance; TP, title protection; TR, tariff restrictions; Y, statistically significant correlations (green, positive; red, negative).

Source: European Commission, Joint Research Centre, 2018.

<sup>(4)</sup> The indicator 'quantitative restrictions' is deleted from the analysis for the profession of real estate agent given that all of its values are equal to zero.

**Figure 3.** Two examples of the relationship between continuous professional development requirements and the Restrictiveness Index



Source: European Commission, Joint Research Centre, 2018.

**Correlation between the Restrictiveness Index and the categories**

Table 2 shows the correlations between the Restrictiveness Index and the categories. In general, the categories are correlated with the RI (in 25 out of 28 combinations the correlation is significant). The category ‘regulatory approach’ presents the strongest association, reflecting the major effect that the restriction ‘exclusive or shared reserved activities’ has on the Restrictiveness Index.

With regard to professions, it is observed that half of the categories are not correlated with the Restrictiveness Index for the profession of lawyer. This result is actually predictable given the low level of correlation observed between the RI and most restrictions on the profession of lawyer. Likewise, it is observed for the category exercise requirements for the profession of tourist guide. In this case, none of the restrictions belonging to this category has a significant association with the Restrictiveness Index.

**Table 2.** Correlation analysis between the Restrictiveness Index and the categories

	Real estate agent	Accountant	Engineer	Tourist guide	Architect	Patent agent	Lawyer	Total number of 'N'
Regulatory approach	Y	Y	Y	Y	Y	Y	Y	0
Qualification requirements	Y	Y	Y	Y	Y	Y	N	1
Other entry requirements	Y	Y	Y	Y	Y	Y	N	1
Exercise requirements	Y	Y	Y	N	Y	Y	Y	1
Total number of 'N'	0	0	0	1	0	0	2	3

The correlation analysis is based on the Kendall’s correlation coefficients. N, no statistically significant correlations; Y, statistically significant correlations.

Source: European Commission, Joint Research Centre, 2018.

## Correlation between the indicators and the categories

Table 3 provides information about the importance of the associations between the indicators and the categories. In general, all the indicators in the framework are more strongly correlated with their own category than with any others (see Annex I). Accordingly, it can be said that the grouping of the different types of restrictions into the categories selected by the development team – and based on experts’ opinion – seems to be consistent from both a conceptual and a statistical perspective. Yet some baffling issues should be flagged.

- The indicators ‘quantitative restrictions’, ‘tariff restrictions’ and ‘advertising restrictions’ are significantly correlated with their own categories in only three out of seven professions.
- Lawyer is the profession that shows the lowest number of significant correlations between the indicators and their own categories. Only 5 out of 11 indicators are significantly correlated with their corresponding category.

**Table 3.** Analysis of the correlation between the indicators and the categories

	Accountant				Architect				Engineer				Lawyer				
	DRA	DQR	DOR	DER	DRA	DQR	DOR	DER	DRA	DQR	DOR	DER	DRA	DQR	DOR	DER	
TP	<b>Y</b>	Y	Y	Y	<b>Y</b>	N	N	N	<b>Y</b>	N	N	<b>Y</b>	-	-	-	-	
ESRA	<b>Y</b>	Y	Y	Y	<b>Y</b>	Y	N	N	<b>Y</b>	N	N	N	<b>Y</b>	N	N	N	
ER	<b>Y</b>	<b>Y</b>	<b>Y</b>	<b>Y</b>	<b>Y</b>	<b>Y</b>	N	N	N	<b>Y</b>	<b>Y</b>	<b>Y</b>	<b>Y</b>	N	N	N	
CPDR	N	<b>Y</b>	<b>Y</b>	<b>Y</b>	N	<b>Y</b>	N	N	N	<b>Y</b>	N	N	N	N	N	N	
QR	N	Y	N	N	<b>Y</b>	N	<b>Y</b>	<b>Y</b>	N	N	N	N	N	N	N	N	
CRPB	<b>Y</b>	<b>Y</b>	<b>Y</b>	<b>Y</b>	N	N	N	N	N	<b>Y</b>	<b>Y</b>	<b>Y</b>	N	N	<b>Y</b>	N	
OR	<b>Y</b>	<b>Y</b>	<b>Y</b>	<b>Y</b>	N	N	<b>Y</b>	N	N	N	<b>Y</b>	N	N	N	<b>Y</b>	N	
RCF	<b>Y</b>	<b>Y</b>	<b>Y</b>	<b>Y</b>	N	N	<b>Y</b>	<b>Y</b>	<b>Y</b>	N	<b>Y</b>	<b>Y</b>	N	N	N	<b>Y</b>	
RPII	<b>Y</b>	<b>Y</b>	<b>Y</b>	<b>Y</b>	N	<b>Y</b>	N	<b>Y</b>	N	N	N	<b>Y</b>	N	N	N	N	
TR	N	N	N	N	N	N	N	N	N	N	N	<b>Y</b>	N	N	N	<b>Y</b>	
AR	N	N	N	N	N	N	N	N	N	N	N	<b>Y</b>	N	N	N	<b>Y</b>	
	Patent agent				Real estate agent				Tourist guide				ALL PROFESSIONS				
	DRA	DQR	DOR	DER	DRA	DQR	DOR	DER	DRA	DQR	DOR	DER	DRA	DQR	DOR	DER	
TP	<b>Y</b>	N	N	N	<b>Y</b>	<b>Y</b>	<b>Y</b>	<b>Y</b>	<b>Y</b>	<b>Y</b>	N	N	TP	<b>6 Y</b>	3 Y	2 Y	3 Y
ESRA	<b>Y</b>	N	<b>Y</b>	<b>Y</b>	<b>Y</b>	<b>Y</b>	<b>Y</b>	<b>Y</b>	<b>Y</b>	<b>Y</b>	<b>Y</b>	N	ESRA	<b>7 Y</b>	4 Y	4 Y	3 Y
ER	N	<b>Y</b>	<b>Y</b>	<b>Y</b>	<b>Y</b>	<b>Y</b>	<b>Y</b>	<b>Y</b>	<b>Y</b>	<b>Y</b>	<b>Y</b>	N	ER	4 Y	<b>7 Y</b>	5 Y	5 Y
CPDR	N	<b>Y</b>	N	N	<b>Y</b>	<b>Y</b>	<b>Y</b>	<b>Y</b>	<b>Y</b>	<b>Y</b>	<b>Y</b>	N	CPDR	2 Y	<b>6 Y</b>	3 Y	3 Y
QR	N	N	N	N	<b>Y</b>	<b>Y</b>	<b>Y</b>	<b>Y</b>	N	N	<b>Y</b>	N	QR	2 Y	2 Y	<b>3 Y</b>	2 Y
CRPB	<b>Y</b>	<b>Y</b>	<b>Y</b>	<b>Y</b>	<b>Y</b>	<b>Y</b>	<b>Y</b>	<b>Y</b>	<b>Y</b>	<b>Y</b>	<b>Y</b>	N	CRPB	4 Y	5 Y	<b>6 Y</b>	4 Y
OR	N	<b>Y</b>	<b>Y</b>	<b>Y</b>	<b>Y</b>	<b>Y</b>	<b>Y</b>	N	<b>Y</b>	<b>Y</b>	<b>Y</b>	N	OR	3 Y	4 Y	<b>7 Y</b>	2 Y
RCF	<b>Y</b>	<b>Y</b>	<b>Y</b>	<b>Y</b>	<b>Y</b>	<b>Y</b>	<b>Y</b>	<b>Y</b>	N	N	N	<b>Y</b>	RCF	4 Y	3 Y	5 Y	7 Y
RPII	<b>Y</b>	<b>Y</b>	<b>Y</b>	<b>Y</b>	<b>Y</b>	<b>Y</b>	<b>Y</b>	<b>Y</b>	N	N	N	<b>Y</b>	RPII	3 Y	4 Y	3 Y	<b>6 Y</b>
TR	N	N	N	N	<b>Y</b>	N	N	<b>Y</b>	-	-	-	-	TR	1 Y	0 Y	0 Y	3 Y
AR	N	N	<b>Y</b>	N	N	N	N	N	-	-	-	-	AR	0 Y	0 Y	1 Y	3 Y

The indicators that belong to the same dimension are flagged in bold. AR, advertising restrictions; CPDR, continuous professional development requirements; CRPB, compulsory registration in professional bodies; DRA, regulatory approach; DER, exercise requirements; DOR, other entry requirements; DQR, qualification requirements; ER, education requirements; ESRA, exclusive or shared reserved activities; N, no statistically significant correlations; OR, other requirements; QR, quantitative restrictions; RCF, restrictions on corporate forms; RPII, requirements for professional indemnity insurance; TP, title protection; TR, tariff restrictions; Y, statistically significant correlations at the 10stically. Reading key: Table 3 shows if the association between the restrictions and the categories are statistically significant. The table also summarises the total number of significant relationships between the indicators and the categories. For example, the indicator ‘exclusive or shared reserved activities’ counts seven significant positive associations with its own category, ‘regulatory approach’.

Source: European Commission, Joint Research Centre, 2018.

Overall, the correlation analysis at the three different levels corroborates the conceptual framework defined by the developer. Nevertheless, some facts need to be carefully considered.

- The indicator 'quantitative restrictions' presents a weak statistical association with the Restrictiveness Index in comparison with all other types of restrictions. This indicator seems not to make a significant contribution to the RI for any professions other than lawyer and tourist guide.
- The statistical consistency of the proposed conceptual framework is not reflected for the profession of lawyer. In this profession, most of the correlations are not significant, and some statistical incoherence has been detected (i.e. the negative relationship between the continuous professional development restriction and the RI).

### **2.2.2. Impact of the indicators on the Restrictiveness Index's scores**

The Restrictiveness Index and its components are simple arithmetic averages of the underlying indicators. Developers and users of composite indicators often consider that the weights assigned to the indicators match the indicators' importance in the final indicator. However, in practice, the correlation structure of the underlying indicators and their different impacts do not always allow the weights assigned to the indicators to be considered equivalent to their importance (Becker et al., 2017). In these cases, the pie-shares of the underlying indicators show the importance of the indicators to the final construction of the indicators and their alignment with the nominal weight. Table 4 highlights first that 'exclusive or shared reserved activities', 'education requirements' and 'title protection' powerfully contribute to build up the Restrictiveness Index over all the seven professions. On average, they represent 32.1, 20 and 13.7 percentage points of the Restrictiveness Index's scores, respectively. These percentages show that restrictions' contributions are aligned with their nominal weights (22.3, 13.4 and 8.9 percentage points, respectively). In addition, 'continuous professional development', 'compulsory registration in professional bodies' and 'other requirements' have a concrete impact on the Restrictiveness Index that is generally aligned with their nominal weights, whereas 'advertising restrictions' records a higher impact than its nominal weights only for the profession of accountant. The same structure appears in the categories 'regulatory approach' and 'qualification requirements', which represent the highest proportions of the RI (45.8 and 26.0 percentage points, respectively), and these proportions are also aligned with the nominal weights. Nevertheless, 'exercise requirements' has an average impact of 19.4 percentage points on the Restrictiveness Index's score, which is lower than its nominal weight of 30.36 percentage points. Over all the seven professions, 'title protection', 'exclusive or shared reserved activities' and 'education requirements' provide the most information aligned with the conceptual framework, while 'quantitative restrictions' and 'tariff restrictions' provide the least information.



**Table 4.** Impact of the indicators on the Restrictiveness Index's scores — pie-shares of the indicators

Category	Indicator	Accountant	Architect	Engineer	Lawyer	Patent agent	Real estate agent	Tourist guide	AVERAGAGE	Nominal weights
Regulatory approach	TP	12.3%	15.8%	17.6%	14.7%	18.5%	11.5%	5.2%	13.7%	8.9%
	ESRA	19.8%	28.2%	28.2%	25.2%	25.9%	39.7%	57.4%	32.1%	22.3%
Qualification requirements	ER	19.2%	21.8%	21.0%	15.8%	28.1%	14.7%	19.8%	20.0%	13.4%
	CPDR	7.3%	7.9%	6.5%	7.1%	5.9%	4.7%	2.3%	6.0%	3.6%
Other entry requirements	QR	0.7%	0.1%	0.4%	0.2%	0.3%	0.0%	2.6%	0.6%	10.7%
	CRPB	3.7%	2.8%	3.0%	2.9%	1.6%	2.3%	0.8%	2.4%	4.5%
	OR	6.3%	5.0%	4.7%	15.4%	5.6%	2.7%	0.8%	5.8%	6.3%
Exercise requirements	RCF	12.2%	9.0%	8.7%	9.6%	6.5%	16.3%	0.4%	9.0%	13.4%
	RPII	4.1%	7.5%	7.4%	3.8%	3.8%	4.9%	10.7%	6.0%	6.3%
	TR	0.4%	1.8%	1.8%	2.8%	1.9%	2.8%	0.0%	1.6%	7.1%
	AR	14.2%	0.1%	0.7%	2.6%	2.1%	0.2%	0.0%	2.8%	3.6%

AR, advertising restrictions; CPDR, continuous professional development requirements; CRPB, compulsory registration in professional bodies; ER, education requirements; ESRA, exclusive or shared reserved activities; OR, other requirements; QR, quantitative restrictions; RCF, restrictions on corporate forms; RPII, requirements for professional indemnity insurance; TP, title protection; TR, tariff restrictions. The dark green cells mean that the indicator has a high impact on the index's score (more than 9 % of the Restrictiveness Index), the light green cells mean a moderate impact (between 9 % and 5 % of the Restrictiveness Index) and the white cells mean a low impact (less than 5 % of the Restrictiveness Index). Reading key: Table 4 shows the percentage that each restriction represents in the total score of the Restrictiveness Index. For instance, the restriction 'title protection' represents 12.3 % of the score of the RI for the profession of accountant. On average, for all professions, this restriction contributes 13.7 % to the score of the RI.

