

**T.C.
ISTANBUL AYDIN UNIVERSITY
INSTITUTE OF GRADUATE STUDIES**



**ASSESSMENT OF INTERNATIONAL DIGITAL
ECONOMY AND SOCIETY INDEX
AND FORECASTING OF TURKEY'S DIGITAL ECONOMY**

MASTER'S THESIS

Mohamed Noufal ZERHOUNI

**Department of Business
Business Administration Program**

JUNE, 2022

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JUNE, 2022

ONAY FORMU

DECLARATION

It has been written to fulfill the graduation requirements of the Master in Business I hereby declare with the respect that the study “Assessment Of International Digital Economy And Society Index And Forecasting Of Türkiye’s Digital Economy”, which I submitted as a Master thesis, is written without any assistance in violation of scientific ethics and traditions in all the processes from the project phase to the conclusion of the thesis and that the works I have benefited are from those shown in the Bibliography. (28/05/2022)

Mohamed Noufal ZERHOUNI

FOREWORD

It has been written to fulfill the graduation requirements of the Master in Business Administration at Istanbul Aydın University. I would like to thank Dr. Tayfun Tuncay TOSUN for his guidance and support throughout this process and to Dr. Çiğdem ÖZARI for the advice on the thesis proposal and the mathematical models to use. Thanks also to the members of the committee who attended my master's thesis defense. I appreciated the chance to discuss issues with my friends and family. It kept me motivated whenever I lost interest. I particularly admire the wisdom and kindness of my parents: they have always given me invaluable advice and support.

June, 2022

Mohamed Noufal ZERHOUNI

ASSESSMENT OF INTERNATIONAL DIGITAL ECONOMY AND SOCIETY INDEX AND FORECASTING OF TURKEY'S DIGITAL ECONOMY

ABSTRACT

This study assesses the International Digital Economy and Society Index (I-DESI), which measures the progress of the digital economy, clusters countries, and forecasts their scores. First of all, because the initial criteria weights are chosen subjectively according to EU policy orientation, they were compared to new ones, generated using entropy method characterized by its objectivity. Then, the ranking model of the I-DESI is assessed by using the Entropy-based, the TOPSIS-based, and the Entropy-based TOPSIS models. Ranks agreement among the four models is tested using Kendall W. Afterword, in order to check the similarities of the EU countries, hierarchical and K-mean clustering methods are performed. At the end, forecasting of the I-DESI, by using Gompertz II model, is performed in order to compare Turkey's forecasts by dimension to the forecasts of the I-DESI-45 countries average. The findings demonstrate that the Entropy method gives the highest weights to "Connectivity" and "Integration of Digital Technology and Business" dimensions, whereas the I-DESI scoring model gives it to "Connectivity" and "Human Capital". The Entropy method, on average, gives nearly double the weight to the "Use of Internet Services by Citizens" than to the "Digital Public Services", whereas the I-DESI scoring model gives both the same weight. Also, a very strong correlation exists between the I-DESI model and the TOPSIS-based and the Entropy-based models. While a moderate positive one is with the Entropy-based TOPSIS model. The four ranking models agree to a considerable extent. The differences found between the scoring model and the entropy means that countries (mostly non-EU) who are doing well in "Use of Internet Services" dimension, like Turkey, get penalized in the I-DESI computation as the subjectively fixed weight is almost half what the entropy generated. The correlation found between the four ranking models means the I-DESI model, even including the use of subjective criteria weights and

aggregating using the score model is a similar model of scoring and ranking when compared to objective multi-criteria decision methods (Entropy and TOPSIS). The Kendall agreement between the four models means that they generate almost the same ranks. Recommendations could be used to adapt strategies for digital competitiveness. Such strategies should include: Scoring higher and faster in the I-DESI in the future, requires giving more importance to two dimensions: Connectivity and "Human Capital", because they weight together 50%. Added to that, maintaining the rising performance of Use of Internet Services dimension, this strategy orientation will prove effective and straightforward: (i) Expanding the fixed broadband and increasing internet speed, (ii) Boosting trainings for people to acquire basic and advanced IT skills (word, spreadsheets, coding) and to increase the number of ICT graduates from educational institutions, (iii) Increasing the use of technology related to banking and shopping transactions and the number of internet users in rural areas in particular, (iv) Enhancing e-government services to comparable leading countries and making it possible to complete each step of key services completely online.

Keywords: Digital Economy Assessment, I-DESI, Türkiye, Entropy, Spearman's Correlation, K-Mean Clustering, TOPSIS, Gompertz model

ULUSLARARASI DİJİTAL EKONOMİ VE TOPLUM ENDEKSİ DEĞERLENDİRMESİ VE TÜRKİYE DİJİTAL EKONOMİSİNİN TAHMİNİ

ÖZET

Bu çalışma, dijital ekonomilerin gelişimini ölçen, ülkeleri kümeleyen ve puanlarını tahmin eden Uluslararası Dijital Ekonomi ve Toplum Endeksi (I-DESI)'ini değerlendirmektedir. Her şeyden önce, ilk kriter ağırlıkları AB politika yönelimine göre öznel olarak seçildiğinden, nesnelliği ile karakterize edilen entropi yöntemi kullanılarak oluşturulan yenileriyle karşılaştırılmaktadır. Daha sonra Entropi, TOPSIS ve Entropi tabanlı TOPSIS modelleri kullanılarak I-DESI'nin sıralama modeli değerlendirilmektedir. Dört model arasındaki sıralama uyumu Kendall W. Afterword kullanılarak test edilmiş, AB ülkelerinin benzerliklerini kontrol etmek için ise hiyerarşik ve K-ortalama kümeleme yöntemleri uygulanmıştır. Son olarak, Türkiye'nin boyutsal tahminlerini I-DESI-45 ülke ortalamasının tahminleriyle karşılaştırmak için Gompertz II modeli kullanılarak I-DESI tahmini yapılmıştır. Bulgular, Entropi yönteminin "Bağlanabilirlik" ve "Dijital Teknoloji ve İş Entegrasyonu" boyutlarına, I-DESI puanlama modelinin ise "Bağlanabilirlik" ve "İnsan Sermayesi" boyutlarına en yüksek ağırlıkları verdiğini göstermektedir. Entropi yöntemi ortalama olarak "İnternet Hizmetlerinin Vatandaşlar Tarafından Kullanımı"na "Dijital Kamu Hizmetleri"ne göre yaklaşık iki kat daha fazla ağırlık verirken, I-DESI puanlama modeli her ikisine de aynı ağırlığı vermektedir. Ayrıca, I-DESI modeli ile TOPSIS tabanlı ve Entropi tabanlı modeller arasında çok güçlü bir korelasyon vardır. Entropi tabanlı TOPSIS modelinde orta derecede olumlu bir durum var. Dört sıralama modeli önemli ölçüde birbirine benzerdir. Puanlama modeli ile entropi arasında bulunan farklılıklar, Türkiye gibi "İnternet Hizmetlerinin Kullanımı" boyutunda başarılı olan ülkelerin (çoğunlukla AB dışı) öznel olarak sabit ağırlık, entropinin ürettiğinin neredeyse yarısı kadar olduğu için I-DESI hesaplamasında cezalandırıldığı anlamına gelir. Dört sıralama modeli arasında bulunan korelasyon, sübjektif kriter ağırlıklarının kullanılması ve puan modeli kullanılarak toplanması dahil olmak üzere I-DESI modelinin, objektif çok kriterli

karar yöntemleriyle (Entropi ve TOPSIS) karşılaştırıldığında benzer bir puanlama ve sıralama modeli olduğu anlamına gelir. Dört model arasındaki Kendall anlaşması, neredeyse aynı sıraları oluşturdukları anlamına geliyor. Öneriler, stratejileri dijital rekabet gücüne uyarlamak için kullanılabilir. Bu stratejiler şunları içermelidir: Gelecekte I-DESI'de daha yüksek ve daha hızlı puan almak için, "Bağlantı" ve "İnsan Sermayesi" bu iki boyuta daha fazla önem verilecektir, çünkü ikisi birlikte %50'dir. Buna ek olarak, İnternet Hizmetlerinin Kullanımı boyutunun artan performansını koruyarak, bu strateji yönelimi etkili ve anlaşılır olacaktır: (i) Sabit geniş bantın yaygınlaştırılması ve internet hızının artırılması, (ii) Kişilerin temel ve ileri düzeyde BT becerileri (kelime, elektronik tablolar, kodlama) edinmelerine yönelik eğitimlerin artırılması ve eğitim kurumlarından BİT mezunlarının sayısının artırılması, (iii) bankacılık ve alışveriş işlemleriyle ilgili teknolojinin kullanımı ve özellikle kırsal alanlardaki internet kullanıcılarının sayısının artırılması, (iv) e-Devlet hizmetlerinin benzer önde gelen ülkelere göre genişletilmesi ve temel hizmetlerin her bir adımının tamamen çevrimiçi olarak tamamlanmasının mümkün kılınması.

Anahtar Kelimeler: Dijital Ekonomi Değerlendirmesi, I-DESI, Türkiye, Entropy, Spearman Korelasyonu, K-Mean Kümelemesi, TOPSIS, Gompertz Modeli

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ABBREVIATIONS

AGNES	: Agglomerative Nesting
AHP	: Analytic Hierarchy Process
BAP	: Budget Allocation Process
BIRCH	: Balanced Iterative Reducing and Clustering using Hierarchies
CA	: Conjoint Analysis
CLIQUE	: CLustering in QUest
COPRAS	: COMplex PROportional ASsessment
CURE	: Clustering Using REpresentatives
DBSCAN	: Density-based spatial clustering of applications with noise
DEA	: Data Envelopment Analysis
DENCLUE	: DENsity-based CLUstEring
DESI	: Digital Economy and Society Index
DIANA	: Divise Analysis
DiGiX	: Digitization Index
ELECTRE	: ELimination Et Choice Translating REality
GCI	: Global Connectivity Index
I-DESI	: International Digital Economy and Society Index
I-DESI-45	: International Digital Economy and Society Index 45 countries
ICT	: Information and Communication Technology
MAUT	: Multi-Attribute Utility Theory
MCDM	: Multi-criteria decision-making
OECD	: The Organization for Economic Cooperation and Development
OPTICS	: Ordering Points To Identify Cluster Structure
PROMETHEE	: Preference Ranking Organization METHod for Enrichment of Evaluations
STING	: Statistical Information Grid Clustering Algorithm
TOPSIS	: Technique for Order of Preference by Similarity to Ideal Solution
TUENA	: Turkish National Information Infrastructure Plan

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I. INTRODUCTION

A. Research Overview and Significance

The magnitude of global economic digitalization, according to McKinsey Global Institute analysts, can be likened to the 18–19th-century industrial revolution, which drastically affected the world power distribution system and accelerated the industrialization of a lot of nations (Boden et al., 2010).