Source: European Commission, Joint Research Centre, 2018.

### 2.2.3. Analysis of the impact on the country ordering when one component of the RI is omitted at a time

#### *Impact when one indicator is omitted*

The study of the impact of the components (underlying indicator or category) on the Restrictiveness Index is enriched by providing alternative simulated rankings based on the omission of one component at a time. One would normally expect to observe some variability in rankings in those cases. If not, the omitted component makes no difference, adding no significant valuable information to the RI. Table 5 outlines the average shifts in the RI country rankings when one indicator is omitted at a time. Over all the seven professions, 'exclusive or shared reserved activities' and 'title protection' are confirmed to have on average the greatest impacts on RI country ranking. In fact, the omission of 'exclusive or shared reserved activities' or 'title protection' would produce an average shift of, respectively, 2.96 or 1.39 positions in the RI country rankings. Immediately after them follow 'restrictions on corporate forms' and 'requirements for professional indemnity insurance'. The strongest impact is made by 'exclusive or shared reserved activities' for the professions of architect and lawyer. On the other hand, 'quantitative restrictions' and 'advertising restrictions' are the underlying indicators that contribute least information.

**Table 5.** Average shift in the RI country rankings when one indicator is omitted at a time

Indicator deleted	Accountant	Architect	Engineer	Lawyer	Patent agent	Real estate agent	Tourist guide	Average	Nominal weights (%)
TP	1.53	2.86	2.96	0.07	1.36	0.79	0.18	1.39	8.9
ESRA	1.82	4.86	3.11	6.18	2.32	0.86	1.54	2.96	22.3
ER	0.67	1.29	1.18	1.54	0.54	0.29	0.46	0.85	13.4
CPDR	0.79	1.21	0.68	1.04	0.14	0.07	0.11	0.58	4.5
QR	0.36	0.21	0.32	0.5	0.07	0	0.29	0.25	10.7
CRPB	0.39	0.68	1.36	0.5	0.5	0.14	0.21	0.54	3.6
OR	0.21	1.25	1.36	1.29	0.43	0.21	0.71	0.78	6.3
RCF	0.46	2.04	2.18	2	0.39	0.14	0.04	1.04	6.3
RPII	0.89	2.61	1.39	1.04	0.71	0.75	0.14	1.08	13.4
TR	0.11	0.86	1.25	1.89	0.29	0.36	0.04	0.69	7.1
AR	0.9	0.21	0.61	0.93	0.11	0.07	0.04	0.41	3.6

AR, advertising restrictions; CPDR, continuous professional development requirements; CRPB, compulsory registration in professional bodies; ER, education requirements; ESRA, exclusive or shared reserved activities; OR, other requirements; QR, quantitative restrictions; RCF, restrictions on corporate forms; RPII, requirements for professional indemnity insurance; TP, title protection; TR, tariff restrictions. The dark green cells mean that deleting the indicator has a high impact on the ranking (average shift in country's ranking greater than 2), the light green cells mean a moderate impact (average shift in country's ranking between 1 and 2) and the white cells mean a low impact (average shift in country's ranking less than 1). Reading key: Table 5 shows the impact on the Restrictiveness Index rankings when one restriction is omitted. For instance, if the restriction 'title protection' is omitted from the analysis, the new ranking of countries differs on average by 1.53 positions from the original ranking for the profession of accountant. If all professions are taken into account, the impact of not considering the restriction 'title protection' is 1.39 positions.

Source: European Commission, Joint Research Centre, 2018.

## **Impact when one category is omitted**

Table 6 outlines the average shifts in the Restrictiveness Index country rankings when one category is omitted at a time. Regulatory approach and exercise requirements are the categories with the highest impacts on the RI country rankings on average. The omission of the former produces an average shift of 3.17 positions in country ranking; the omission of the latter produces an average shift of 2 positions across the seven professions. The strongest contribution is made by regulatory approach for the professions of lawyer and architect. This reflects the contribution of 'exclusive or shared reserved activities', which belongs to this category.

**Table 6.** Average shift in the Restrictiveness Index country rankings when one category is omitted at a time

Category deleted	Accountant	Architect	Engineer	Lawyer	Patent Agent	Real estate agent	Tourist guide	Average
Regulatory approach	1.82	5.04	3.54	6.18	2.46	1.11	2.07	3.17
Qualification requirements	1.14	1.64	1.14	1.32	0.75	0.21	0.54	0.96
Other entry requirements	0.25	1.43	2.00	1.64	0.71	0.14	0.79	0.99
Exercise requirements	1.89	2.61	3.00	3.79	1.61	0.96	0.18	2.01

The dark green cells mean that deleting the category has a high impact on the ranking (average shift in country's ranking greater than 2), the light green cells mean a moderate impact (average shift in country's ranking between 1 and 2) and the white cells mean a low impact (average shift in country's ranking less than 1). Reading key: Table 6 shows the impact on the Restrictiveness Index rankings when one category is omitted. For example, if the category 'regulatory approach', including the restrictions 'title protection' and 'exclusive or shared reserved activities', is omitted from the analysis, the new ranking of countries differs on average by 1.82 positions from the original ranking for the profession of accountant. If all professions are taken into account, the impact of not considering this category is 3.17 positions, on average.

Source: European Commission, Joint Research Centre, 2018.

Table 7 shows the countries most affected if one indicator is omitted at a time. First, it confirms that 'exclusive or shared reserved activities' and 'title protection' make the strongest contribution to the Restrictiveness Index; in fact, their absence affects the EU-28 ranking for all the seven professions, with, respectively, 79 and 34 shifts in country rankings. Second, the professions of architect and lawyer have around 20 country shifts because of the omission of 'exclusive or shared reserved activities', after which come those of patent agent and accountant, with around 10 shifts. The profession of architect has precisely 20 country shifts; Bulgaria moves from 19th place to 9th, and Malta from 15th place to 5th. The profession of lawyer has precisely 18 country shifts, with Bulgaria and Ireland shifting, respectively, from 19th place to 3rd and from 10th to 25th. Third, 'restrictions on corporate forms' and 'requirements for professional indemnity insurance' have a remarkable impact on the rankings of three professions: architect, civil engineer and lawyer. On the other hand, 'quantitative restrictions' and 'advertising restrictions' cause very few country shifts; likewise for the professions of patent agent, real estate agent and tourist guide.

Table 8 closes this section on the statistical coherence of the Restrictiveness Index. It summarises how the 11 types of restrictions (indicators) meet the criteria of statistical coherence. These criteria unveil how much impact the 11 types of restrictions have on the Restrictiveness Index, its score and the country ordering. The higher the number of criteria met, the higher the statistical coherence of the indicator(s) over all the seven professions, and vice versa. 'Exclusive or shared reserved activities', 'educational requirements' and 'title protection' have the highest numbers of matched criteria (20, 17 and 16 ticks, respectively). Thus, these types of restrictions seem to represent the strongest influence on the Restrictiveness Index across all professions. In contrast, 'quantitative restrictions', 'advertising restrictions' and 'tariff restrictions' show the smallest numbers of ticks (two, four and five, respectively).

In addition, 'continuous professional development requirements' for the profession of patent agent does not meet any of the analysed criteria; neither does 'compulsory registration in professional bodies' for the profession of lawyer.

**Table 7.**The countries most affected when one indicator is omitted at a time

PROFESSION	INDICATORS										
	TP	ESRA	ER	CPD	CRPB	QR	OR	RCF	RPII	TR	AR
ACCOUNTANT	HR (-7) SK (-7) CZ (-4) UK (3)	LU (7) HR (5) IE (-4) IT (-4) PT (4) NL (4) AT (3) DE (3) MT (-3) UK (3)	-	BE (3) EL (-3) IE (3)	-	-	-	-	LT (3) LU (-4)	-	SI (4)
ARCHITECT	PL (-11) IT (-10) SK (-8) HU (8) SP (4) BE (3) CZ (3) DE (3) IE (3) SI (3)	AT (+6) BE (-5) BG (-10) CY (-5) PL (4) CZ (-4) DE (-5) EL (-3) ES (7) RO (8) UK (-9) SK (6) FR (-9) LT (3) HR (8) LU (3) IE (6) MT (-10) IT (7) PT (8) SI (6)	CZ (3) DE (-3) ES (-3) PT (3)	RO (4) BG (-3) CY (-3) MT (-3)	IE (-5) LV (-4)	-	IE (-4) IT (-4) ES (4) BE (3)	BE (8) AT (7) CY (6) IE (-6) MT (6) LV (-4) PL (3) BG (-3)	CY (9) MT (-9) EL (-5) ES (-5) HU (-5) BE (3) CZ (3) DE (3) PT (3) RO (3)	DE (9)	-
CIVIL ENGINEER	PL (-11) IT (-10) SK (-8) HU (8) SP (4) BE (3) CZ (3) DE (3) IE (3) SI (3)	UK (9) BG (-8) PT (7) MT (-7) IE (-7) AT (6) IT (6) RO (5) PL (4)	EL (4) IT (-4) HR (-3) RO (-3)	AT (3)	PT (-6) DE (-5) RO (-4)	DE (3)	IT (-4) CY (3) LT (3) LV (3) PL (-3)	EL (10) MT (8) AT (7) CY (7) PT (-7) HR (-4) BG (-3) IT (-3)	MT (-5) HU (-4) LV (3) ES (-3) FI (-3) SK (-3)	DE (7) LU (6)	DE (3)
LAWYER	-	BG (-16) IE (15), EL (14) FI (13), LT (12) EE (-12), DK (-11) CY (7) ES (7) FR (6) IT (6) LU (6), LV (6) MT (-7) NL (-5) SE (-5) PT (4), RO (4)	RO (-6) IT (-4) DK (3) EL (3) ES (3)	MT (6) RO (4)	MT (-6)	UK (7)	UK (6) CY (-4) DK (3) ES (-3) SK (3)	EL (7) ES (-6) FR (-6) UK (-6) IE (5) RO (4) AT (-3)	LV (-9) EL (-6)	PL (8) BG (5) EL (5) DE (4) IE (-3) LU (-3)	AT (-4) MT (3)
PATENT AGENT	CZ (-4) BE (-3) EE (3) FI (3) LT (-3) SE (3) UK (-3)	CZ (7) EE (6) HU (6) SK (6) PL (-5) ES (-4) FR (-4) IE (-4) NL (-4) PT (3) BG (3) DE (-3)	-	-	-	-	-	-	NL (-4) RO (-4) CZ (3) ES (3)	-	-
REAL ESTATE AGENT	DE (3) LU (3) SE (-3)	AT (5) FI (-4)	-	-	-	-	-	-	-	-	-
TOURIST GUIDE	-	HR (-6) EL (5) FR (-5) PT (5) RO (5) SK (5) CY (-4)	-	-	-	-	-	-	-	-	-
ALL PROFESSIONS	34	79	13	10	6	2	14	23	24	9	3
NOMINAL WEIGHT (%)	8.9	22.3	13.4	3.6	10.7	4.5	6.3	13.4	6.3	7.1	3.6

AR, advertising restrictions; CPDR, continuous professional development requirements; CRPB, compulsory registration in professional bodies; ER, education requirements; ESRA, exclusive or shared reserved activities; OR, other requirements; QR, quantitative restrictions; RCF, restrictions on corporate forms; RPII, requirements for professional indemnity insurance; TP, title protection; TR, tariff restrictions. Reading key: Table 7 shows the countries most affected if one indicator at a time is omitted (three or more positions shift). For instance, ESRA makes one of the largest contributions to the RI. Its absence affects the EU-28 ranking for all the seven professions, with 79 shifts in country rankings. Its omission affects strongly the professions of architect and lawyer, accounting for around 20 shifts.

Source: European Commission, Joint Research Centre, 2018.

**Table 8.**Summary of the Restrictiveness Index statistical coherence

	3.1 Impact on the RI (correlation analysis)											3.2 Impact on the RI's scores											3.3 Impact on the country ordering of the RI											
	TP	ESRA	ER	CPDR	QR	CRPB	OR	RCF	RPII	TR	AR	TP	ESRA	ER	CPDR	QR	CRPB	OR	RCF	RPII	TR	AR	TP	ESRA	ER	CPDR	QR	CRPB	OR	RCF	RPII	TR	AR	
Accountant	√	√	√	√		√	√	√	√			√	√	√	√			√	√			√	√	√										
Architect	√	√	√			√		√	√			√	√	√	√			√		√			√	√	√	√			√	√	√			
Civil engineer	√	√	√			√		√		√	√	√	√	√	√					√			√	√	√	√		√	√	√	√	√	√	
Lawyer		√	√							√	√	√	√	√	√			√						√	√	√			√	√	√	√	√	
Patent agent		√	√			√	√	√	√			√	√	√			√	√					√	√										
Real estate agent	√	√	√	√	√	√	√	√	√	√	√	√	√	√					√															
Tourist guide	√	√	√	√	√	√	√					√	√	√						√				√										
Number of √	5	7	7	3	2	6	4	5	4	3	3	7	7	7	4	0	1	4	2	3	0	1	4	6	3	3	0	1	3	3	3	2	0	

AR, advertising restrictions; CPDR, continuous professional development requirements; CRPB, compulsory registration in professional bodies; ER, education requirements; ESRA, exclusive or shared reserved activities; OR, other requirements; QR, quantitative restrictions; RCF, restrictions on corporate forms; RPII, requirements for professional indemnity insurance; TP, title protection; TR, tariff restrictions. Reading key: Table 8 shows how much impact the 11 restrictions have on the Restrictiveness Index, its score and the country ordering. The higher the number of criteria met, the higher the statistical coherence of the indicator(s) for all the seven professions, and vice versa. For instance, ESRA meets the criteria for all the seven professions (seven ticks in each of two columns and six in a third) and for the three types of impact (three ticks in a row).

Source: European Commission, Joint Research Centre, 2018.

### **3. Impact of modelling assumptions on the RI results**

The score and ranking of each country on the overall Restrictiveness Index depend on two basic modelling assumptions: the given nominal weights of the indicators, and the arithmetic formula to aggregate these indicators. A good modelling practice requires assessing the robustness of the RI to changes in these basic assumptions.

As suggested in the relevant literature on composite indicators (Saisana et al., 2005; Saisana et al., 2011), the robustness assessment of the Restrictiveness Index was based on a combination of a Monte Carlo experiment and a multi-modelling approach that dealt with two issues: category weights and the aggregation formula. The robustness assessment conducted in this report is based on the analysis of the sensitivity and uncertainty associated with the RI. The sensitivity analysis involves investigating the robustness of the two basic modelling assumptions that are used to build up the RI. The first aspect to check is if the scores and rankings for each country and profession are robust to changes in the weights assigned to each one of the individual indicators. The second is if the scores and rankings are consistent to changes in the formula used to aggregate the individual indicators (arithmetic versus geometric method of aggregation).

Complementary to the sensitivity analysis, the robustness of the Restrictiveness Index is also explored through a study of the uncertainty caused at the same time by the randomness of the given weights and of the different formulas of aggregation. The uncertainty analysis responds to some extent to potential criticism that the country scores associated with aggregate measures are generally not calculated under conditions of certainty, although they are frequently presented as such (Saisana et al., 2017).

#### **3.1. Sensitivity of the RI to perturbations in the weights**

As commonly recommended in the literature, the Monte Carlo simulation is a useful and powerful tool for investigating the robustness assessment of the weights to perturbations. In order to do so, a Monte Carlo experiment has been implemented in which 10 000 sets of weights for the categories were randomly sampled from a uniform continuous distribution over the interval centred in the given nominal weights. The range of the weights' variation was chosen to ensure a wide enough interval to have meaningful robustness checks<sup>(5)</sup>. In all simulations, sampled weights are rescaled so that they always add up to 1. Table 9 shows the nominal values of the weights, as well as the range of the uniform distribution from which the simulated weights are randomly chosen.

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<sup>(5)</sup> The choice of the range for the weights' variation is based on the JRC COIN team's expertise built upon previous audit reports. Specifically, the range for each nominal weight represents  $\pm 40\%$  around the nominal weight. The impact of choosing different percentages of range variation does not significantly affect the results of the simulation. See Annex II for a detailed explanation of how different ranges have an impact on the outcome of the simulation.

**Table 9.**Sensitivity of the RI to perturbations of the weights: nominal values of the weights and range of the associated uniform distribution

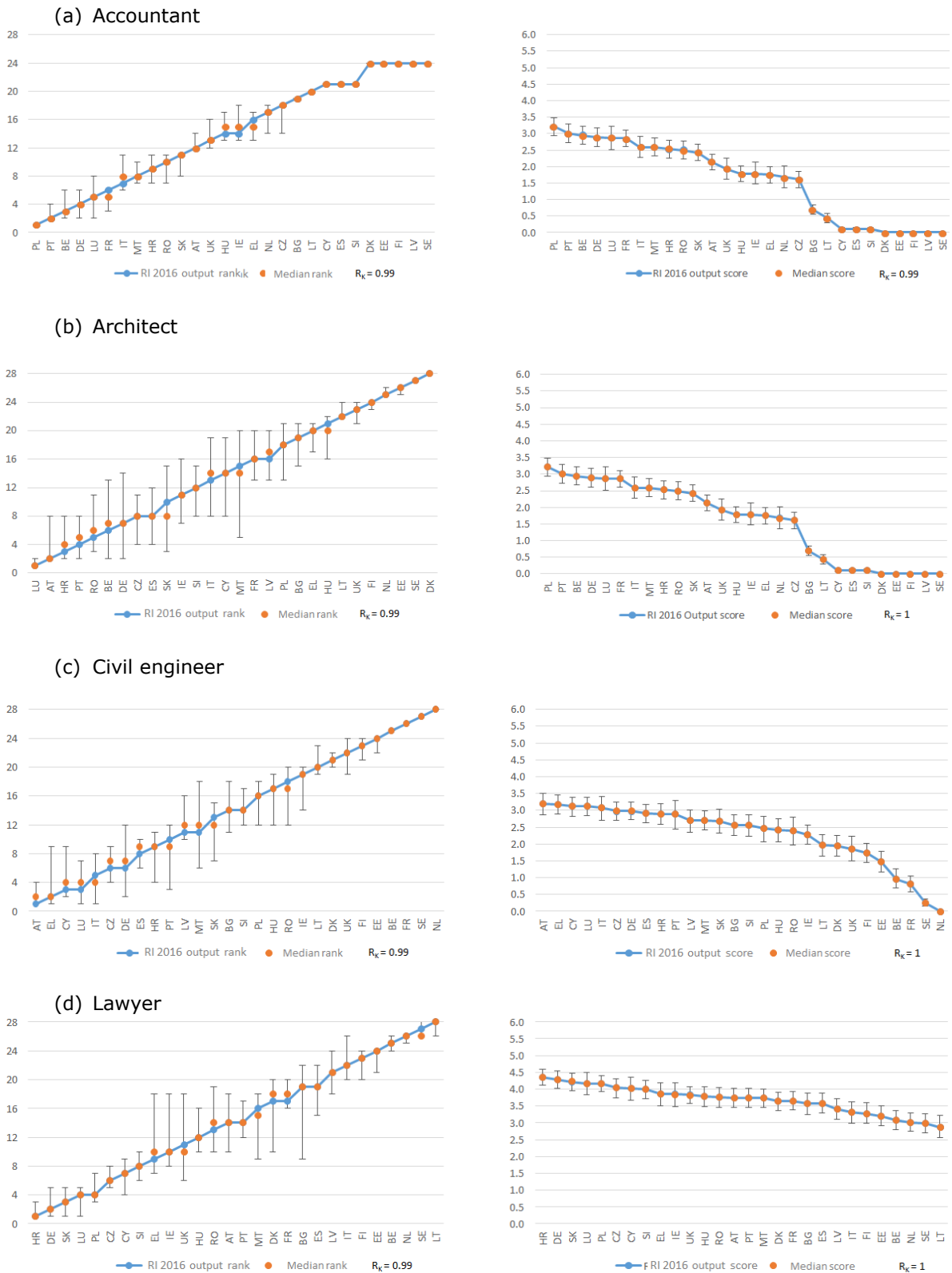
<b>Sensitivity to perturbations of the weights</b>			
<b>Category</b>	<b>Indicators</b>	<b>Reference value for the weight</b>	<b>Distribution assigned for sensitivity analysis (<math>\pm 40\%</math> of the nominal weight)</b>
<b>Regulatory approach</b>	<b>Title protection</b>	0.3125	U[0.1875, 0.4375]
	<b>Exclusive or shared reserved activities</b>		
<b>Qualification requirements</b>	<b>Education requirements</b>	0.1696	U[0.1018, 0.2374]
	<b>CPD requirements</b>		
<b>Other entry requirements</b>	<b>Compulsory registration in professional bodies</b>	0.2143	U[0.1286, 0.3000]
	<b>Quantitative restrictions</b>		
	<b>Other requirements</b>		
<b>Exercise requirements</b>	<b>Restrictions on corporate forms</b>	0.3036	U[0.1822, 0.4250]
	<b>Requirements for professional indemnity insurance</b>		
	<b>Tariff restrictions</b>		
	<b>Advertising restrictions</b>		

Source: European Commission, Joint Research Centre, 2018.

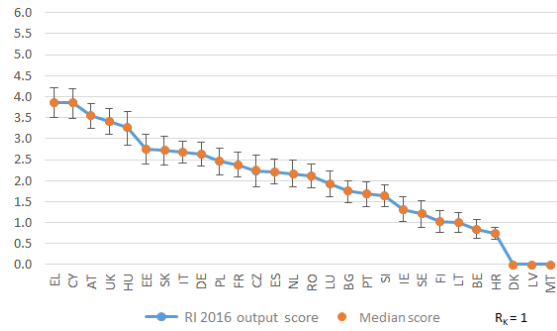
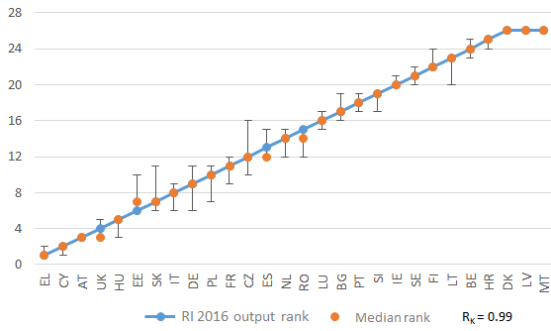
The main results of the sensitivity of the RI to perturbations in the weights for each profession are shown in Figure 4. This figure provides information about the country rankings and scores for each one of the professions under scrutiny, as well as the median and 95 % confidence intervals computed across 10 000 Monte Carlo simulations. Countries are ordered from best to worst according to their score and ranking (blue line), the orange dot being the median. The analysis reveals that the RI's rankings and scores are relatively robust to changes in the weights. This result is derived from three facts. First, the country rankings and scores are close to the median and lie within the simulated intervals in all professions. Second, the ranking intervals are narrow for most countries across the seven professions (fewer than 10 positions for 95 % of the cases). Therefore, there is no great variability in the simulated scores and rankings. Finally, the Kendall's correlation coefficients reflect a strong association between the rankings or scores and their corresponding medians (in all cases the correlation coefficient is greater than 0.98).



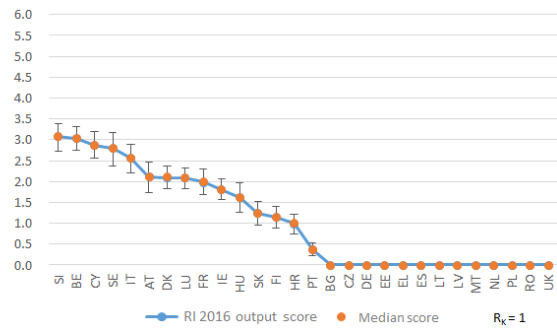
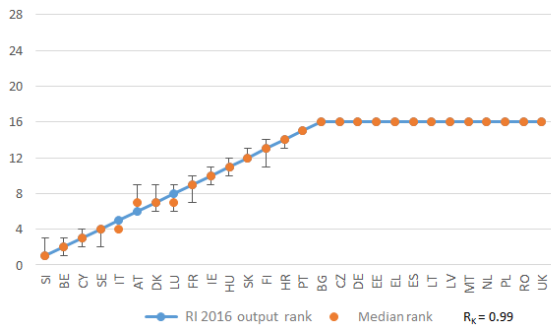
**Figure 4.** The assessment of the robustness of the RI to perturbations of the weights: comparison between the RI and the median of the simulated indicators based on a Monte Carlo experiment (left, rankings; right, scores)



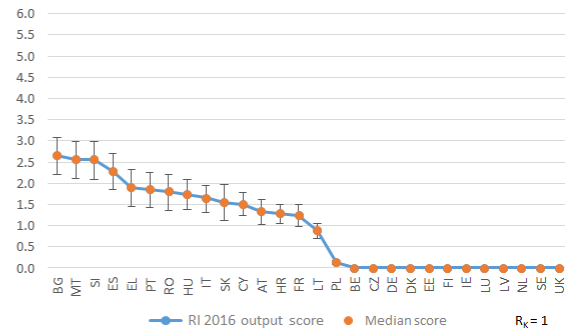
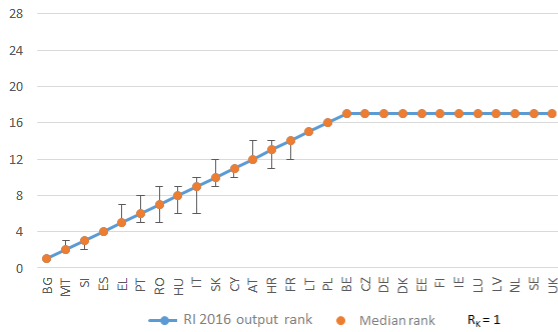
(e) Patent agent



(f) Real estate agent



(g) Tourist guide



$R_k$ , Kendall's correlation coefficient between the Restrictiveness Index scores or rankings and the corresponding median based on 10 000 Monte Carlo simulations for the category weights and for each profession. The choice of the range for the weights' variation was set as  $\pm 40\%$  of the nominal value.