The term "digital economy" was coined by Nicholas Negroponte (1995). In 2017, the World Economic Forum Organization (WEF) saw the future of the economy in its digitization. To accelerate development, the Forum set goals for the integration of the "digital economy and society." (Stavytskyy et al., 2019)

There are several definitions of "digital economy." To mention a few, "the Digital Economy" refers to the portion of overall economic output obtained from a variety of broad "digital" sources. Digital talents, digital equipment (hardware, software, and communications equipment), and intermediary digital goods and services are all examples of digital inputs. Such wide initiatives represent the digital economy's foundations" (Knickrehm et al., 2016). It is a complicated system of various levels/layers connected by an almost infinite and always expanding number of nodes, according to research commissioned by the European Parliament. Platforms are piled on top of one another, allowing for various paths to end users but making it impossible to exclude specific participants, i.e. competitors" (Van Gorp & Honnefelder, 2015).

The International DESI (I-DESI) was designed and first published in 2016 to provide an objective evaluation of the EU's advancement toward a digital society and economy in contrast to non-EU economies. The objective was to reproduce and expand on the DESI index results by discovering metrics that evaluate similar criteria for non-EU nations (Afonasova et al., 2018).

The added value of this study is seen in both the techniques utilized and the outcomes regarding digital competitiveness. On the one hand, assessing a composite

index connected to countries' digital competitiveness using mathematical models and applying multiple clustering methods and a diffusion model is a topic that has received little attention. The proposed methodology includes several steps that can help researchers explore data and forecast trends or convergences/divergences across digital economies (Laitsou et al, 2020). On the other hand, the findings are highly relevant for policymakers and researchers in digital economics at the international and domestic levels, given the scarcity of data on digital competitiveness at the moment, and the growing need for long-term policies as a result of the growth of Industry 4.0. (Laitsou et al, 2020). The results suggest not only the parameters where policy efforts should be directed but also the "period" (years) when convergence will emerge under the current conditions. Such a framework can be used to evaluate estimated convergence with other 27 EU countries and 18 non-EU countries "before and after" the implementation of a digital policy (Laitsou et al, 2020).

B. Research Objectives

The study's goal is to evaluate the I-DESI overall computation method, also known as the scoring model, using the Entropy method. Because of the initial weights coefficients used in the I-DESI are chosen subjectively according to the EU digital policy orientation, the main purpose here is to assess the degree of objectivity by comparing these weights with new ones calculated in this study using an objective weighting method i.e. The Entropy method. First, the criteria weights are recalculated using the Entropy method and contrasted to the initial I-DESI criteria weights at the dimension level. The study then seeks to evaluate the ranking offered by the I-DESI methodology because the latter only ranks countries based on aggregated weighted scores by subdimension, dimension, then the overall score, while the TOPSIS and Entropy can be applied in many ways to calculate objective scores and therefore rankings. To do this, three models were employed to recalculate the I-DESI total score and rank countries' performance: the Entropy-based model, the TOPSIS-based model, and the Entropy-based TOPSIS model (Zerhouni & Özari, 2022). As a result, the following research objectives were established:

- Comparing I-DESI criteria weights by using an objective method (Entropy).
- Comparing the I-DESI overall ranking model to three other models such as entropy-based, TOPSIS-based, and entropy-based TOPSIS models.

- Performing the hierarchical clustering on the I-DESI 45 countries.
- Performing a variance walk between DESI and I-DESI clusters. As hierarchical clustering data on the DESI-27 countries are available from the EU. The purpose here is for the EU countries to be able to check if they stay in the same cluster or move up or down when compared to other 26 EU-countries versus other 44 countries.
- Employing use the K-means clustering method to perform a second clustering. The purpose is to have a second view of countries' generated clusters alongside the hierarchical clusters mentioned in this section above.
- Forecasting the 45 digital economies covered by the I-DESI index. The purpose is to compare Turkey's forecasts by dimension to the forecasts of the I-DESI-45 average in order to advise policymakers on related strategies.

C. Study Scope and Thesis Structure

This study primarily assesses the I-DESI for the period 2015-2018, using mathematical and statistical models such as Entropy, TOPSIS, Spearman's regression, and Kendall W; grouping digital economies into clusters and forecasting I-DESI 45 country scores. Focus on Turkey relates to the comparison Turkey's forecasts by dimension to the forecasts of the I-DESI-45 average.

This study consists of five main sections, which briefly explained below:

- Section 1 highlights the significance of the study, the purpose of the research, and the scope of the investigation.
- Section 2 provides a brief review of the literature on digital economy measurements, the status and performance of Turkey's digital economy, multiple-criteria decision methods in general, then Entropy and TOPSIS methods in particular, clustering methods, and finally the Gompertz II diffusion model.
- Section 3 covers the entropy and TOPSIS methodologies used in the research, as well as Kendall's W test. Also included is an explanation of the K-mean clustering method, which was followed by the Gompertz II model, used to forecast the scores of the forty-five (45) countries of the I-DESI.

- Section 4 shows the application of the proposed methodology to the I-DESI data.
- Section 5 consists of a summary of the research findings and planning and policy recommendations for the Turkish digital economy.

II. LITERATURE REVIEW

A. Measurement of Digital Economy

Indexes that assess aspects of digital economy development, such as information society indices, are examples of indices that are gaining significance alongside economic and social indices (Stavytskyy et al., 2019). Through its worldwide network interaction indicator Global Connectivity Index (GCI), Huawei© studies digital economic advancements and notices that the index's rise reflects an increase in the competitiveness, innovation, and productivity of the national economy.

The Digitization Index (DiGiX), which investigates the characteristics, agent behavior, and organizations that enable a state to fully leverage Information and Communication Technologies (ICTs) for increased competitiveness and welfare, is the next widely accepted attempt in the scientific literature (Camara & Tuesta, 2017). It is a synthetic index that aggregates a country's 100 most important digital performance indicators. The DiGiX is divided into six primary categories: infrastructure, enterprise adoption, costs, household adoption, regulation, and content (Haltiwanger & Jarmin, 2000). There are also more indices available in the literature, such as the E-Readiness Index, Knowledge-Economy Index, Networked Readiness Index, Digital Access Index, Technology Achievement Index, etc.

The European Union established the Digital Economy and Society Index (DESI) in 2015 to identify priority investment sectors for the rise of the digital market and to assist EU countries in enhancing digital competitiveness (Stoica & Bogoslov, 2017).

The International Digital Economy and Society Index (I-DESI) mirrors and expands on the EU Digital Economy and Society Index (DESI) by utilizing 24 datasets to allow trend analysis and comparison of 45 countries' digital performance. The I-DESI includes the EU's 27 member states as well as 18 non-EU countries with

a global spread. Six of the 18 non-EU countries are European, five are Asian, five are American, and two are Australasian (European Commission, 2020).

The I-DESI index is chosen in this study for several reasons, including:

- The scope of the study: includes all European Union member countries as well as 18 non-EU members.
- Data: numerical data metrics can be used to do assessments and forecasts;
- Comprehensiveness: research topics are highly related to the usage of ICT;
- Data: numerical data metrics can be used to do assessments and forecasts;
- Credibility: of the institutions that develop and measure the index.

B. DESI & I-DESI Focused Studies

Researchers employed DESI and similar indexes to measure digital competitiveness and its connection. Some of them are noted as follows: (a) the e-government system in Romania (Lixăndroiu, 2018), (b) the Croatian economy's digital transformation in comparison to EU member-states (Jurcevic et al. 2020), (c) society's sustainable development (Jovanovic et al. 2018), and (d) digital competencies and skills of EU-28 human capital (Folea, 2018). (e) The Human Capital Dimension of Digitization: A Comparative Study for Turkey and Russia (Sezen & Briukhanova, 2021), (f) The Transition to the Digital Economy, Its Measurement, and the Association Between Digitalization and Productivity (Yılmaz, 2021). Laitso et al., (2020) used DESI data and Gompertz II model to predict evolution of the digital economy for Greece.

Because of the recent creation of the DESI and I-DESI, since year 2015, the focused literature on them is scarce.

C. Turkey's Digital Economy

After the mid-1990s, attempts in Türkiye to design policies and strategies for ICT development, as well as the economic and social implications of new technologies, proliferated. National documents and tools have covered several aspects of Türkiye's information society policies, strategies, goals, and practices. TUENA (1999), e-Turkey Initiative Action Plan (2000), e-Transformation Turkey Project Short-term Action Plan (2003-2004, 2005), and Information Society Strategy

and Action Plan (2006-2010) are national plans and programs that specifically address information society policies (Ministry of Development Turkey, 2015).

The Information Society Strategy and Action Plan 2015-2018 was developed with an emphasis on growth and employment under eight major pillars (G20 DETF, 2018). Five criteria were crucial in developing the Strategy's focus and context. Turkey's progress and ongoing needs in transitioning to an information society; Turkey's fundamental problems and immediate opportunities; national, thematic, and regional policy documents, particularly The Tenth Development Plan; and international policy trends, particularly the Digital Agenda for Europe initiative (Ministry of Development Turkey, 2015). Figure 1 depicts the main pillars and focus of the information society strategy for 2015-2018.