Source: European Commission, Joint Research Centre, 2018.

In addition, the divergences between the Restrictiveness Index's rankings and scores and those simulated by the Monte Carlo experiment are rather small. Table 10 summarises these divergences. The average score divergences are between 3.35 %, registered for the profession of lawyer, and 6.22 %, for the profession of engineer. Regarding the RI's rankings, on average, the divergence is around one position. The maximum ranking divergence is observed for the profession of architect, with an average divergence of 1.36 positions, and the minimum is for the profession of real estate agent, with an average divergence of 0.27 positions.

**Table 10.** The assessment of the robustness of the RI to perturbations of the weights: comparison between the RI and the simulated indicators based on a Monte Carlo experiment

	Accountant	Architect	Engineer	Lawyer	Patent agent	Real estate agent	Tourist guide
<b>Divergence in scores (%)</b>	6.37	5.76	6.22	3.35	5.81	4.12	5.55
<b>Average shift in ranking</b>	0.59	1.36	1.17	1.19	0.56	0.27	0.23

Source: European Commission, Joint Research Centre, 2018.

All in all, the Monte Carlo experiment carried out in this section shows that the Restrictiveness Index's rankings and scores are relatively robust to changes in the weights given that there no significant differences between the scores and rankings of the RI and those simulated by the Monte Carlo experiment.

### 3.2. Sensitivity of the RI to the formula used to aggregate the indicators

This section describes the methods used to aggregate the different types of restrictions that are part of the RI. The original construction of the RI is based on the linear weighted sum of the 11 indicators. Additive aggregation is by far the most common and simplest method of aggregation. However, the problem with this method is that poor performance in some individual indicators can be compensated for by good performance in others. For example, Table 11 reports the scores for Hungary and Ireland for the profession of accountant. Both countries score the same under an additive method of aggregation (1.79) and, therefore, they have the same position in the ranking (position 14). However, the two countries represent different intensities of regulation, which is probably not reflected in the RI. Ireland shows lower levels of regulation in three out of the four categories and, consequently, the profession of accountant could be assumed to be less regulated in that country. The geometric aggregation method could be a good candidate to solve this problem, since this method is less compensatory than the arithmetic ones <sup>(6)</sup>. In our simple example, the geometric aggregation makes Ireland score less than Hungary, moving it up one position in the corresponding ranking of regulatory intensity. Therefore, according to the geometric formula of aggregation, RI reveals that the profession of accountant appears to be less regulated in Ireland than in Hungary.

<sup>(6)</sup> In the case of geometric aggregation, categories are multiplied to obtain the score of the index. The category weights appear as exponents in the multiplication.

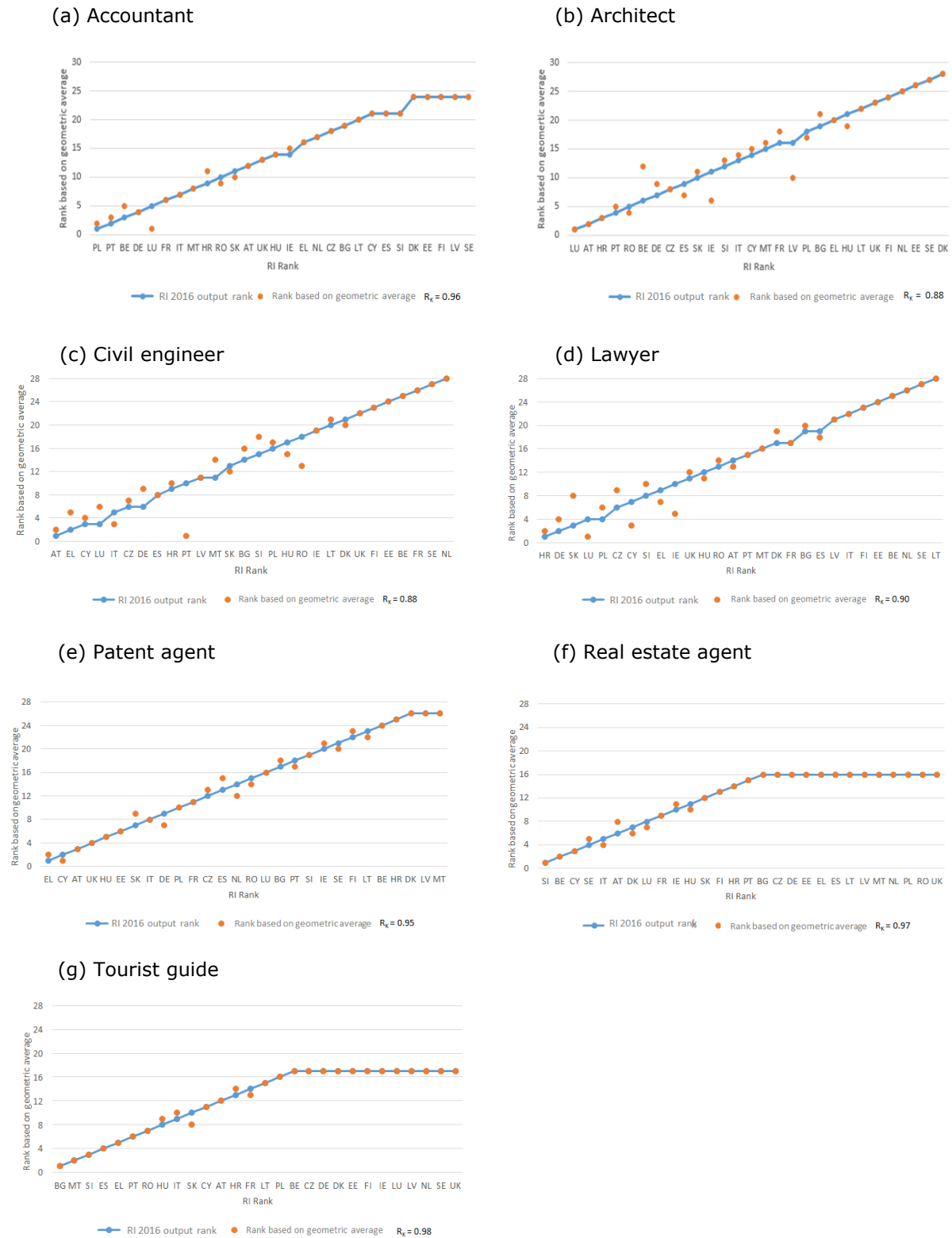
**Table 11.** An example of differences between the arithmetic and geometric methods of aggregation for the profession of accountant

Country	METHOD OF AGGREGATION				CATEGORIES			
	Arithmetic		Geometric		Regulatory approach	Qualification requirements	Other entry requirements	Exercise requirements
	Score	Ranking	Score	Ranking				
HU	1.79	14	1.93	14	0.66	0.65	0.37	0.11
IE	1.79	14	1.87	15	0.54	0.60	0.27	0.38

Source: European Commission, Joint Research Centre, 2018.

Figure 5 compares the country rankings of the RI by profession based on two methods of aggregation: the arithmetic formula and the geometric formula. In most cases, the arithmetic and the geometric formula of aggregation display the same ranking (52 % of the cases), or show less than two positions of divergence (92 % of the cases). The biggest difference accounts for only nine positions, in Portugal for the profession of civil engineer. The figure also reveals that there is a strong relationship between the arithmetic and geometric rankings as shown by the Kendall's coefficients (greater than 0.85 for all professions).

**Figure 5.** Sensitivity analysis: impact of the geometric formula on the Restrictiveness Index's ranking



Source: European Commission, Joint Research Centre, 2018.

Table 12 shows the average difference in the ranking between the arithmetic and the geometric method of aggregation. The results corroborate what was mentioned above: there are no significant ranking differences between the two methods of aggregation. The highest difference is observed for the profession of engineer, but the ranking difference is only 1.54 positions on average. For the professions of accountant, patent agent, real estate agent and tourist guide, the difference is almost negligible (less than one position of difference).

**Table 12.**Sensitivity analysis: arithmetic versus geometric formula of aggregation

	<b>Accountant</b>	<b>Architect</b>	<b>Engineer</b>	<b>Lawyer</b>	<b>Patent agent</b>	<b>Real estate agent</b>	<b>Tourist guide</b>	<b>Average</b>
<b>Average difference in ranking</b>	0.46	1.25	1.54	1.32	0.64	0.29	0.21	1.23

*Source:* European Commission, Joint Research Centre, 2018.

In summary, the sensitivity analysis indicates that the formula of aggregation is not an influential methodological assumption that affects the country rankings across professions. The arithmetic procedure of aggregation seems to be adequate, and it does not statistically differ from those results that would have been obtained if the geometric method of aggregation had been employed. Additional reasons support the decision to maintain the arithmetic formula. First, as previously mentioned, the arithmetic formula is the most common way of aggregating individual indicators. Second, it is easier to implement and to understand than the geometric formula.

### 3.3. Uncertainty analyses for the RI: weights and aggregation methods

The uncertainty analysis is based on a combination of a Monte Carlo experiment and a multi-modelling approach that considers at the same time the two underlying methodological assumptions taken into account in the construction of the RI: the dimension weights and the aggregation formula of the category scores. These assumptions are the main source of uncertainty in the RI. In total, two models were tested based on the combination of the arithmetic and the geometric average, combined with 10 000 Monte Carlo simulations per model (random weights versus fixed weights), for a total of 20 000 simulations for the RI. Table 13 summarises the sources of uncertainty considered in this analysis.

**Table 13.** Uncertainty analysis for the Restrictiveness Index: weights and aggregation methods

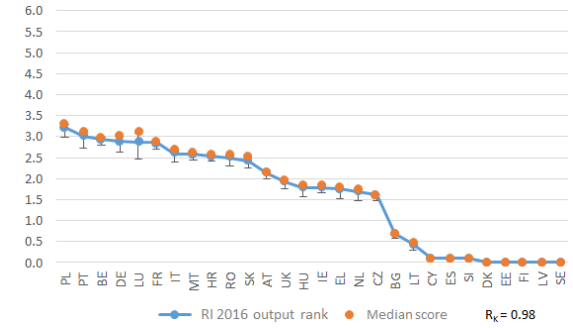
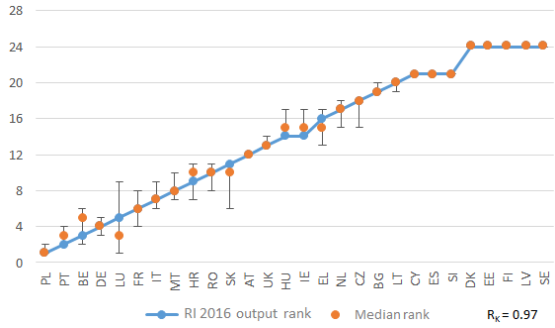
<b>I. Uncertainty in the aggregation formula at category level</b>		
Reference: arithmetic average	Alternative: geometric average	
<b>II. Uncertainty to perturbations of the weights at category level</b>		
<b>Category</b>	<b>Reference value for the weight</b>	<b>Distribution assigned for robustness analysis (<math>\pm 40\%</math> of the nominal)</b>
Regulatory approach	0.3125	U[0.1875, 0.4375]
Qualification requirements	0.1696	U[0.1018, 0.2374]
Other entry requirements	0.2143	U[0.1286, 0.3000]
Exercise requirements	0.3036	U[0.1822, 0.4250]

Source: European Commission, Joint Research Centre, 2018.