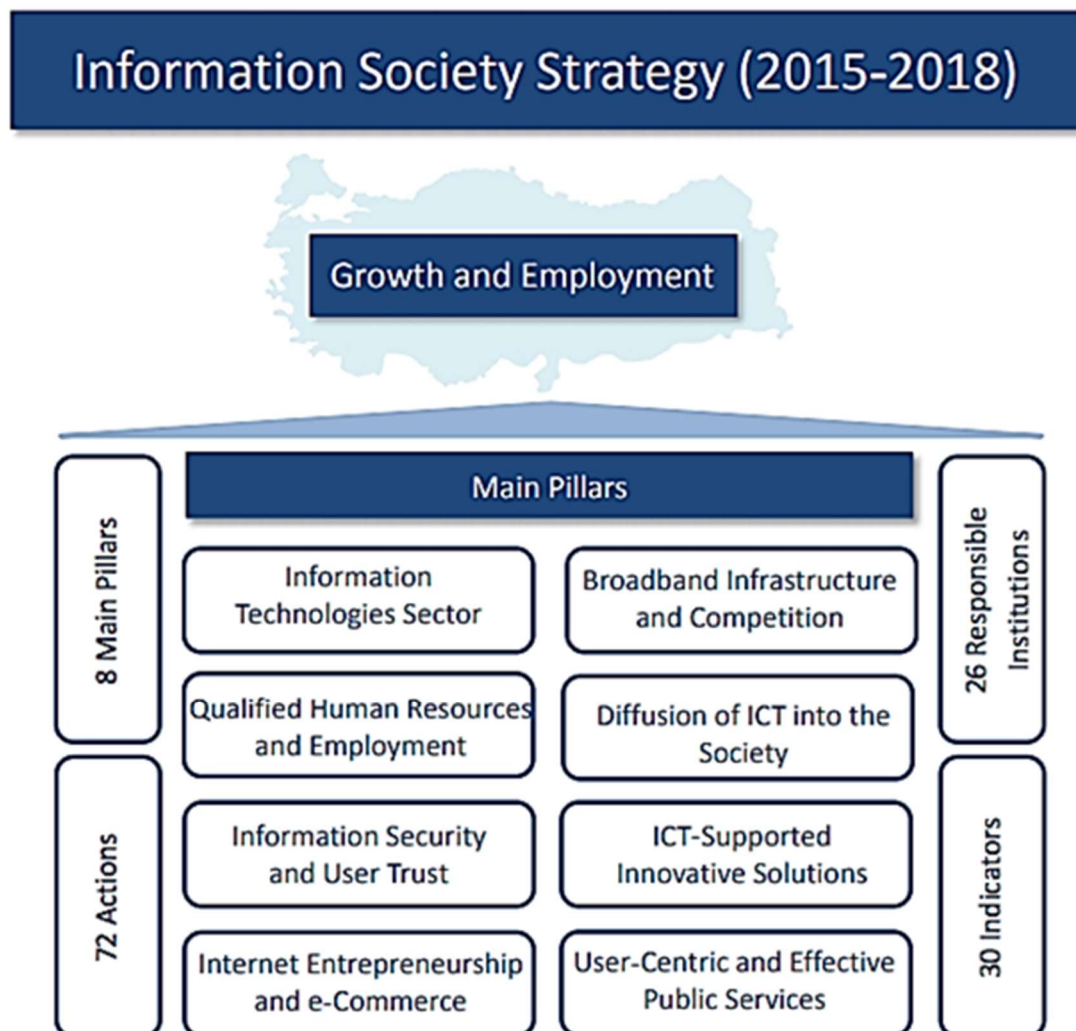


Figure 1 the Main Pillars and Focus of 2015-2018 Information Society Strategy (Source: G20 DETF, 2018).

In terms of I-DESI scores, Turkey's overall score improved by six (6) points, one (1) point more than the average score growth between 2015 and 2018. Substantial progress has been made in two (2) dimensions: "Citizen Internet Use" (a rise of twenty-one 21 points) and "Digital Public Services" (twenty 20 points increase). While there was a negative divergence in the "Integration of Digital Technology" dimension (ten 10 points drop). The overall score progress may be explained by Türkiye's implementation of the aforementioned information society strategy 2015-2018.

Nonetheless, in comparison to the other forty-four (44) countries in the index, Türkiye has been ranked last for four (4) consecutive years. Table 1 provides information related to the Normalized Scores of Türkiye according to the index I-DESI.

Table 1 The Normalized Scores of Turkey according to the index I-DESI
(Source: European Commission, 2020)

Level of measurement	2015	2016	2017	2018
Overall Score (I-DESI level)	28	26	32	34
Connectivity	43	40	46	43
Human Capital	17	19	17	23
Citizen Use of Internet	16	21	30	37
Integration of Digital Technology	34	19	31	24
Digital Public Services	25	24	27	45
Average Score of covered countries	45.4	47.1	49.1	50.4

Table 2 provides information related to the rank of Turkey among countries belonging to the I-DESI for the period 2015-2018.

Table 2 The Nominal Ranks of Turkey according to the index I-DESI (Source: European Commission, 2020)

Level of measurement	2015	2016	2017	2018
Overall Rank (I-DESI level)	45	45	45	45
Connectivity	43	45	44	45
Human Capital	45	45	45	45
Citizen Use of Internet	44	44	38	35
Integration of Digital Technology	28	44	38	33
Digital Public Services	44	45	45	36
Number of Covered Countries	45	45	45	45

The Connectivity dimension assesses the deployment and quality of broadband infrastructure. Türkiye ranks last in the I-DESI-45 countries (Figure 2). Even though Connectivity's score (43 points) has not changed from 2015, its rank dropped two (2) positions since.

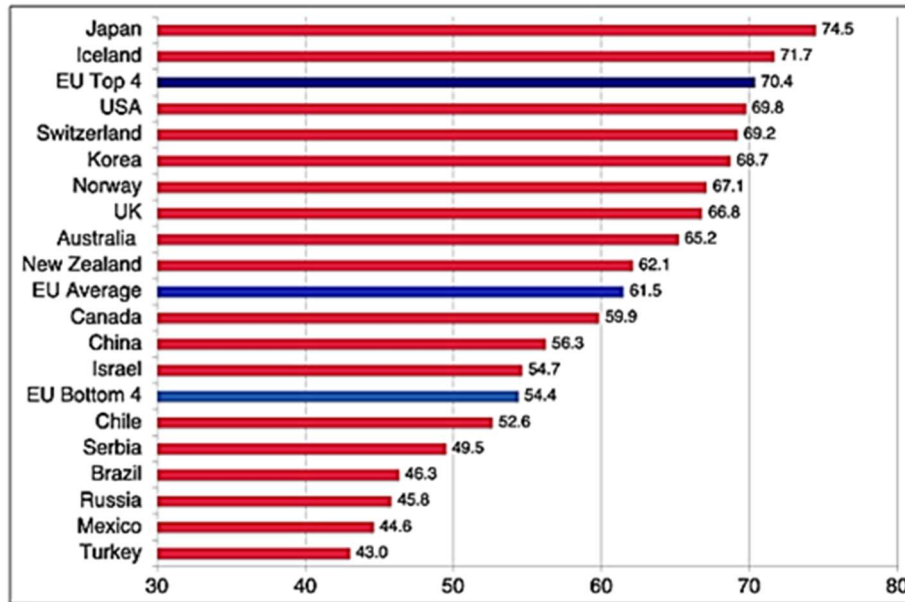


Figure 2 Normalized country scores for the connectivity dimension in 2018 (Source: European Commission, 2020)

The Human Capital dimension assesses the required skills to capitalize on the opportunities provided by digitization. Even though Turkey has made some progress, it remains well below the I-DESI average. The country's rank remained for the four (4) years at the bottom of the I-DESI-45 countries with a score of 23 points in 2018 (Table 2, Figure 3).

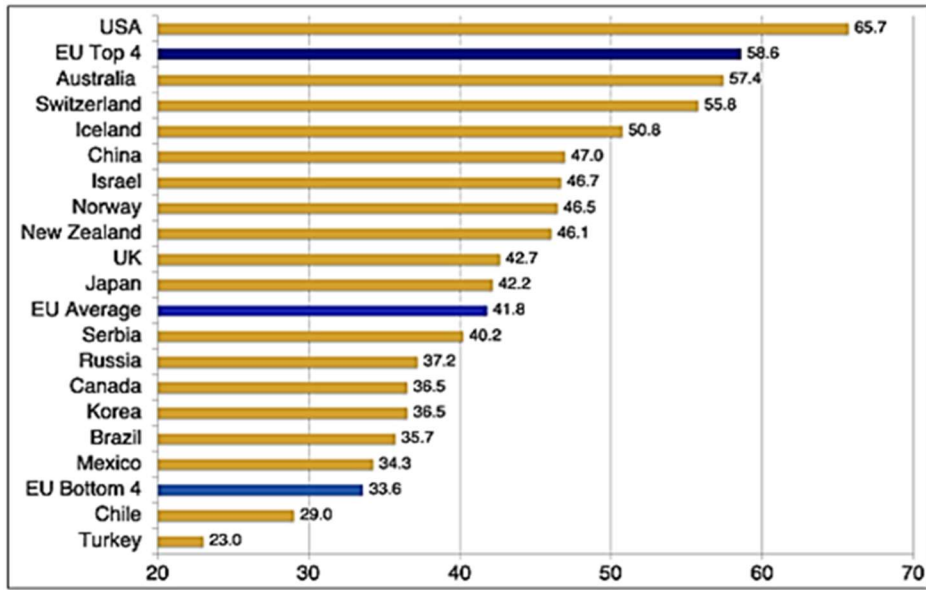


Figure 3 Normalized country scores for the human capital dimension in 2018 (Source: European Commission, 2020)

The Use of Internet Services dimension assesses a wide range of online activities, including the consumption of online material (videos, music, games, etc.), video calls, online shopping, and banking. Table 2 and Figure 4 reveal that Turkey was ranked in the 35th position with a score of 37 points, in 2018, way below the EU average.

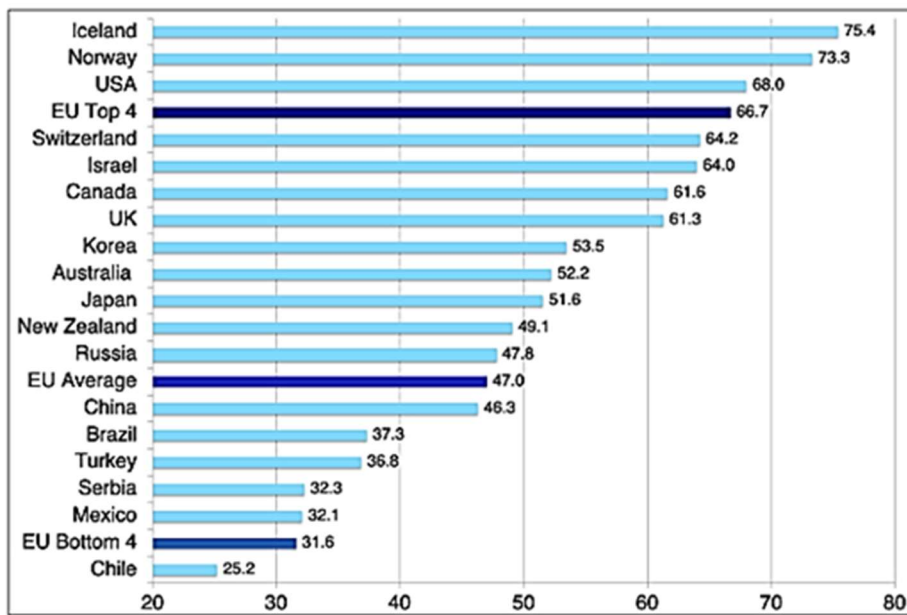


Figure 4 Normalized country scores for the Use of Internet Services dimension in 2018 (Source: European Commission, 2020)

The Integration of Digital Technology dimension assesses business and e-commerce digitization. This component is mostly aimed toward enterprises, arguing that the use of digital technologies may improve efficiency and save costs. Furthermore, digital technologies are among the most essential ways to engage consumers with brands and organizations, and internet sales can make companies expand into worldwide markets.