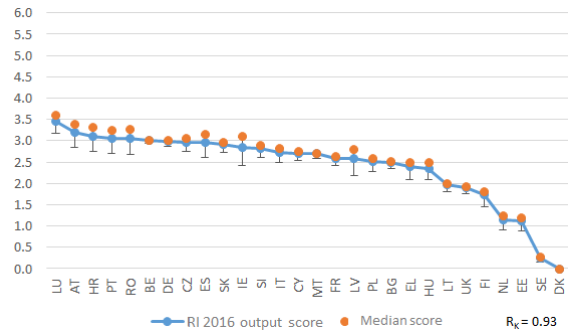
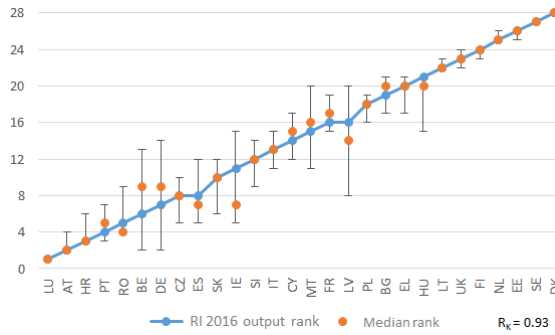
The main results of the uncertainty analysis are shown in Figure 6, with median rankings and scores and 95 % confidence intervals computed across 20 000 Monte Carlo simulations for the RI. The Restrictiveness Index's scores and rankings are placed within the simulated confidence intervals, and there is a strong statistical association between the scores and rankings and the simulated medians for all professions (Kendall's correlation coefficient greater than 0.9).

**Figure 6.** Robustness analysis RI ranking (scores) versus median ranking (scores) and 95 (confidence intervals)

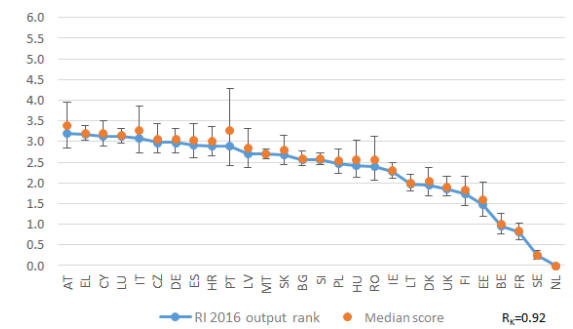
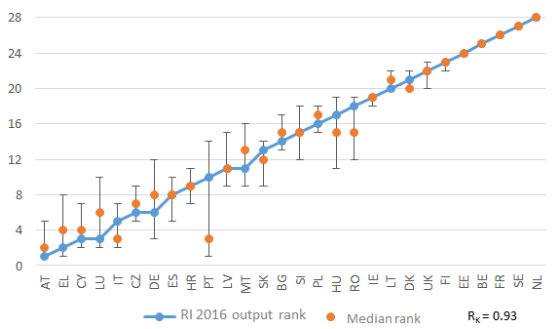
(a) Accountant



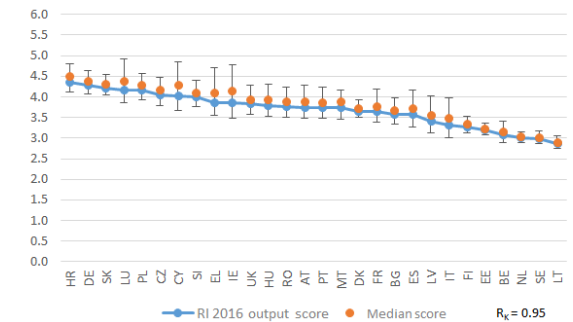
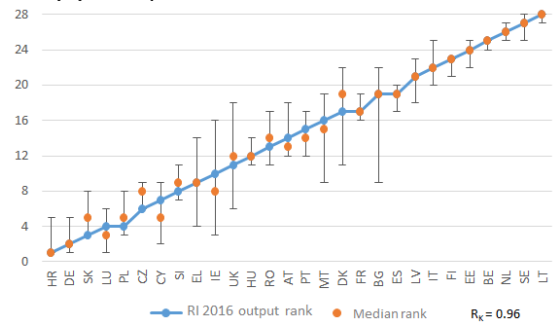
(b) Architect



(c) Civil engineer

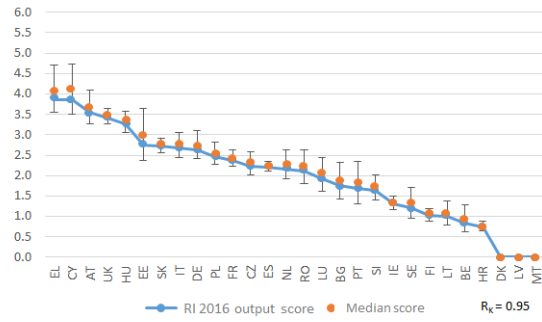
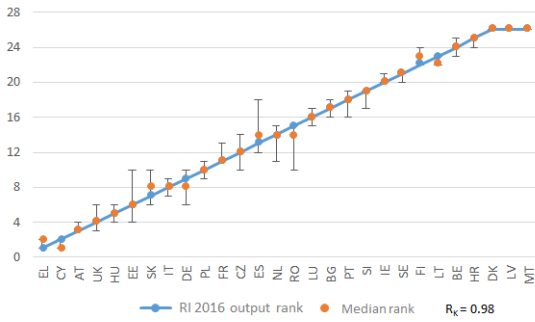


(d) Lawyer

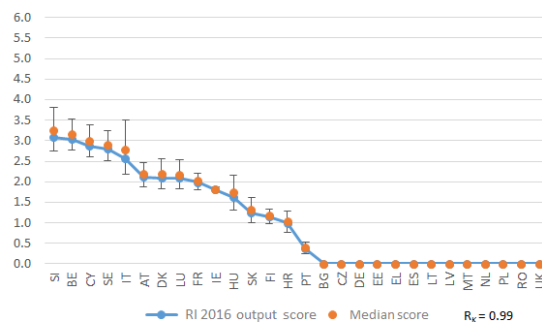
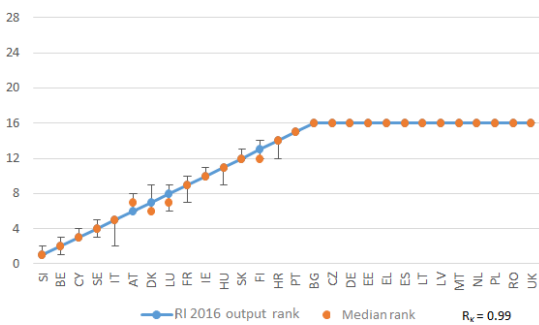




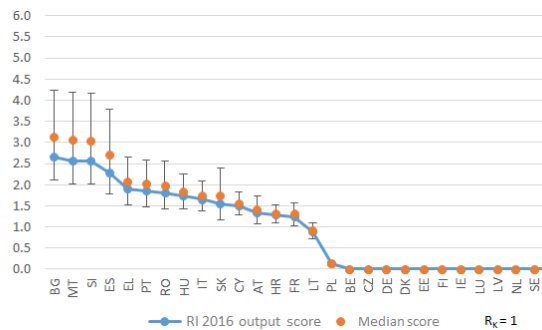
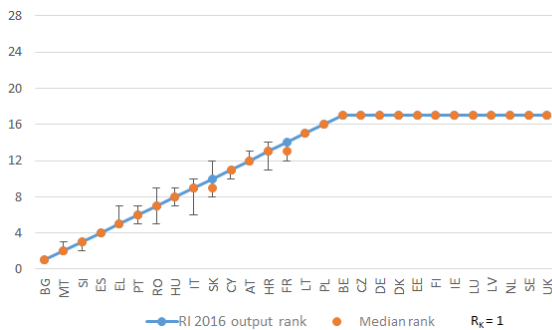
(e) Patent agent



(f) Real estate agent



(g) Tourist guide



$R_k$ , Kendall's correlation coefficient between the median ranking and scores and the RI ranking and scores. Median and intervals for each profession are calculated over 20 000 simulated scenarios, combining random weights and geometric versus arithmetic average at the category level.

Source: European Commission, Joint Research Centre, 2018.

Table 14 reports the published rankings and the 95 % confidence intervals that account for uncertainties in the category weights and the aggregation formula. All published country rankings lie within the simulated intervals, and these are narrow enough for most countries across all professions (less than or equal to five positions for 86 % of all cases) to allow meaningful inferences to be drawn. The RI's rankings are shown to be both representative of a plurality of scenarios and robust to changes in the category weights and the aggregation formula. If one considers the median ranking across the simulated scenarios as representative of these scenarios, then the fact that the RI ranking is close to the median ranking (differing by two positions or less) for 98 % of the countries across all professions suggests that the RI is a suitable summary measure. Furthermore, the narrow confidence intervals for the majority of the countries' rankings for the seven professions imply that the RI's rankings are also robust to changes in the category weights and the aggregation formula at the same time.

**Table 14.** Robustness analysis: country rankings and simulated 95 confidence intervals for the Restrictiveness Index

	ACCOUNTANT				ARCHITECT				CIVIL ENGINEER				LAWYER			
	RI rank	Country	Median	Confidence interval	RI rank	Country	Median	Confidence interval	RI rank	Country	Median	Confidence interval	RI rank	Country	Median	Confidence interval
1	PL	1	[1, 2]	1	LU	1	[1, 1]	1	AT	1	[1, 5]	1	HR	1	[1, 5]	
2	PT	3	[2, 4]	2	AT	2	[2, 4]	2	EL	2	[1, 8]	2	DE	2	[1, 5]	
3	BE	5	[2, 6]	3	HR	3	[3, 7]	3	CY	5	[2, 7]	3	SK	5	[3, 8]	
4	DE	4	[3, 5]	4	PT	4	[3, 9]	3	LU	3	[2, 10]	4	LU	3	[1, 6]	
5	LU	2	[1, 9]	5	RO	4	[4, 10]	5	IT	5	[2, 7]	4	PL	5	[3, 8]	
6	FR	6	[4, 8]	6	BE	9	[2, 14]	6	CZ	8	[5, 9]	6	CZ	8	[6, 9]	
7	IT	7	[6, 9]	7	DE	9	[2, 14]	6	DE	5	[3, 12]	7	CY	5	[2, 9]	
8	MT	8	[7, 10]	8	CZ	8	[5, 10]	8	ES	9	[5, 10]	8	SI	9	[7, 11]	
9	HR	10	[7, 11]	9	ES	7	[4, 13]	9	HR	9	[7, 11]	9	EL	9	[4, 14]	
10	RO	10	[8, 11]	10	SK	10	[6, 11]	10	PT	8	[1, 14]	10	IE	8	[3, 16]	
11	SK	10	[6, 11]	11	IE	7	[4, 16]	11	LV	12	[9, 15]	11	UK	12	[6, 18]	
12	AT	12	[12, 12]	12	SI	12	[10, 14]	11	MT	12	[9, 16]	12	HU	12	[11, 14]	
13	UK	13	[13, 14]	13	IT	13	[11, 15]	13	SK	14	[9, 14]	13	RO	14	[11, 17]	
14	HU	15	[14, 17]	14	CY	15	[12, 18]	14	BG	13	[13, 17]	14	AT	13	[12, 18]	
14	IE	15	[14, 17]	15	MT	16	[11, 20]	15	SI	14	[12, 18]	15	PT	14	[12, 17]	
16	EL	15	[13, 17]	16	FR	17	[15, 19]	16	PL	15	[15, 18]	16	MT	15	[9, 19]	
17	NL	17	[15, 18]	16	LV	14	[8, 21]	17	HU	19	[11, 19]	17	DK	19	[11, 22]	
18	CZ	18	[15, 18]	18	PL	18	[16, 19]	18	RO	17	[12, 19]	17	FR	17	[16, 19]	
19	BG	19	[19, 19]	19	BG	20	[17, 21]	19	IE	19	[18, 19]	19	BG	19	[9, 22]	
20	LT	20	[20, 20]	20	EL	20	[16, 21]	20	LT	19	[20, 22]	19	ES	19	[17, 20]	
21	CY	21	[21, 21]	21	HU	20	[15, 21]	21	DK	21	[20, 22]	21	LV	21	[18, 23]	
21	ES	21	[21, 21]	22	LT	22	[22, 23]	22	UK	22	[20, 23]	22	IT	22	[20, 25]	
21	SI	21	[21, 21]	23	UK	23	[22, 24]	23	FI	23	[22, 23]	23	FI	23	[21, 23]	
24	DK	24	[24, 24]	24	FI	24	[23, 24]	24	EE	24	[24, 24]	24	EE	24	[22, 25]	
24	EE	24	[24, 24]	25	NL	25	[25, 26]	25	BE	25	[25, 25]	25	BE	25	[24, 25]	
24	FI	24	[24, 24]	26	EE	26	[25, 26]	26	FR	26	[26, 26]	26	NL	26	[25, 27]	
24	LV	24	[24, 24]	27	SE	27	[27, 27]	27	SE	27	[27, 27]	27	SE	27	[25, 28]	
24	SE	24	[24, 24]	28	DK	28	[28, 28]	28	NL	28	[28, 28]	28	LT	28	[27, 28]	

Most

Restrictive countries

Least

Most Restrictive countries Least

PATENT AGENT				REAL ESTATE AGENT				TOURIST GUIDE			
RI rank	Country	Median	Confidence interval	RI rank	Country	Median	Confidence Interval	RI rank	Country	Median	Confidence Interval
1	EL	2	[1, 2]	1	SI	1	[1, 2]	1	BG	1	[1, 1]
2	CY	1	[1, 2]	2	BE	2	[1, 3]	2	MT	2	[2, 3]
3	AT	3	[3, 4]	3	CY	3	[3, 4]	3	SI	3	[2, 3]
4	UK	4	[3, 6]	4	SE	4	[3, 5]	4	ES	4	[4, 4]
5	HU	5	[4, 6]	5	IT	5	[2, 5]	5	EL	5	[5, 7]
6	EE	6	[4, 10]	6	AT	7	[6, 8]	6	PT	6	[5, 7]
7	SK	8	[6, 10]	7	DK	6	[6, 9]	7	RO	7	[5, 9]
8	IT	8	[7, 9]	8	LU	7	[6, 9]	8	HU	8	[7, 9]
9	DE	8	[6, 10]	9	FR	9	[7, 10]	9	IT	9	[6, 10]
10	PL	10	[9, 11]	10	IE	10	[10, 11]	10	SK	9	[8, 12]
11	FR	11	[11, 13]	11	HU	11	[9, 11]	11	CY	11	[10, 11]
12	CZ	12	[10, 14]	12	SK	12	[12, 13]	12	AT	12	[12, 13]
13	ES	14	[12, 18]	13	FI	12	[12, 14]	13	HR	13	[11, 14]
14	NL	14	[11, 15]	14	HR	14	[12, 14]	14	FR	13	[12, 14]
15	RO	14	[10, 15]	15	PT	15	[15, 15]	15	LT	15	[15, 15]
16	LU	16	[15, 17]	16	BG	16	[16, 16]	16	PL	16	[16, 16]
17	BG	17	[16, 18]	16	CZ	16	[16, 16]	17	BE	17	[17, 17]
18	PT	18	[16, 19]	16	DE	16	[16, 16]	17	CZ	17	[17, 17]
19	SI	19	[17, 19]	16	EE	16	[16, 16]	17	DE	17	[17, 17]
20	IE	20	[20, 21]	16	EL	16	[16, 16]	17	DK	17	[17, 17]
21	SE	21	[20, 21]	16	ES	16	[16, 16]	17	EE	17	[17, 17]
22	FI	23	[22, 24]	16	LT	16	[16, 16]	17	FI	17	[17, 17]
23	LT	22	[22, 23]	16	LV	16	[16, 16]	17	IE	17	[17, 17]
24	BE	24	[23, 25]	16	MT	16	[16, 16]	17	LU	17	[17, 17]
25	HR	25	[24, 25]	16	NL	16	[16, 16]	17	LV	17	[17, 17]
26	DK	26	[26, 26]	16	PL	16	[16, 16]	17	NL	17	[17, 17]
26	LV	26	[26, 26]	16	RO	16	[16, 16]	17	SE	17	[17, 17]
26	MT	26	[26, 26]	16	UK	16	[16, 16]	17	UK	17	[17, 17]

**NB:** The median rankings and 95 % confidence intervals are computed across the 20 000 Monte Carlo simulations for the Restrictiveness Index. The Monte Carlo simulation assumes a uniform distribution  $\pm 40\%$  of the nominal weight.

Source: European Commission, Joint Research Centre, 2018.

## 4. Conclusions

The JRC analysis suggests that the Restrictiveness Index is robust, with a statistically coherent and balanced two-level structure (i.e. not dominated by any category or indicator; all indicators contribute to the construction of the index to a certain extent). On the whole, the analysis of the correlations at different levels reveals that the statistical structure of the Restrictiveness Index is aligned with its conceptual framework, given that most of the indicators correlate strongly with their respective categories. Furthermore, all categories correlate strongly and fairly evenly with the Restrictiveness Index itself, which indicates that the framework is well balanced.

The key points can be summarised as follows. First, the version of the Restrictiveness Index model presented by the developers is coherent, well balanced and robust, displaying strong associations between the underlying indicators and the RI categories. Hence, it offers a sound basis for policy interpretations. Second, the findings show a certain degree of heterogeneity in the indicators across countries and professions. Nevertheless, some patterns in the data are detected. The survey design influences the data structure. The hybrid features of the data, a mix between categorical and continuous variables, are yielded because of the coding process selected through the survey design. Probably, a more balanced coding system could help to gather more suitable variables/indicators: an even number of sub-questions and homogeneous criteria to assign the scores. Third, some restrictions have a greater impact than others on the Restrictiveness Index. In order of importance, they are 'exclusive or shared reserved activities', 'educational requirements' and 'title protection'. On the other hand, 'advertising restrictions', 'quantitative restrictions' and 'tariff restrictions' — in descending order — seem to have a minor influence on the indicator framework. Fourth, with regard to the professions, different degrees of alignment are identified between the theoretical and statistical frameworks, with the greatest alignment for the profession of real estate agent and the least alignment for the profession of lawyer. This finding also displays some statistical incoherence. Fifth, the categories 'regulatory approach' and 'exercise requirements' make the greatest contributions to the Restrictiveness Index, as suggested by the weights as well. Sixth, the results also confirm the robustness of the proposed weights and the suitability of the arithmetic average as a formula for aggregating the individual indicators. The Restrictiveness Index's country rankings and scores are relatively robust to methodological assumptions. The Monte Carlo simulation allows it to be verified that the RI is sensitive neither to perturbations in the nominal weights nor to modifications in the aggregation formula. These facts imply that, for most of the countries included in the Restrictiveness Index, the overall scores and rankings are the result of the underlying data and not because of the modelling choices. These and other minor issues, outlined in this report, are suggested for further examination in the next version(s) of the Restrictiveness Index.

Given that lower levels of regulatory restrictions may lead to better economic performances, the Restrictiveness Index may be a suitable tool to capture how the levels of restrictiveness of regulation in countries develop over time. The audit has shown the potential of the Restrictiveness Index, subject to some minor hints for future releases, in reliably identifying weaknesses and best practices. The Restrictiveness Index can be used to monitor national performances in assessing how restrictive regulations of the seven professions under scrutiny are across the 28 Member States of the European Union.

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## 5. Annexes

### 5.1. Annex I: Correlation analysis

#### (a) Accountant

			INDICATORS											CATEGORIES				INDEX
			DRA		DQR		DOR			DER				DRA	DQR	DOR	DER	
			TP	ESRA	ER	CPD	CRPB	QR	AuR	RCF	RPII	TR	AR					
INDICATORS	DRA	TP	1.00	0.34	0.50	0.60	0.72	0.22	0.21	0.52	0.44	0.04	-0.12	0.67	0.61	0.60	0.49	0.64
		ESRA	0.34	1.00	0.56	0.09	0.42	0.11	0.51	0.50	0.41	0.14	-0.04	0.76	0.34	0.46	0.47	0.60
	DQR	ER	0.50	0.56	1.00	0.47	0.56	0.21	0.61	0.55	0.47	-0.03	-0.06	0.60	0.74	0.68	0.50	0.65
		CPD	0.60	0.09	0.47	1.00	0.61	0.41	0.23	0.42	0.45	-0.16	0.01	0.30	0.77	0.50	0.43	0.46
	DOR	CRPB	0.72	0.42	0.56	0.61	1.00	0.31	0.25	0.56	0.44	0.19	-0.11	0.60	0.63	0.79	0.52	0.61
		QR	0.22	0.11	0.21	0.41	0.31	1.00	-0.18	0.06	0.11	-0.08	-0.02	0.15	0.33	0.26	0.05	0.21
		AuR	0.21	0.51	0.61	0.23	0.25	-0.18	1.00	0.41	0.36	-0.17	-0.01	0.44	0.45	0.52	0.39	0.43
	DER	RCF	0.52	0.50	0.55	0.42	0.56	0.06	0.41	1.00	0.79	-0.18	-0.19	0.58	0.53	0.58	0.85	0.72
		RPII	0.44	0.41	0.47	0.45	0.44	0.11	0.36	0.79	1.00	-0.18	-0.21	0.50	0.47	0.44	0.83	0.64
		TR	0.04	0.14	-0.03	-0.16	0.19	-0.08	-0.17	-0.18	-0.18	1.00	-0.12	0.12	-0.05	-0.02	-0.05	-0.03
		AR	-0.12	-0.04	-0.06	0.01	-0.11	-0.02	-0.01	-0.19	-0.21	-0.12	1.00	-0.07	0.00	-0.12	-0.04	-0.03
	CATEGORIES	DRA	0.67	0.76	0.60	0.30	0.60	0.15	0.44	0.58	0.50	0.12	-0.07	1.00	0.50	0.59	0.56	0.78
DQR		0.61	0.34	0.74	0.77	0.63	0.33	0.45	0.53	0.47	-0.05	0.00	0.50	1.00	0.65	0.50	0.63	
DOR		0.60	0.46	0.68	0.50	0.79	0.26	0.52	0.58	0.44	-0.02	-0.12	0.59	0.65	1.00	0.49	0.64	
DER		0.49	0.47	0.50	0.43	0.52	0.05	0.39	0.85	0.83	-0.05	-0.04	0.56	0.50	0.49	1.00	0.72	
INDEX		0.64	0.60	0.65	0.46	0.61	0.21	0.43	0.72	0.64	-0.03	-0.03	0.78	0.63	0.64	0.72	1.00	

Correlation analysis based on the Kendall's tau correlation coefficients. The cells in green indicate correlations that are statistically significant at the 10 % level.

Source: European Commission, Joint Research Centre, 2018.

**(b) Architect**

			INDICATORS											CATEGORIES				INDEX
			DRA		DQR		DOR			DER				DRA	DQR	DOR	DER	
			TP	ESRA	ER	CPD	CRPB	QR	AuR	RCF	RPII	TR	AR					
INDICATORS	DRA	TP	1.00	-0.06	0.24	-0.14	0.38	0.12	-0.08	0.26	0.16	0.18	0.12	0.44	0.03	0.24	0.28	0.40
		ESRA	-0.06	1.00	0.21	0.38	0.25	-0.16	-0.03	0.18	0.32	-0.11	-0.16	0.69	0.35	0.12	0.14	0.50
	DQR	ER	0.24	0.21	1.00	0.18	0.37	-0.19	-0.01	0.14	0.37	0.12	-0.19	0.31	0.59	0.22	0.25	0.29
		CPD	-0.14	0.38	0.18	1.00	0.08	0.13	-0.32	0.05	0.27	-0.14	0.13	0.21	0.72	-0.12	0.08	0.21
	DOR	CRPB	0.38	0.25	0.37	0.08	1.00	0.11	0.18	0.55	0.25	0.31	0.11	0.36	0.22	0.67	0.51	0.47
		QR	0.12	-0.16	-0.19	0.13	0.11	1.00	-0.20	0.12	0.15	0.41	1.00	-0.08	-0.09	-0.03	0.28	0.15
		AuR	-0.08	-0.03	-0.01	-0.32	0.18	-0.20	1.00	0.21	-0.12	0.13	-0.20	-0.08	-0.21	0.68	0.12	0.01
	DER	RCF	0.26	0.18	0.14	0.05	0.55	0.12	0.21	1.00	0.16	0.09	0.12	0.29	0.08	0.49	0.70	0.50
		RPII	0.16	0.32	0.37	0.27	0.25	0.15	-0.12	0.16	1.00	-0.04	0.15	0.30	0.37	0.02	0.47	0.41
		TR	0.18	-0.11	0.12	-0.14	0.31	0.41	0.13	0.09	-0.04	1.00	0.41	-0.01	-0.05	0.28	0.31	0.07
		AR	0.12	-0.16	-0.19	0.13	0.11	1.00	-0.20	0.12	0.15	0.41	1.00	-0.08	-0.09	-0.03	0.28	0.15
	CATEGORIES	DRA	0.44	0.69	0.31	0.21	0.36	-0.08	-0.08	0.29	0.30	-0.01	-0.08	1.00	0.30	0.19	0.22	0.68
DQR		0.03	0.35	0.59	0.72	0.22	-0.09	-0.21	0.08	0.37	-0.05	-0.09	0.30	1.00	0.04	0.14	0.28	
DOR		0.24	0.12	0.22	-0.12	0.67	-0.03	0.68	0.49	0.02	0.28	-0.03	0.19	0.04	1.00	0.39	0.29	
DER		0.28	0.14	0.25	0.08	0.51	0.28	0.12	0.70	0.47	0.31	0.28	0.22	0.14	0.39	1.00	0.53	
INDEX			0.40	0.50	0.29	0.21	0.47	0.15	0.01	0.50	0.41	0.07	0.15	0.68	0.28	0.29	0.53	1.00

Correlation analysis based on the Kendall's tau correlation coefficients. The cells in green indicate correlations that are statistically significant at the 10 % level. The cell in red means an association that is statistically significant at the 10 % level, but negatively correlated.

Source: European Commission, Joint Research Centre, 2018.