Turkey was ranked thirty-third (33rd) among the I-DESI-45 (Table 2), which is the best rank achieved among all five DESI dimensions. Regardless of this rank, its score of twenty-four (24) is well below the EU average and the I-DESI average (Figure 5), while the dimension rank climbs from forty-fourth (44th) in the last three years.

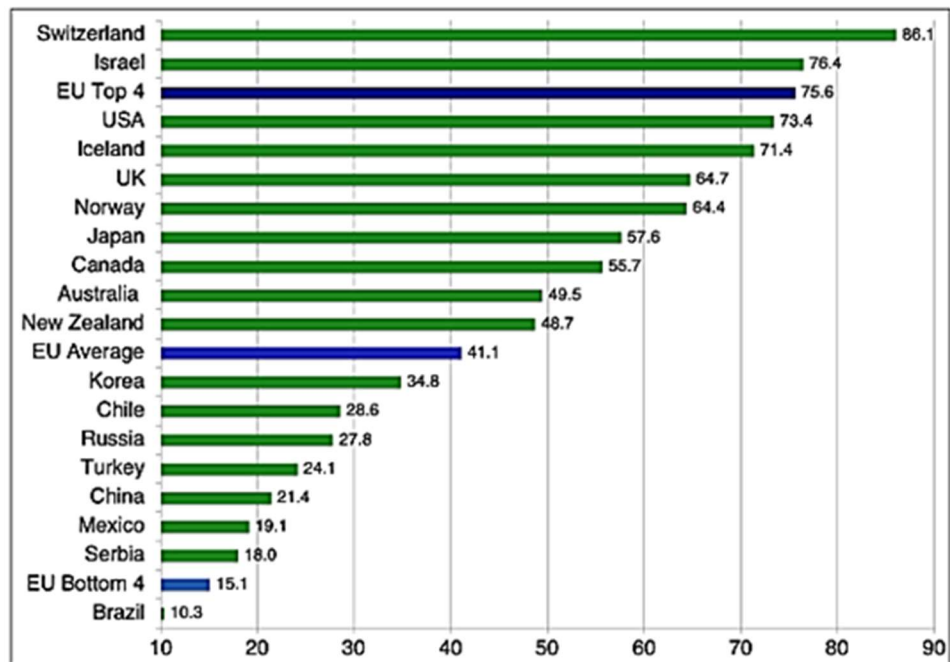


Figure 5 Normalized country scores for the business technology integration dimension in 2018 (Source: European Commission, 2020)

The final dimension is Digital Public Services, which assesses the digitization of government services with a focus on e-Government and e-Health. The significance of this dimension stems from the fact that digitized public services can result in efficiency improvements for government, citizens, and enterprises alike. This measures the digitization of public services, focusing on e-Government and e-

Health. The importance of this dimension lies in the fact that digitized public services can lead to efficiency gains for public administration, citizens, and businesses alike.

Turkey was ranked in the 36th position among the IDESI-45, in 2018 (Table 2), climbing from the last position in one year. 18 points were added to the dimension's score for the same period. The country score was 45 points in 2018, while the EU average was 56 and the I-DESI average was 58 (Figure 6).

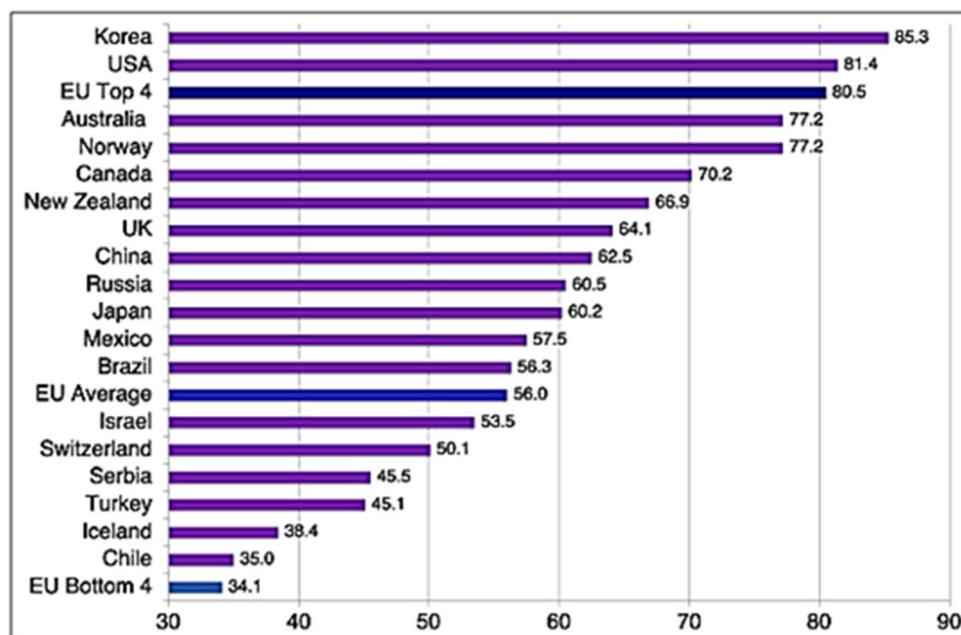


Figure 6 Normalized country scores for the public services dimension in 2018 (Source: European Commission, 2020)

D. Multi-Criteria Decision Making (MCDM)

Economic policy decision-making is crucial because decision-makers aim to make policies with the fewest negative consequences. Multi-Criteria Decision Analysis has shown a substantial quantity of applications over the last few decades. Its significance in a variety of application sectors has expanded considerably, especially when new approaches arise and current ones improve (Velasquez & Hester, 2013). The following are eleven popular Multi-criteria decision-making (MCDM) methodologies identified by the latter researchers: 1) MAUT, 2) AHP, 3) Fuzzy Set Theory, 4) Case-based Reasoning, 5) Data Envelopment Analysis, 6)

Simple Multi-Attribute Rating Technique, 7) Goal Programming, 8) ELECTRE, 9) PROMETHEE, 10) Simple Additive Weighting, and 11) Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS).

MCDM techniques are powerful instruments for handling complex problems. They help managers and other decision-makers weigh multiple criteria and rank various options (Azadeh et al., 2016; Moradian et al., 2019). Ananda and Herath (2005) used MAUT in a real-world application to investigate risk preferences in connection with forest land use in Australia. Bentes et al. (2012) used AHP to prioritize performance components and indicators during an assessment of a Brazilian telecommunications company's organizational performance. Hermans, Brijs, Wets, and Vanhoof (2009) assessed road safety performance criteria in several countries. Data envelopment analysis (DEA) is used to provide policymakers in any country with a model to assist them in prioritizing efforts to improve the safety of their local highways in the most efficient way feasible. ELECTRE has been utilized to tackle issues in the fields of energy, economics, the environment, water management, and transportation (Velasquez & Hester, 2013). In addition, an integrated model incorporating entropy and COPRAS algorithms was employed to determine the optimal location in Turkey for the Olympic Games (Caraca et al., 2019).

The weighting technique in MCDM scenarios is conducted based on the relative importance of each factor. This operation is undertaken following the target component's performance. Weights can be calculated using alternative data or the designer's experience (Moradian et al., 2019).

1. Entropy Method

Without a doubt, the weights utilized may have a significant impact on the listed units. For example, Saisana et al. show that, in the case of the Technology Achievement Index, changing the weights of individual indicators appears to affect some of the units studied, notably those ranking in the center (2005). No or Equal Weights, Budget Allocation Process (BAP), Analytic Hierarchy Process (AHP), and Conjoint Analysis (CA) are some weighting methods reported in the literature. Because the "subjectivity" feature makes weight selection more arbitrary, other statistical approaches that are more "objective" are favored (Ray, 2008), such as Data

Envelopment Analysis (DEA), Factor Analysis, Multiple Linear Regression Analysis, Principal Component Analysis, and the Entropy method. Although there are other ways of evaluating the importance/weight of key parts of the digital economy, the entropy was chosen to owe to the objectivity it gives and the ease with which it can be calculated.

2. TOPSIS Method

As previously stated, another goal of the current study is to rank countries and assess their digital economy performance. TOPSIS, an MCDM technique, was chosen for this task because it can efficiently compute the relative strength of each alternative. TOPSIS's simplicity facilitates better understanding and interpretation of its results (Azadeh et al., 2016). TOPSIS, according to Hwang and Yoon, is a powerful technique for dealing with multiple attribute decision-making problems (Hwang and Yoon, 1981). TOPSIS bases its decision on the shortest distance from the positive ideal solution and the largest distance from the negative ideal solution (Birtles and Griggs, 1997; Chen, 2019b).

The TOPSIS technique is enhanced by the entropy method, which is used to fix the weight and decision output more objectively (Chen, 2019a). TOPSIS with entropy has lately acquired appeal in a range of applications. Wang et al., for example, presented a symbiotic technology evaluation technique for the iron and steel industry (2020). Oluah et al. (2020) selected Phase Change Material for Trombe Wall Systems using the entropy-based TOPSIS technique. Alao et al. used the waste stream of cities to pick the best waste-to-energy technology.

E. Clustering Methods

Clustering is defined by Pahwa and Chhabra (2013) as the process of grouping a set of physical or abstract items into classes of comparable objects. Cluster analysis is the process of identifying similarities between data based on features discovered in the data and grouping comparable objects into clusters. It is based on the maximization of intra-class similarity while limiting inter-class similarity (Pahwa & Chhabra, 2013).

Clustering algorithms are divided into four types: Partitioning-based, hierarchical-based, density-based, and grid-based algorithms (Pahwa & Chhabra, 2013).

- Partitioning Methods: They produce a set of (k) clusters, with each item belonging to one of them. There are two basic partitioning algorithms: k-mean (MacQueen, 1967) and k-medoids (Kaufman & Rousseeuw, 1990).
- Hierarchical Methods: They group data objects into a tree-like structure. A hierarchical tree is used to depict the closeness of data objects in hierarchical clustering methods. The tree is built from the bottom up (AGNES) or the top-down (DIANA). BIRCH (Zhang et al., 1996), CURE (Guha, 1998), and CHAMELEON are examples of hierarchical-based clustering algorithms (Karypis et al., 1999).
- Density-based Methods: They consider clusters as dense regions of items in the data space, with clusters divided by low-density regions. DBSCAN (Ester et al., 1996), OPTICS (Ankerst et al., 1999), HOP (Eisenstein and Hut, 1998), and DENCLUE are examples of density-based clustering algorithms (Hinneburg and Keim, 1998).
- Grid-based Methods: A uniform grid mesh is used to cover the problem space domain at first (Liao, 1999). STING (Wang et al., 1997), WaveCluster (Sheikholeslami, 1998), and CLIQUE are examples of grid-based clustering methods (Agrawal, 1998).