**(c) Civil engineer**

		INDICATORS											CATEGORIES				INDEX	
		DRA		DQR		DOR			DER				DRA	DQR	DOR	DER		
		TP	ESRA	ER	CPD	CRPB	QR	AuR	RCF	RPII	TR	AR						
INDICATORS	DRA	TP	1.00	-0.19	0.11	-0.01	0.20	0.23	-0.26	0.23	0.13	0.07	0.27	0.32	0.09	0.03	0.33	0.37
		ESRA	-0.19	1.00	0.15	0.29	0.16	-0.12	0.26	0.27	0.27	-0.10	0.02	0.67	0.24	0.20	0.17	0.39
	DQR	ER	0.11	0.15	1.00	-0.07	0.43	-0.05	0.31	0.38	-0.01	0.40	0.04	0.17	0.55	0.46	0.29	0.37
		CPD	-0.01	0.29	-0.07	1.00	0.20	0.23	-0.18	-0.06	0.23	-0.16	-0.04	0.17	0.50	0.09	-0.04	0.13
	DOR	CRPB	0.20	0.16	0.43	0.20	1.00	0.04	0.11	0.53	0.03	0.25	0.12	0.23	0.40	0.74	0.38	0.43
		QR	0.23	-0.12	-0.05	0.23	0.04	1.00	-0.08	0.05	0.19	0.12	0.17	0.05	0.01	0.15	0.08	0.10
		AuR	-0.26	0.26	0.31	-0.18	0.11	-0.08	1.00	0.21	-0.07	0.18	-0.11	0.14	0.07	0.51	0.06	0.22
	DER	RCF	0.23	0.27	0.38	-0.06	0.53	0.05	0.21	1.00	-0.06	0.33	0.29	0.46	0.25	0.48	0.62	0.69
		RPII	0.13	0.27	-0.01	0.23	0.03	0.19	-0.07	-0.06	1.00	0.02	0.16	0.32	0.10	-0.02	0.40	0.17
		TR	0.07	-0.10	0.40	-0.16	0.25	0.12	0.18	0.33	0.02	1.00	0.28	0.00	0.21	0.28	0.50	0.27
		AR	0.27	0.02	0.04	-0.04	0.12	0.17	-0.11	0.29	0.16	0.28	1.00	0.25	-0.04	0.05	0.47	0.35
	CATEGORIES	DRA	0.32	0.67	0.17	0.17	0.23	0.05	0.14	0.46	0.32	0.00	0.25	1.00	0.20	0.20	0.41	0.67
DQR		0.09	0.24	0.55	0.50	0.40	0.01	0.07	0.25	0.10	0.21	-0.04	0.20	1.00	0.32	0.18	0.37	
DOR		0.03	0.20	0.46	0.09	0.74	0.15	0.51	0.48	-0.02	0.28	0.05	0.20	0.32	1.00	0.29	0.40	
DER		0.33	0.17	0.29	-0.04	0.38	0.08	0.06	0.62	0.40	0.50	0.47	0.41	0.18	0.29	1.00	0.62	
INDEX		0.37	0.39	0.37	0.13	0.43	0.10	0.22	0.69	0.17	0.27	0.35	0.67	0.37	0.40	0.62	1.00	

Correlation analysis based on the Kendall's tau correlation coefficients. The cells in green indicate correlations which are statistically significant at the 10 % level.

Source: European Commission, Joint Research Centre, 2018.

**(d) Lawyer**

		INDICATORS											CATEGORIES				INDEX	
		DRA		DQR		DOR			DER				DRA	DQR	DOR	DER		
		TP	ESRA	ER	CPD	CRPB	QR	AuR	RCF	RPII	TR	AR						
INDICATORS	DRA	TP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		ESRA	-	1.00	0.05	-0.26	-0.10	0.06	-0.08	0.08	-0.25	0.18	0.06	1.00	-0.17	-0.06	-0.01	0.62
	DQR	ER	-	0.05	1.00	-0.47	-0.05	-0.14	0.10	-0.01	0.11	0.36	-0.02	0.05	0.60	0.04	0.18	0.26
		CPD	-	-0.26	-0.47	1.00	0.04	0.01	-0.09	-0.15	0.18	-0.46	-0.22	-0.26	0.07	-0.03	-0.19	-0.30
	DOR	CRPB	-	-0.10	-0.05	0.04	1.00	0.05	0.23	-0.25	-0.08	0.01	-0.33	-0.10	-0.04	0.41	-0.22	-0.04
		QR	-	0.06	-0.14	0.01	0.05	1.00	0.30	-0.28	0.05	-0.17	0.05	0.06	-0.13	0.30	-0.25	0.07
		AuR	-	-0.08	0.10	-0.09	0.23	0.30	1.00	-0.02	-0.22	0.19	0.19	-0.08	0.01	0.94	0.08	0.21
	DER	RCF	-	0.08	-0.01	-0.15	-0.25	-0.28	-0.02	1.00	-0.20	0.00	0.31	0.08	-0.15	-0.06	0.37	0.10
		RPII	-	-0.25	0.11	0.18	-0.08	0.05	-0.22	-0.20	1.00	0.02	-0.07	-0.25	0.27	-0.21	0.31	0.01
		TR	-	0.18	0.36	-0.46	0.01	-0.17	0.19	0.00	0.02	1.00	0.15	0.18	0.06	0.15	0.49	0.45
		AR	-	0.06	-0.02	-0.22	-0.33	0.05	0.19	0.31	-0.07	0.15	1.00	0.06	-0.10	0.08	0.48	0.29
	CATEGORIES	DRA	-	1.00	0.05	-0.26	-0.10	0.06	-0.08	0.08	-0.25	0.18	0.06	1.00	-0.17	-0.06	-0.01	0.63
DQR		-	-0.17	0.60	0.07	-0.04	-0.13	0.01	-0.15	0.27	0.06	-0.10	-0.17	1.00	-0.01	0.05	0.06	
DOR		-	-0.06	0.04	-0.03	0.41	0.30	0.94	-0.06	-0.21	0.15	0.08	-0.06	-0.01	1.00	0.02	0.19	
DER		-	-0.01	0.18	-0.19	-0.22	-0.25	0.08	0.37	0.31	0.49	0.48	-0.01	0.05	0.02	1.00	0.33	
INDEX		-	0.62	0.26	-0.30	-0.04	0.07	0.21	0.10	0.01	0.45	0.29	0.63	0.06	0.19	0.33	1.00	

Correlation analysis based on the Kendall's tau correlation coefficients. The indicator TP is omitted from the analysis given that all values are zero. The cells in green indicate correlations which are statistically significant at the 10 % level. The cells in red mean associations that are statistically significant at the 10 % level, but negatively correlated.

Source: European Commission, Joint Research Centre, 2018.

**(e) Patent agent**

			INDICATORS											CATEGORIES				INDEX
			DRA		DQR		DOR			DER				DRA	DQR	DOR	DER	
			TP	ESRA	ER	CPD	CRPB	QR	AuR	RCF	RPII	TR	AR					
INDICATORS	DRA	TP	1.00	0.04	0.07	0.18	0.03	-0.24	0.04	0.17	-0.04	0.36	0.24	0.42	0.12	0.03	0.16	0.23
		ESRA	0.04	1.00	0.30	-0.17	0.54	0.18	0.27	0.57	0.45	0.08	-0.05	0.76	0.23	0.42	0.50	0.68
	DQR	ER	0.07	0.30	1.00	0.31	0.40	0.17	0.51	0.41	0.34	-0.01	0.19	0.22	0.86	0.53	0.37	0.43
		CPD	0.18	-0.17	0.31	1.00	0.21	0.29	0.36	0.21	0.28	-0.10	0.19	-0.08	0.52	0.29	0.19	0.18
	DOR	CRPB	0.03	0.54	0.40	0.21	1.00	0.21	0.50	0.63	0.54	0.06	0.41	0.45	0.38	0.81	0.63	0.66
		QR	-0.24	0.18	0.17	0.29	0.21	1.00	0.33	0.20	0.22	-0.09	-0.13	0.07	0.21	0.29	0.18	0.21
		AuR	0.04	0.27	0.51	0.36	0.50	0.33	1.00	0.55	0.49	-0.10	0.33	0.20	0.53	0.76	0.48	0.51
	DER	RCF	0.17	0.57	0.41	0.21	0.63	0.20	0.55	1.00	0.64	0.09	0.23	0.54	0.44	0.61	0.81	0.78
		RPII	-0.04	0.45	0.34	0.28	0.54	0.22	0.49	0.64	1.00	-0.23	0.02	0.37	0.40	0.54	0.66	0.63
		TR	0.36	0.08	-0.01	-0.10	0.06	-0.09	-0.10	0.09	-0.23	1.00	0.05	0.18	-0.04	-0.01	0.22	0.12
		AR	0.24	-0.05	0.19	0.19	0.41	-0.13	0.33	0.23	0.02	0.05	1.00	0.01	0.18	0.39	0.31	0.15
	CATEGORIES	DRA	0.42	0.76	0.22	-0.08	0.45	0.07	0.20	0.54	0.37	0.18	0.01	1.00	0.20	0.33	0.49	0.69
DQR		0.12	0.23	0.86	0.52	0.38	0.21	0.53	0.44	0.40	-0.04	0.18	0.20	1.00	0.50	0.38	0.44	
DOR		0.03	0.42	0.53	0.29	0.81	0.29	0.76	0.61	0.54	-0.01	0.39	0.33	0.50	1.00	0.62	0.62	
DER		0.16	0.50	0.37	0.19	0.63	0.18	0.48	0.81	0.66	0.22	0.31	0.49	0.38	0.62	1.00	0.73	
INDEX			0.23	0.68	0.43	0.18	0.66	0.21	0.51	0.78	0.63	0.12	0.15	0.69	0.44	0.62	0.73	1.00

Correlation analysis based on the Kendall's tau correlation coefficients. The cells in green indicate correlations that are statistically significant at the 10 % level.

Source: European Commission, Joint Research Centre, 2018.

**(f) Real estate agent**

		INDICATORS												CATEGORIES				INDEX
		DRA		DQR		DOR			DER				DRA	DQR	DOR	DER		
		TP	ESRA	ER	CPD	CRPB	QR	AuR	RCF	RPII	TR	AR						
INDICATORS	DRA	TP	1.00	0.37	0.61	0.15	0.54	-	0.48	0.67	0.43	0.23	0.33	0.63	0.54	0.57	0.48	0.60
		ESRA	0.37	1.00	0.72	0.48	0.62	-	0.45	0.56	0.55	0.51	0.27	0.83	0.72	0.67	0.66	0.78
	DQR	ER	0.61	0.72	1.00	0.41	0.75	-	0.46	0.60	0.55	0.25	0.22	0.81	0.90	0.74	0.53	0.79
		CPD	0.15	0.48	0.41	1.00	0.48	-	0.17	0.53	0.61	0.28	0.35	0.43	0.57	0.48	0.61	0.49
	DOR	CRPB	0.54	0.62	0.75	0.48	1.00	-	0.39	0.67	0.56	0.24	0.19	0.68	0.73	0.81	0.56	0.71
		QR	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		AuR	0.48	0.45	0.46	0.17	0.39	-	1.00	0.29	0.24	0.27	0.22	0.50	0.47	0.69	0.27	0.46
	DER	RCF	0.67	0.56	0.60	0.53	0.67	-	0.29	1.00	0.62	0.17	0.21	0.67	0.58	0.61	0.69	0.65
		RPII	0.43	0.55	0.55	0.61	0.56	-	0.24	0.62	1.00	0.31	0.26	0.58	0.60	0.54	0.84	0.69
		TR	0.23	0.51	0.25	0.28	0.24	-	0.27	0.17	0.31	1.00	0.42	0.44	0.28	0.25	0.54	0.43
		AR	0.33	0.27	0.22	0.35	0.19	-	0.22	0.21	0.26	0.42	1.00	0.30	0.24	0.18	0.34	0.30
	CATEGORIES	DRA	0.63	0.83	0.81	0.43	0.68	-	0.50	0.67	0.58	0.44	0.30	1.00	0.77	0.71	0.65	0.91
DQR		0.54	0.72	0.90	0.57	0.73	-	0.47	0.58	0.60	0.28	0.24	0.77	1.00	0.74	0.60	0.78	
DOR		0.57	0.67	0.74	0.48	0.81	-	0.69	0.61	0.54	0.25	0.18	0.71	0.74	1.00	0.53	0.70	
DER		0.48	0.66	0.53	0.61	0.56	-	0.27	0.69	0.84	0.54	0.34	0.65	0.60	0.53	1.00	0.74	
INDEX		0.60	0.78	0.79	0.49	0.71	-	0.46	0.65	0.69	0.43	0.30	0.91	0.78	0.70	0.74	1.00	

Correlation analysis based on the Kendall's tau correlation coefficients. The indicator QR is omitted from the analysis given that all values are zero. The cells in green indicate correlations that are statistically significant at the 10 % level.

Source: European Commission, Joint Research Centre, 2018.

**(g) Tourist guide**

		INDICATORS											CATEGORIES				INDEX	
		DRA		DQR		DOR			DER				DRA	DQR	DOR	DER		
		TP	ESRA	ER	CPD	CRPB	QR	AuR	RCF	RPII	TR	AR						
INDICATORS	DRA	TP	1.00	0.48	0.37	0.69	0.28	0.01	0.35	-0.11	-0.08	-	-	0.59	0.45	0.34	-0.14	0.56
		ESRA	0.48	1.00	0.64	0.35	0.36	0.37	0.42	0.06	0.24	-	-	0.95	0.67	0.57	0.20	0.90
	DQR	ER	0.37	0.64	1.00	0.27	0.38	0.21	0.40	0.18	0.21	-	-	0.65	0.94	0.42	0.28	0.64
		CPD	0.69	0.35	0.27	1.00	0.16	-0.12	0.30	-0.08	-0.05	-	-	0.41	0.42	0.18	-0.09	0.40
	DOR	CRPB	0.28	0.36	0.38	0.16	1.00	0.18	0.15	0.19	-0.10	-	-	0.41	0.37	0.52	0.09	0.42
		QR	0.01	0.37	0.21	-0.12	0.18	1.00	0.15	-0.12	-0.09	-	-	0.33	0.19	0.59	-0.15	0.34
		AuR	0.35	0.42	0.40	0.30	0.15	0.15	1.00	0.07	-0.13	-	-	0.43	0.42	0.67	-0.02	0.46
	DER	RCF	-0.11	0.06	0.18	-0.08	0.19	-0.12	0.07	1.00	-0.05	-	-	0.06	0.16	0.03	0.76	0.05
		RPII	-0.08	0.24	0.21	-0.05	-0.10	-0.09	-0.13	-0.05	1.00	-	-	0.18	0.19	-0.15	0.59	0.21
		TR	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		AR	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	CATEGORIES	DRA	0.59	0.95	0.65	0.41	0.41	0.33	0.43	0.06	0.18	-	-	1.00	0.69	0.57	0.17	0.95
DQR		0.45	0.67	0.94	0.42	0.37	0.19	0.42	0.16	0.19	-	-	0.69	1.00	0.43	0.26	0.69	
DOR		0.34	0.57	0.42	0.18	0.52	0.59	0.67	0.03	-0.15	-	-	0.57	0.43	1.00	-0.07	0.61	
DER		-0.14	0.20	0.28	-0.09	0.09	-0.15	-0.02	0.76	0.59	-	-	0.17	0.26	-0.07	1.00	0.18	
INDEX		0.56	0.90	0.64	0.40	0.42	0.34	0.46	0.05	0.21	-	-	0.95	0.69	0.61	0.18	1.00	

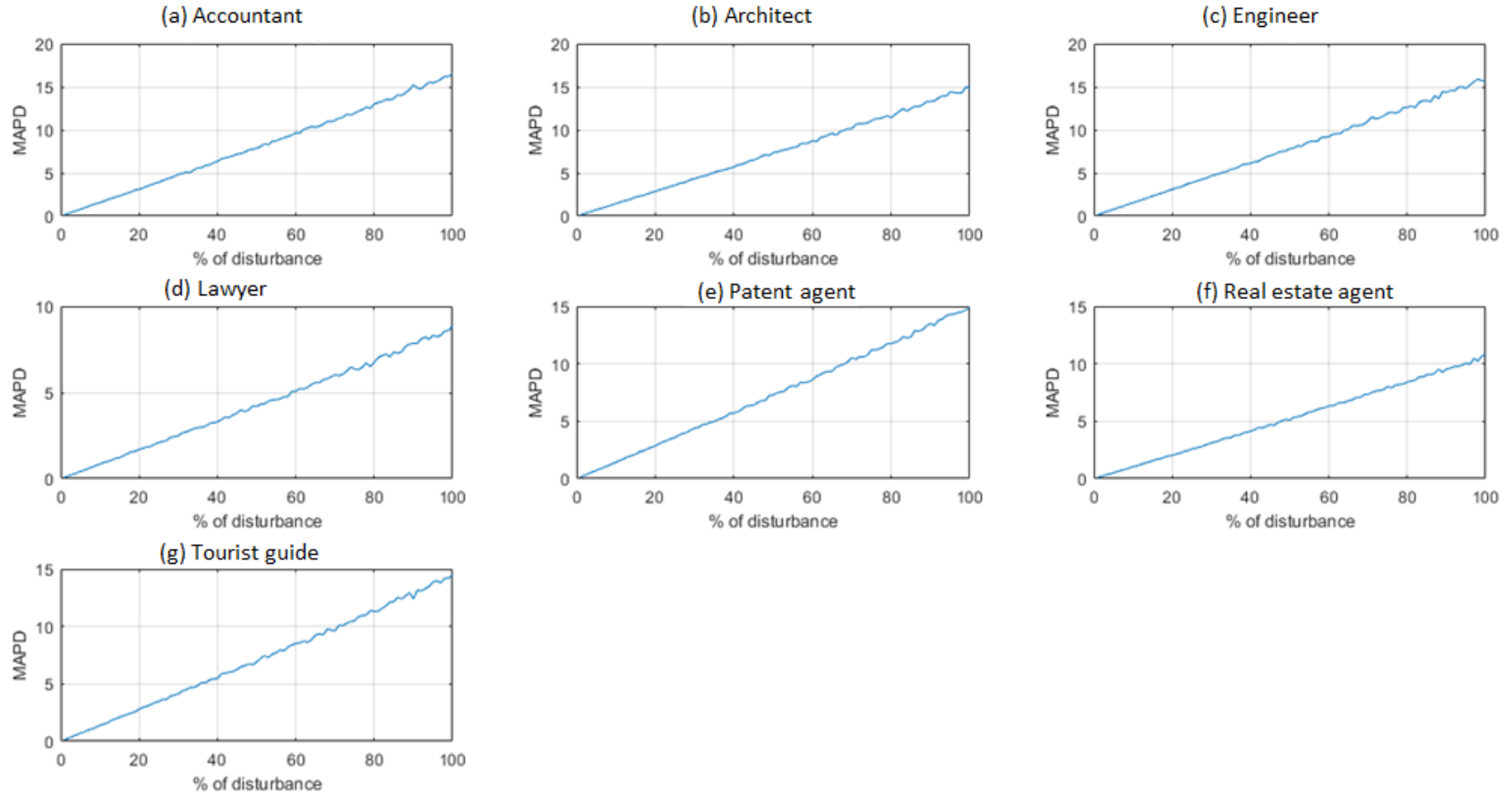
Correlation analysis based on the Kendall's tau correlation coefficients. The indicators TR and AR are omitted from the analysis given that all values are zero. The cells in green indicate correlations which are statistically significant at the 10 % level.

Source: European Commission, Joint Research Centre, 2018.

## 5.2. Annex II: Sensitivity of the simulated scores to different values of the disturbance parameter $d$

The Monte Carlo simulation was used to investigate the robustness assessment of the weights. In order to do so, it is proposed to implement an experiment in which 10 000 set of weights for the 11 indicators (and the 4 categories) were randomly sampled from a uniform continuous distribution over the interval  $[w_i^0 \cdot (1 - d), w_i^0 \cdot (1 + d)]$ , where  $w_i^0$  is the nominal weight and  $d$  is the parameter that determines the length of the interval. The value of  $d$  can be understood as the level at which the nominal weights are distorted. The parameter  $d$  can go from 0 (no distortion) to 1. In this experiment, it is assumed  $d = 0.4$ . The draws for the new weights come from a uniform distribution over the interval whose lower and upper bounds represent 60 % and 140 % of the nominal weight  $w_i^0$ , respectively. The choice of the range for the weights' variation was based on the JRC COIN team's previous experience. However, one could consider that the low variability in the scores of the index, or in the ranking, could be because of the low value chosen for  $d$ . In order to carry out a sound experiment, we must also verify the responsiveness of the scores and rankings when different values for the parameter  $d$  are assumed. Figure A.1 and Figure A.2 present for all professions the sensitivity of the score and of the ranking, respectively, to marginal changes in the parameter  $d$  ( $d$  goes from 0 to 1). As expected, the deviation statistics increase as the value of the parameter  $d$  increases. However, in the scenario in which the variability is maximum, when  $d$  takes the value 1, the percentages of divergence in the scores and in the average shift country rankings are relatively low. Specifically, for the score, the greatest deviation is observed for the profession of accountant (the divergence is slightly above 16 %) and the least deviation is for the profession of lawyer (approximately 9 %). Regarding the sensitivity of the ranking, the average shift shows that the professions of architect, engineer and lawyer show the highest deviations (three positions on average). In summary, it seems that the choice of the parameter  $d$  in the Monte Carlo experiment does not have a significant impact on the results.

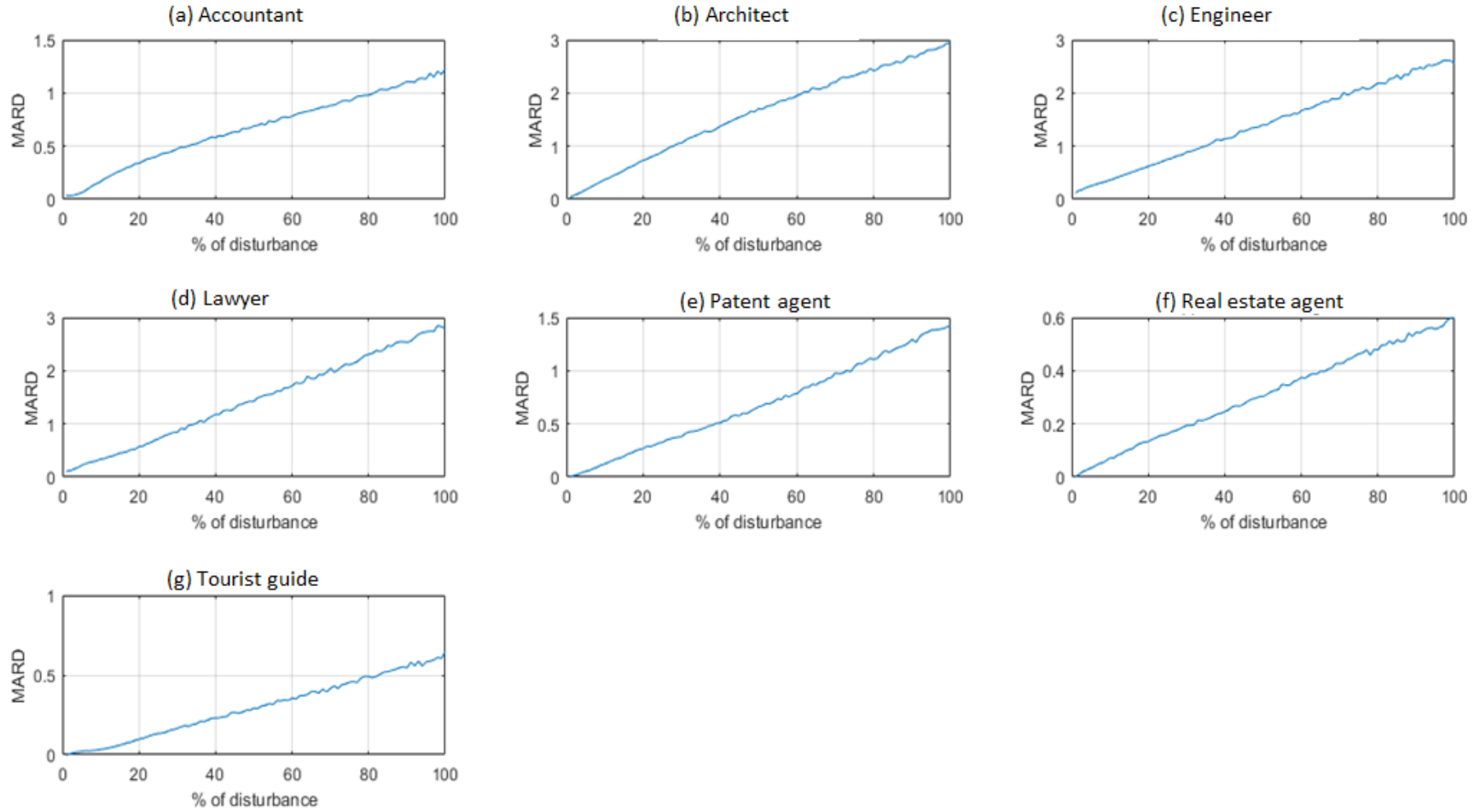
**Figure A.1.** Sensitivity of the mean absolute percentage deviation to changes in the parameter  $d$



MAPD, mean absolute percentage deviation, a measure of the existing deviation between the Restrictiveness Index's score and the scores obtained by the different simulations.

Source: European Commission, Joint Research Centre, 2018.

**Figure A.2.** Sensitivity of the mean absolute ranking deviation to changes in the parameter  $d$



MARD, mean absolute ranking deviation, a measure of the existing deviation between the Restrictiveness Index's ranking and the rankings obtained by the different simulations.

Source: European Commission, Joint Research Centre, 2018.



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Publications Office

doi:10.2760/209047

ISBN 978-92-79-96746-7