Using the DESI in measuring the EU-27 digital economies (2016), the European Commission adopted a Top-down clustering method and divided EU member states according to two factors: “the average rate of development” and “the current stage of development” of the digital economy. Details in this regard are presented in Table 3. In this study, the same hierarchical clustering method (Top-Down) will be applied to I-DESI data.

Table 3 Classification of EU Countries according To Progress and Performance towards Digital Economy (source: Mateus, 2016)

		The rate of growth relative to the average for the European Union	
		< 2%	> 2%
The level of development relative to the EU average	> 0.52 points	“Lagging ahead”: Sweden, Estonia, Denmark, Finland, Belgium, United Kingdom, Ireland, Luxembourg, Lithuania	“Running ahead”: Netherland, Estonia, Germany, Austria, Portugal
	< 0.52 points	“Falling behind”: France, Czech Republic, Slovakia, Hungary, Poland, Cyprus, Bulgaria	“Catching up”: Spain, Latvia, Italy, Croatia, Romany

THE I-DESI 2020 official report from the European Commission did not cover any clustering of the countries studied as was the case for the DESI report. The only performance of EU Top-4 and EU Bottom-4 was highlighted for visualization ease. The present study performed, on the I-DESI-45, two clustering methods:

- Top-down hierarchical clustering;
- K-means clustering method.

F. Gompertz II Model

Based on DESI data, Laitso et al. (2020) predicted the Greek economy using the Gompertz II diffusion model. This study contributes to the research applies these forecasting techniques to the I-DESI index. Furthermore, the proposed index's application in the Turkish economic landscape is limited and primarily aims at presenting or comparing data. The study broadens the examination of the Turkish economy by assessing 2015-2018 trends and documenting forecasts for the five dimensions of the I-DESI index.

The Gompertz II diffusion model, one of the most commonly used sigmoid models has been fitted to growth data (Vogels et al., 1975) as well as many other

types of data, resulting in a massive literature (Tjørve and Tjørve, 2017). The proposed model has been widely used in technologically sensitive areas, including research in a variety of fields and national contexts. Wu and Chu (2010) tested its accuracy in Taiwan's mobile telephone market by including technological variables (the introduction of smartphones) and the rise of services in their research (e.g., social media and YouTube). Çik et al. (2016) compared forecasting ability with other models for fixed broadband service in the Republic of Croatia, while Sudtasan and Mitomo (2017) evaluated their accuracy for Thailand's mobile communications market and fixed broadband market.

Several studies have been conducted to investigate the model's usefulness and accuracy, including (a) 200 developed and developing countries in the 1990s (Rouvinen, 2006), (b) mobile telephony subscriptions in Greece (Michalakelis et al. 2008), (c) mobile phone and mobile density in India (Singh, 2008), (d) the influence of social, technological, economic, and political factors on the diffusion speed of mobile telephony (Gupta & Jain, 2012) (e) the diffusion of mobile telephony in China (Liu et al., 2012) and the diffusion of mobile telephone subscriptions in Peru (Yamakawa et al., 2013). The above-mentioned investigations concluded that the Gompertz model best reflects the diffusion process when compared to other models. In terms of the need to better foresee digital competitiveness, the Gompertz II model has emerged as the most accurate model when technological considerations are taken into account (Laitsou et al., 2020).

III. RESEARCH METHODOLOGY

A. Research Design and Data

The research methodology is based on an assessment of secondary sources collected from the European Commission's website (Foley et al., 2018). The data analyzed comprises 4320 I-DESI data points associated with 24 indicators (criteria) across 45 countries from 2015 to 2018. As indicated in Appendix A, the I-DESI adopted a weighting system that represents the relevance of indicators. The overall index is computed from the bottom up: indicators are aggregated into sub-dimensions, sub-dimensions into dimensions, and dimensions into the overall index. Connectivity, Human Capital, Internet Service Use, Digital Technology Integration, and Digital Public Services are the five dimensions. At the top level, the I-DESI score is computed as follows: (Foley et al., 2018):

$$DESI = \sum_{i=1}^5 a_i w_i$$

where a_i is the value of the (*ith*) indicator of the first level, w_i is the weight (importance level) of the (*ith*) indicator.

The multi-criteria decision-making (MCDM) procedure provides a ranking solution of the countries to identify the best quantitative solution from the alternatives. The entropy and TOPSIS methods were used independently and jointly in this study, and the findings were compared with the I-DESI ranking using Spearman correlation and the Kendall W Test.

The decision matrix of MCDM problems included m alternatives and n criteria. The current study covers 45 alternatives ($m=45$ countries) and 24 criteria ($n=24$ indicators). x_{ij} ($i=1; 2; \dots; m; j=1; 2; \dots; n$) elements in the decision matrix, which represents the performance score of the (*ith*) alternative to the (*jth*) criteria (Rao, 2007; Moradian et al., 2019).

B. Entropy Method

The weight of all indicators is derived by information entropy based on the degree of index dispersion.

For a decision matrix B with m alternatives and n indicators:

Step 1: In matrix B, feature weight is of the (*j*th) alternatives to the(*j*th) factor:

$$(1 \leq i \leq m, 1 \leq j \leq n)$$

$$p_{ij} = X_{ij} / \sum_{i=1}^m X_{ij}$$

Equation (1)

Step 2: The output entropy e_j of the *j*th factor becomes

$$e_j = -k \sum_{i=1}^m p_{ij} \ln p_{ij}, (k = 1 / \ln m, 1 \leq j \leq n)$$

Equation (2)

Step 3: Variation coefficient of the *j*th factor: (g_j) can be calculated as follows:

$$d_j = 1 - e_j, (1 \leq j \leq n)$$

Equation (3)

Step 4: Calculate the weight of entropy (w_j):

$$w_j = g_j / \sum_{i=1}^m g_j, (1 \leq j \leq n)$$

Equation (4)

C. TOPSIS Method

The TOPSIS assessment process encompasses six major steps as shown below (Dashore et al., 2013):

Step 1: Calculating the normalized decision matrix A. The normalized value (a_{ij}) is calculated as:

$$a_{ij} = x_{ij} / \sum_{i=1}^m (x_{ij})^2, \quad (1 \leq i \leq m, 1 \leq j \leq n)$$

Equation (5)

Step 2: Calculating the weighted normalized decision matrix:

$$V = (a_{ij} * w_j)$$

Equation (6)

where (w_j) is the weight of the (i th) criterion and

$$\sum_{i=1}^n w_i = 1.$$

Equation (7)

Step 3: Calculating the ideal solution V^+ and the negative ideal solution V^-

$$V^+ = \{v_1^+, v_2^+, v_3^+, \dots, v_n^+\} = \{(\text{Max } v_{ij} \mid j \in J), (\text{Min } v_{ij} \mid j \in J)\}$$

Equation (8)

$$V^- = \{v_1^-, v_2^-, v_3^-, \dots, v_n^-\} = \{(\text{Min } v_{ij} \mid j \in J), (\text{Max } v_{ij} \mid j \in J)\}$$

Equation (9)

Step 4: Calculating the separation measures, using the (m) dimensional Euclidean distance, where

$$S_i^+ = \sqrt{\sum_{j=1}^n (V_{ij} - V^+)^2}, \text{ where } (1 \leq i \leq m, 1 \leq j \leq n)$$

Equation (10)

$$S_i^- = \sqrt{\sum_{j=1}^n (V_{ij} - V^-)^2}, \text{ where } (1 \leq i \leq m, 1 \leq j \leq n)$$

Equation (11)

Step 5: Calculating the relative closeness to the ideal solution

$$P_i = S_i^- / (S_i^+ + S_i^-), (1 \leq i \leq m, 1 \leq j \leq n)$$

Equation (12)

where the larger is, (P_i) the closer the alternative is to the ideal solution.

Step 6: The larger TOPSIS value, the better the alternative.

D. Kendall W Test

Kendall's Coefficient of Concordance W is a measure of agreement among a group of (p) judges who have rank-ordered a collection of (n) objects. It analyzes the ranking variability of the ranked objects to the total rank variability; a high ratio shows agreement among ranking judges. Kendall W statistic can be calculated in two steps as follow (Siegel, 1956; Siegel and Castellan, 1988):

$$S = \sum_{i=1}^n (R_i - \bar{R})^2$$

Equation (13)

S is a sum-of-squares statistic over the row sums of ranks (R_i). (R) is the mean of the (R_i) values. After that, Kendall's W statistic can be obtained from:

$$W = 12S / (p^2(n^3 - n) - pT)$$

Equation (14)

where (n) is the number of objects, (p) the number of judges. (T) is a correction factor for tied ranks (Siegel, 1956; Siegel and Castellan, 1988; Zar, 1999):

$$T = \sum_{k=1}^m (t_k^3 - t_k)$$

Equation (15)

E. K-means Clustering Method

The K-means clustering method is used to categorize countries based on their digital economy performance. The following are the steps in the K-means clustering algorithm's calculation (Yu et al., 2019; Alao et al., 2020).

Step 1: Determining the number k of the desired clusters.

Step 2: Determining the initial centroids that are chosen randomly from the energy performance score matrix D, and the number k of clusters is equal to the number of initial centroids.

Step 3: Searching the nearest centroid of each data point by calculating the distance to each centroid with Euclidean distance.

Step 4: Clustering the data by the minimum distance. A data point will be part of a group if it is the closest to its cluster center.

Step 5: Searching for a new centroid based on the average of the data for each cluster.

Step 6: Repeating from step 3 until no data point was assigned otherwise algorithm stops.

F. Gompertz II Model

Despite having four parameters, the model pertains to the Richards family of three-parameter sigmoidal growth models. Other well-known models include the Bertalanffy (1957), logistic, and negative exponential (Tjørve and Tjørve, 2010), as well as a variety of attempted parameterizations. A single parameter in the Gompertz II model governs the starting value of the curve (i.e., the intersection with the y-axis), while other factors do not affect the starting point.

This study applies Gompertz II, as a forecasting method, to a selection of indicators matching the criteria for applying data prediction techniques, over the next 12 years. Afterward, the study recomposes the I-DESI index, aggregates the results from indicators to sub-dimensions and finally into the five dimensions. As a result, convergences and/or divergences are detected to forecast the evolution of the scores for Türkiye and the I-DESI-45. Emphasis is put on revealing the time when Türkiye could exceed the I-DESI-45 average, for each of the five dimensions or the I-DESI index as a whole.

As indicated before in section F of the literature review chapter, Laitso et al., (2020) applied Gompertz model on DESI-27 data to predict and compare forecasted Greece scores to forecasted DESI average. This study applies the same methodology on I-DESI-45 data and predicts and compares forecasted Turkey scores to forecasted I-DESI-45 average.

From a methodological point of view, the procedure could be described in several phases (Laitso et al., 2020):

1. Phase 1:

Selection of data in compliance with the following requirements:

- Data values are calculated as percentages of the total population or groups of the population;
- Data covering three years minimum. All data respect this second requirement.

This selection is essential to keep data that can be used during the forecasting procedure (Laitso et al., 2020). Appendix E presents the five (5) dimensions, the subdimensions, as well as the indicators that develop each sub-dimension. During the

first phase, sixteen (16) of the twenty-four (24) recommended indicators are finally chosen. Selected indicators have a white background in Appendix E.

It should be noted that the index's components do not have equal weights. Connectivity and "Human Capital" are the two key components, each accounting for 25% of the total score. "Integration of Digital Technology" accounts for 20%, "Internet Use" accounts for 15%, and Digital Public Services accounts for 10%.

2. Phase 2:

Data is changed from percentages to absolute numbers during this phase. To accomplish this, information and data from the World Bank, the United Nations, the European Commission, the Eurostat European Statistical Office, the OECD, and the National Bureau of Statistics of China are utilized. Depending on the unit of measurement, these figures are mostly related to population, number of employees, number of companies, and so on. The conversion is required to use the Gompertz II model, which is introduced in the subsequent phase.

3. Phase 3:

The Gompertz II model is implemented in Phase 3 by using the formula shown below:

$$Y(t) = Se^{Ae^{-b \times t}}$$

Equation (16)

Where $(b) > 0$ is a scaling factor, (S) represents the saturation level and (A) is the parameter that is associated with the point of inflection (Laitsou et al., 2020). In addition, (A) is a constant parameter that replaces e^{-a} . $Y(t)$ is the estimated diffusion level at time (t) , while the parameters that need to be estimated are (S) , (a) , and (b) . Parameters (a) and (A) are related to the time that diffusion attains 37% of its upper level (Se^{-a}) , and parameter (b) measures the diffusion speed, or how fast the adoption advances (Michalakelis et al., 2008).

Forecasting is performed on the above-mentioned indicators from 2019 to 2030.

4. Phase 4:

Forecasted figures are converted back to population percentages. This is a necessary step in reconstructing the DESI index (Laitsou et al., 2020), thus the I-DESI index in this study. By doing so, the data is used to recalculate all five dimensions (Connectivity, Human Capital, Use of Internet Services, Integration of Digital Technology, and Digital Public Services). Constant values are assumed for the other attributes where no forecast could be performed.

Values for Turkey and the I-DESI-45 countries are predicted by using the proposed model and the above-mentioned research framework, and a comparison (divergence versus convergence) could be undertaken.

IV. FINDINGS AND EVALUATION

For the period 2015-2018, the Entropy and TOPSIS methods are applied independently and combined on I-DESI data. As a result, three scoring and ranking methods are performed:

- Entropy method;
- TOPSIS method;
- Entropy-based TOPSIS method.

It is important to obtain the reliability of the I-DESI outcomes. Each indicator is given a three-digit identifier for presentation purposes, such as "C12," where "C" refers to the dimension, "1" to the sub-dimension, and "2" to the indicator order. Table 4 shows only the first and last countries in alphabetical order for 2018 (Austria, Belgium, Bulgaria, Russia, Turkey, and the United States). Appendix A contains data for all countries from 2015 to 2018.

Table 4 Extract of I-DESI Data (2018) (Source: European Commission 2020)

Indicators / Countries	Code	AT	BE	BG	...	RU	TR	US
Fixed Broadband Coverage	C11	0.200	0.322	0.189	...	0.133	0.067	0.289
Fixed Broadband Take-Up	C12	0.960	1.000	0.900	...	0.756	0.612	1.000
4G Coverage C3	C21	0.980	1.000	1.000	...	0.700	0.930	1.000
Mobile Broadband Take-Up	C22	0.378	0.309	0.457	...	0.374	0.301	0.681
Fixed (wired)-broadband speed; in Mbit/s	C31	0.583	0.640	0.504	...	0.264	0.300	0.405
Broadband Price Index	C41	0.385	0.574	0.328	...	0.847	0.084	0.088
At least basic skills (Word processing)	H11	0.555	0.516	0.259	...	0.282	0.327	0.560
Above basic (advanced spreadsheet skills)	H12	0.467	0.311	0.464	...	0.306	0.087	0.591
At least basic software (coding)	H13	0.246	0.336	0.222	...	0.268	0.150	0.696
Telecommunication emps FTEs	H21	0.471	0.274	0.463	...	0.287	0.217	0.562
ICT Graduates	H22	0.689	0.259	0.387	...	0.631	0.329	0.835

Internet Users	U11	0.795	0.811	0.413	...	0.681	0.517	0.927
Fixed broadband traffic (GB/mth/person)	U12	0.417	0.386	0.068	...	0.137	0.097	0.631
Video Calls	U21	0.327	0.323	0.375	...	0.670	0.437	0.531
Social Networks	U22	0.376	0.635	0.139	...	0.436	0.463	0.653
Banking	U31	0.584	0.687	0.295	...	0.324	0.281	0.742
Shopping	U32	0.603	0.605	0.335	...	0.468	0.251	0.774
Availability latest technologies	I11	0.671	0.800	0.106	...	0.453	0.194	0.540
Firm-level technology absorption	I12	0.457	0.506	0.160	...	0.198	0.506	0.877
SMEs Selling Online	I21	0.242	0.427	0.180	...	0.347	0.100	0.675
Secure Internet Servers per million people	I22	0.221	0.185	0.507	...	0.069	0.057	0.872
eGovernment Users	P11	0.661	0.565	0.424	...	0.448	0.456	0.818
Online Service Completion	P12	0.525	0.342	0.492	...	0.577	0.513	0.954
Open Data OKF OECD	P13	0.517	0.397	0.560	...	0.789	0.384	0.670

A. Criteria Weights Calculation Using Entropy Method

The standardization of scores is determined using (Equation 1) and reported in Table 5. Appendix B contains tables for all countries from 2015 to 2018.

Table 5 Entropy: Extract of Transposed Normalized Decision Matrix (2018)

Code	AT	BE	BG	...	RU	TR	US
C11	-0.073	-0.103	-0.070	...	-0.053	-0.031	-0.095
C12	-0.089	-0.092	-0.085	...	-0.075	-0.064	-0.092
C21	-0.086	-0.087	-0.087	...	-0.067	-0.083	-0.087
C22	-0.074	-0.063	-0.085	...	-0.073	-0.062	-0.113
C31	-0.089	-0.095	-0.080	...	-0.049	-0.054	-0.068
C41	-0.084	-0.112	-0.075	...	-0.146	-0.026	-0.027
H11	-0.092	-0.087	-0.052	...	-0.055	-0.062	-0.092
H12	-0.089	-0.066	-0.089	...	-0.065	-0.024	-0.106
H13	-0.055	-0.070	-0.051	...	-0.059	-0.037	-0.119
H21	-0.103	-0.069	-0.101	...	-0.071	-0.058	-0.116
H22	-0.121	-0.059	-0.080	...	-0.114	-0.071	-0.138
U11	-0.092	-0.093	-0.056	...	-0.082	-0.067	-0.103
U12	-0.105	-0.099	-0.026	...	-0.045	-0.035	-0.140
U21	-0.069	-0.069	-0.077	...	-0.117	-0.086	-0.099
U22	-0.072	-0.106	-0.033	...	-0.080	-0.084	-0.108
U31	-0.088	-0.099	-0.053	...	-0.057	-0.051	-0.105

U32	-0.090	-0.090	-0.058	...	-0.075	-0.046	-0.108
I11	-0.098	-0.112	-0.023	...	-0.074	-0.038	-0.084
I12	-0.087	-0.094	-0.039	...	-0.046	-0.094	-0.138
I21	-0.064	-0.098	-0.051	...	-0.084	-0.032	-0.135
I22	-0.063	-0.055	-0.116	...	-0.025	-0.022	-0.167
P11	-0.094	-0.084	-0.068	...	-0.071	-0.071	-0.110
P12	-0.071	-0.051	-0.067	...	-0.076	-0.070	-0.110
P13	-0.088	-0.072	-0.093	...	-0.119	-0.070	-0.106

Then, as indicated in Table 6, the weights of 24 indicators (criteria) are determined by using (Equation 3) and (Equation 4). The last two columns provide indicator weight (W_j) and dimension weight (W_j/dim). Appendix C contains the results from 2015 to 2017.

Table 6 Entropy: Weight Calculations (2018)

Dimension	Indicators	E_j	D_j	W_j	$W_j/\text{Dimension}$
Connectivity	C11	0.978	0.022	3.28%	21%
	C12	0.997	0.003	0.40%	
	C21	0.999	0.001	0.13%	
	C22	0.986	0.014	2.05%	
	C31	0.981	0.019	2.80%	
	C41	0.920	0.080	11.89%	
Human Capital	H11	0.990	0.010	1.50%	17%
	H12	0.983	0.017	2.55%	
	H13	0.957	0.043	6.45%	
	H21	0.986	0.014	2.11%	
	H22	0.973	0.027	4.01%	
Use of Internet Services	U11	0.991	0.009	1.40%	19%
	U12	0.950	0.050	7.49%	
	U21	0.990	0.010	1.51%	
	U22	0.987	0.013	1.97%	
	U31	0.975	0.025	3.69%	
	U32	0.982	0.018	2.68%	
Integration of Digital Technology	I11	0.959	0.041	6.07%	34%
	I12	0.938	0.062	9.20%	
	I21	0.958	0.042	6.34%	
	I22	0.914	0.086	12.81%	
Digital Public Services	P11	0.986	0.014	2.14%	10%
	P12	0.978	0.022	3.22%	
	P13	0.971	0.029	4.29%	

B. Entropy-based Method:

The data in Appendix A is used to create a decision matrix of 45 nations and 24 criteria scores. The overall scores of countries are derived by using (Equation 6) and entropy weights (W_j) from Table 6. The greater is the score, the higher the rank (Shockley, 2014). Table 9 denotes the overall scores and rankings of countries by using the Entropy method.

C. Entropy-based TOPSIS Method:

The decision matrix is produced using the data in Appendix A. (Equation 6) calculates the normalized decision matrix, and after obtaining the ideal value and the negative ideal value from (Equations 8 and 9), the ideal solution and the negative ideal solution are computed by (Equations 10 and 11). The Transposed Weighted Normalization Matrix (2018) is shown in Table 7; the (V^+) and (V^-) values are final. Appendix D contains data for all countries from 2015 to 2018.

Table 7 TOPSIS: Extract of Transposed Weighted Normalization Matrix (2018)

Indicators / Countries	AT	BE	...	W_j	V^+	V^-
C11	0.113	0.183	...	0.033	0.007	0.001
C12	0.159	0.166	...	0.004	0.001	0.000
C21	0.152	0.155	...	0.001	0.000	0.000
C22	0.117	0.096	...	0.021	0.006	0.002
C31	0.150	0.165	...	0.028	0.006	0.001
C41	0.119	0.178	...	0.119	0.035	0.000
H11	0.160	0.149	...	0.015	0.003	0.001
H12	0.151	0.101	...	0.025	0.006	0.001
H13	0.074	0.101	...	0.065	0.017	0.001
H21	0.185	0.108	...	0.021	0.005	0.001
H22	0.226	0.085	...	0.040	0.011	0.001
U11	0.162	0.165	...	0.014	0.003	0.001
U12	0.170	0.157	...	0.056	0.039	0.002
U21	0.110	0.109	...	0.226	0.147	0.001
U22	0.114	0.193	...	0.133	0.141	0.001
U31	0.146	0.171	...	0.081	0.070	0.001
U32	0.153	0.154	...	0.119	0.064	0.000
I11	0.163	0.194	...	0.110	0.047	0.000
I12	0.130	0.144	...	0.056	0.144	0.000
I21	0.090	0.159	...	0.129	0.037	0.001

I22	0.078	0.065	...	0.024	0.020	0.000
P11	0.164	0.140	...	0.111	0.113	0.001
P12	0.110	0.071	...	0.121	0.107	0.001
P13	0.143	0.110	...	0.218	0.106	0.001

Every viable solution's distance from the ideal solution (S_i^+) and the negative ideal solution (S_i^-) is computed by (Equations 10 and 11). (P_i), the relative degree of approximation is computed by using (Equation 12). Table 8 displays the relative degree of approximation for the 45 countries studied in 2018.

Table 8 Ranking Obtained by Entropy-Based TOPSIS (2018)

Countries	Distance S_i^+	Distance S_i^-	Scoring P_i	Ranking
Austria	0.0503	0.0299	0.3727	24
Belgium	0.0482	0.0343	0.4157	20
Bulgaria	0.0543	0.0284	0.3437	28
Croatia	0.0581	0.0226	0.2797	33
Cyprus	0.0616	0.0211	0.2556	38
Czech Rep.	0.0431	0.0402	0.4831	15
Denmark	0.0383	0.0456	0.5432	9
Estonia	0.0425	0.0398	0.4837	14
Finland	0.0366	0.0473	0.5637	8
France	0.0497	0.0321	0.3923	22
Germany	0.0356	0.0481	0.5749	7
Greece	0.0683	0.0146	0.1764	44
Hungary	0.0609	0.0231	0.2747	34
Ireland	0.0289	0.0552	0.6565	3
Italy	0.0558	0.0321	0.3648	26
Lithuania	0.0505	0.0394	0.4388	18
Latvia	0.0565	0.0281	0.3323	31
Luxembourg	0.0435	0.0491	0.5304	11
Malta	0.0535	0.0309	0.3662	25
Netherlands	0.0244	0.0612	0.7147	2
Poland	0.0587	0.0295	0.3342	30
Portugal	0.0607	0.0200	0.2479	39
Romania	0.0656	0.0177	0.2126	42
Slovakia	0.0592	0.0206	0.2585	36
Slovenia	0.0558	0.0271	0.3271	32
Spain	0.0594	0.0212	0.2633	35
Sweden	0.0389	0.0529	0.5761	6

United Kingdom	0.0389	0.0429	0.5242	12
Iceland	0.0371	0.0533	0.5891	5
Norway	0.0467	0.0406	0.4649	17
Switzerland	0.0210	0.0623	0.7482	1
Republic of Serbia	0.0700	0.0123	0.1498	45
Australia	0.0391	0.0392	0.5007	13
Brazil	0.0643	0.0222	0.2568	37
Canada	0.0492	0.0344	0.4113	21
Chile	0.0667	0.0183	0.2151	41
China	0.0574	0.0317	0.3562	27
Israel	0.0446	0.0528	0.5419	10
Japan	0.0497	0.0374	0.4293	19
Korea, Republic of	0.0574	0.0290	0.3354	29
Mexico	0.0690	0.0191	0.2168	40
New Zealand	0.0446	0.0398	0.4714	16
Russia Federation	0.0567	0.0362	0.3892	23
Turkey	0.0671	0.0161	0.1934	43
United States	0.0357	0.0562	0.6117	4

D. TOPSIS Method:

The results in this section are computed using the same equations as in section (C), with the sole variation being that I-DESI weighting coefficients (Appendix E) are used instead of the entropy weights calculated in section (A). For 2018, Table 9 summarizes input data (weight coefficients for indicators, sub-dimensions, and dimensions) and output data (ideal values "V+" and negative ideal values "V-").

Table 9 TOPSIS Method Using I-Desi Weight Coefficients (2018)

Indicators	Weights	V^+	V^-	Dimension Weight	Sub Dimension Weight
C11	0.042	0.010	0.001	0.25	0.168
C12	0.042	0.007	0.003	0.25	0.168
C21	0.028	0.004	0.003	0.25	0.110
C22	0.028	0.008	0.002	0.25	0.110
C31	0.084	0.019	0.003	0.25	0.335
C41	0.028	0.008	0.000	0.25	0.110
H11	0.042	0.010	0.003	0.25	0.167
H12	0.042	0.010	0.001	0.25	0.167
H13	0.042	0.011	0.000	0.25	0.167

H21	0.063	0.016	0.003	0.25	0.250
H22	0.063	0.017	0.001	0.25	0.250
U11	0.025	0.005	0.001	0.15	0.168
U12	0.025	0.010	0.001	0.15	0.168
U21	0.025	0.006	0.002	0.15	0.168
U22	0.025	0.007	0.001	0.15	0.168
U31	0.025	0.006	0.001	0.15	0.165
U32	0.025	0.005	0.000	0.15	0.165
I11	0.060	0.015	0.000	0.2	0.300
I12	0.060	0.017	0.000	0.2	0.300
I21	0.040	0.012	0.001	0.2	0.200
I22	0.040	0.014	0.000	0.2	0.200
P11	0.050	0.011	0.002	0.15	0.333
P12	0.050	0.010	0.001	0.15	0.333
P13	0.050	0.014	0.001	0.15	0.333

Every viable solution's distance from the ideal solution (S_i^+) and the negative ideal solution (S_i^-) is calculated by (Equations 10 and 11). (P_i), the relative degree of approximation is computed using (Equation 12). Table 10 shows the data for the countries studied, ranked by the relative degree of approximation.

Table 10 Ranking Obtained by TOPSIS and I-DESI Weighting Coefficients (2018)

Countries	Distance S_i^+	Distance S_i^-	Scoring P_i	Ranking
Austria	0.0255	0.0276	0.5198	19
Belgium	0.0283	0.0253	0.4719	23
Bulgaria	0.0335	0.0202	0.3759	32
Croatia	0.0378	0.0150	0.2837	44
Cyprus	0.0329	0.0220	0.4007	30
Czech Rep.	0.0274	0.0253	0.4803	22
Denmark	0.0172	0.0362	0.6778	4
Estonia	0.0228	0.0294	0.5635	16
Finland	0.0174	0.0372	0.6810	3
France	0.0230	0.0325	0.5853	13
Germany	0.0228	0.0316	0.5807	14
Greece	0.0357	0.0183	0.3386	38
Hungary	0.0333	0.0194	0.3683	34
Ireland	0.0193	0.0328	0.6291	7
Italy	0.0374	0.0168	0.3096	41
Lithuania	0.0332	0.0234	0.4134	27
Latvia	0.0327	0.0213	0.3943	31

Luxembourg	0.0224	0.0346	0.6071	8
Malta	0.0293	0.0256	0.4669	24
Netherlands	0.0168	0.0370	0.6880	2
Poland	0.0366	0.0187	0.3380	39
Portugal	0.0350	0.0198	0.3608	35
Romania	0.0349	0.0210	0.3756	33
Slovakia	0.0340	0.0190	0.3594	36
Slovenia	0.0294	0.0229	0.4380	25
Spain	0.0320	0.0218	0.4052	28
Sweden	0.0198	0.0375	0.6549	6
United Kingdom	0.0233	0.0320	0.5794	15
Iceland	0.0243	0.0350	0.5906	12
Norway	0.0227	0.0348	0.6059	9
Switzerland	0.0189	0.0384	0.6708	5
Republic of Serbia	0.0363	0.0190	0.3434	37
Australia	0.0208	0.0317	0.6034	10
Brazil	0.0384	0.0186	0.3261	40
Canada	0.0272	0.0273	0.5015	20
Chile	0.0386	0.0164	0.2987	43
China	0.0317	0.0231	0.4214	26
Israel	0.0228	0.0341	0.5996	11
Japan	0.0272	0.0322	0.5416	17
Korea, Republic of	0.0284	0.0279	0.4958	21
Mexico	0.0395	0.0174	0.3056	42
New Zealand	0.0240	0.0282	0.5410	18
Russia Federation	0.0330	0.0224	0.4048	29
Turkey	0.0382	0.0146	0.2767	45
United States	0.0167	0.0382	0.6952	1

Table 11 displays the results of the three ranking methods as well as the I-DESI data for 2018. Appendix F contains results from 2015 to 2017.

Table 11 Comparison Of The Calculated Scores & Rankings (2018)

Country	I-DESI Overall Index		TOPSIS & Index Weighting Coef.		Entropy		Entropy based TOPSIS	
	Score %	Rank	Score %	Rank	Score %	Rank	Score %	Rank
Austria	52	21	52	19	43	22	37	24
Belgium	49	22	47	23	45	21	42	20

Bulgaria	40	35	38	32	31	33	34	28
Croatia	35	43	28	44	26	39	28	33
Cyprus	47	25	40	30	32	32	26	38
Czech Rep.	47	25	48	22	45	20	48	15
Denmark	70	2	68	4	61	6	54	9
Estonia	57	15	56	16	50	16	48	14
Finland	68	3	68	3	63	5	56	8
France	57	15	59	13	47	18	39	22
Germany	58	13	58	14	55	13	57	7
Greece	40	35	34	38	24	41	18	44
Hungary	41	31	37	34	29	37	27	34
Ireland	60	10	63	7	60	7	66	3
Italy	38	38	31	41	33	31	36	26
Lithuania	44	29	41	27	42	24	44	18
Latvia	41	31	39	31	35	29	33	31
Luxembourg	62	8	61	8	56	10	53	11
Malta	48	23	47	24	40	25	37	25
Netherlands	68	3	69	2	69	2	71	2
Poland	36	42	34	39	31	34	33	30
Portugal	41	31	36	35	30	36	25	39
Romania	41	31	38	33	26	40	21	42
Slovakia	39	37	36	36	31	35	26	36
Slovenia	47	25	44	25	36	28	33	32
Spain	47	25	41	28	34	30	26	35
Sweden	65	6	65	6	64	4	58	6
United Kingdom	59	12	58	15	56	11	52	13
Iceland	62	8	59	12	59	9	59	7
Norway	64	7	61	9	56	12	46	14
Switzerland	66	5	67	5	69	1	75	1
Republic of Serbia	38	38	34	37	22	45	15	45
Australia	60	10	60	10	53	14	50	18
Brazil	37	40	33	40	27	38	26	35
Canada	55	18	50	20	47	19	41	22
Chile	35	43	30	43	24	43	22	41
China	48	23	42	26	38	27	36	25
Israel	58	13	60	11	60	8	54	8
Japan	57	15	54	17	50	17	43	20
Korea	54	19	50	21	43	23	34	28
Mexico	37	40	31	42	24	42	22	40
New Zealand	54	19	54	18	50	15	47	17
Russia Federation	43	30	40	29	39	26	39	21

Turkey	34	45	28	45	23	44	19	43
United States	71	1	70	1	64	3	61	4

Table 12 compares the results of dimension weights derived using the Entropy method to those obtained from the I-DESI initial model. On average, the Entropy method gives the highest weights to "Connectivity" (27%) and "Integration of Digital Technology and Business" (28%) dimensions, whereas the I-DESI scoring model gives it to "Connectivity" (25%) and "Human Capital" (25%) dimensions. On average, the entropy method offers roughly double the weight to the "Use of Internet Services by Citizens" dimension (20%) than to the "Digital Public Services" (9%) dimension, while the scoring model gives both the same (15%) weight.

Table 12 Entropy Weight Coefficients Vs I-DESI Coefficients (2015-2018)

Dimensions	I-DESI	2015		2016		2017		2018	
		Entropy	Diff	Entropy	Diff	Entropy	Diff	Entropy	Diff
Connectivity	25%	31%	6%	29%	4%	29%	4%	21%	-4%
Human Capital	25%	15%	-10%	15%	-10%	16%	-9%	17%	-8%
Use of Internet Services by Citizens	15%	20%	5%	19%	4%	21%	6%	19%	4%
Integration of Digital Technology by Businesses	20%	24%	4%	26%	6%	27%	7%	34%	14%
Digital Public Services	15%	9%	-6%	10%	-5%	7%	-8%	10%	-5%

E. Spearman Correlation

For the period 2015 to 2018, the study of Spearman correlation applied to the three ranking methods and the I-DESI one shows a very strong positive relationship between the TOPSIS method ($r_s = 0.96$), the Entropy method ($r_s = 0.82$) and

the I-DESI initial method, as well as a moderate positive relationship with the Entropy-based TOPSIS method ($r_s = 0.66$). Table 13 presents the computed Spearman correlation ratios.

Table 13 Spearman Correlations Between Ranking Methods (2015-2018)

Spearman Correlation Method	I-DESI Ranking Method			
	2015	2016	2017	2018
Entropy-based TOPSIS	0.644	0.502	0.617	0.870
Entropy	0.786	0.731	0.797	0.953
TOPSIS	0.958	0.943	0.953	0.988

F. Kendall's W Concordance

Kendall's concordance coefficient analysis shows that the ranking of countries according to the four ranking methods is strongly consistent with a confidence interval of 99% (coefficient of concordance ranging between 0.83 and 0.94). Table 14 details Kendall's W results.

Table 14 Kendall's W Concordance Between Ranking Methods (2015-2018)

Year	2015	2016	2017	2018
Kendall's W	0.869	0.826	0.860	0.945

G. Top-Down Clustering of Countries

This part replicates the hierarchical clustering (Top-down) performed for the EU countries in the DESI mentioned earlier in the literature review section (European Commission, 2016). The clustering method is applied to the I-DESI-45 countries after calculating two factors: "Average rate of growth" (1.3% on average) and "Current level of development" (50% on average) of the digital economy. As a result, countries are categorized into four (04) clusters (Table 15):

- Running ahead: above both averages;

- Lagging ahead: above “the level of development” and below “the rate of growth”;
- Catching Up: below “the level of development” and above “the rate of growth”;
- Falling behind: below both averages.

Table 15 Clustering of I-DESI 45 Countries According to Progress and Performance Towards Digital Economy (2018).

		The rate of growth relative to the average I-DESI-45	
		< 1.3%	> 1.3%
The level of development relative to the average I-DESI-45	> 0.50 points	<p>“Lagging ahead”:</p> <p>Austria, Luxembourg, United Kingdom, Iceland, Canada, New Zealand</p>	<p>“Running ahead”:</p> <p>United States, Netherland, Estonia, Germany, Australia, Denmark, Finland, France, Ireland, Sweden, Norway, Switzerland, Israel, Japan, South Korea</p>
	< 0.50 points	<p>“Falling behind”:</p> <p>Belgium, Spain, Hungary, Cyprus, Bulgaria, Italy, Romania, Croatia, Greece, Latvia, Malta, Portugal, Slovakia, Chile, Mexico, Serbia</p>	<p>“Catching up”:</p> <p>Czech Republic, Poland, Lithuania, Slovenia, Brazil, China, Russia, Turkey</p>

A variance walk from DESI clusters to I-DESI clusters is done for the EU-27. The following are the outcomes of the variance walk:

- The average level of development is greater by 2% in the DESI index than in the I-DESI index, while the average rate of growth is greater by +0.7%.
- "Running ahead" cluster: Only two countries downgraded; Austria joined the cluster of "Lagging ahead," and Portugal dropped to the last

cluster "Falling behind" while Sweden, Estonia, Denmark, Finland, and Ireland were promoted to the "Running ahead" cluster;

- "Lagging ahead" cluster: Only two countries downgraded; Lithuania joined the cluster "Catching up" and Belgium dropped to the "Falling behind" cluster. While countries that upgraded to the "Running ahead" cluster are Sweden, Estonia, Denmark, Finland, and Ireland;
- "Catching up" cluster: All five (05) countries dropped to the last cluster "Falling behind" such as Spain, Latvia, Italy, Croatia, Romany;
- "Falling behind" cluster: France joined the "Running ahead" cluster, while the Czech Republic and Poland advanced to the "Catching up" cluster.

H. K-Means Clustering of Countries

R programming and RStudio are used to compute the K-means Clustering algorithm. One of the most difficult issues in clustering in general is the number of clusters or the value of K (Shen et al., 2005). This is also a difficulty with hierarchical and density-based clustering. There are no general methods for calculating the number of clusters (Sugar & James, 2003). There are a few techniques that succeed on an individual basis. The Elbow method and the Silhouette method are two easy methods for finding the number of clusters.

The distance measurements are another aspect in the clustering procedure. A new equation for determining distance for each data set would yield a different value and a different method of forming clusters. Euclidean distance is the most often used distance measure. Manhattan Distance and Minkowski Distance are two more common distance measurements. However, both Euclidean and Manhattan can be classified as Minkowski variations (Singh et al., 2013).

The number of clusters selected is four (04) and was determined based on the Elbow method selected for its popularity and easiness. (Figure 7). Similar to the number of clusters isolated in the section above, comparison of results between K-mean and hierarchical clustering can be performed. Such comparison will help distinguish "look-alike" countries in terms of digital economy status. Such countries share the same cluster based on both clustering methods.

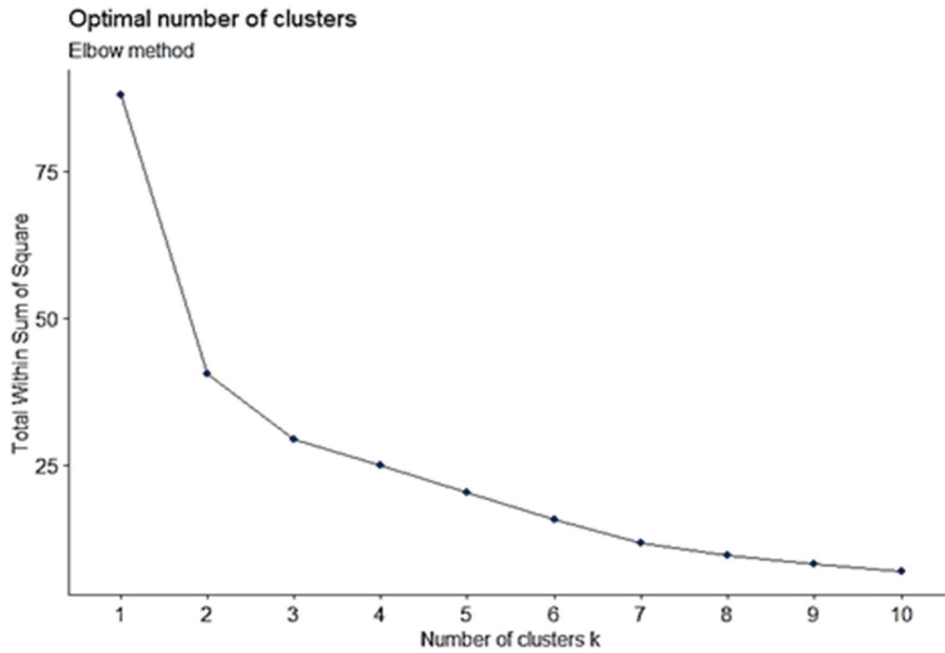


Figure 7 Elbow Method for Selection of Optimal “K” Clusters. (It is originated with the help of Rstudio)

Data from hierarchical clustering is also used in the K-means clustering method for consistency. Figure 8 denotes the clusters formed by using the K-means clustering method with the Euclidean distance. The I-DESI scores are shown on the X-axis, and the rate of growth is shown on the Y-axis.

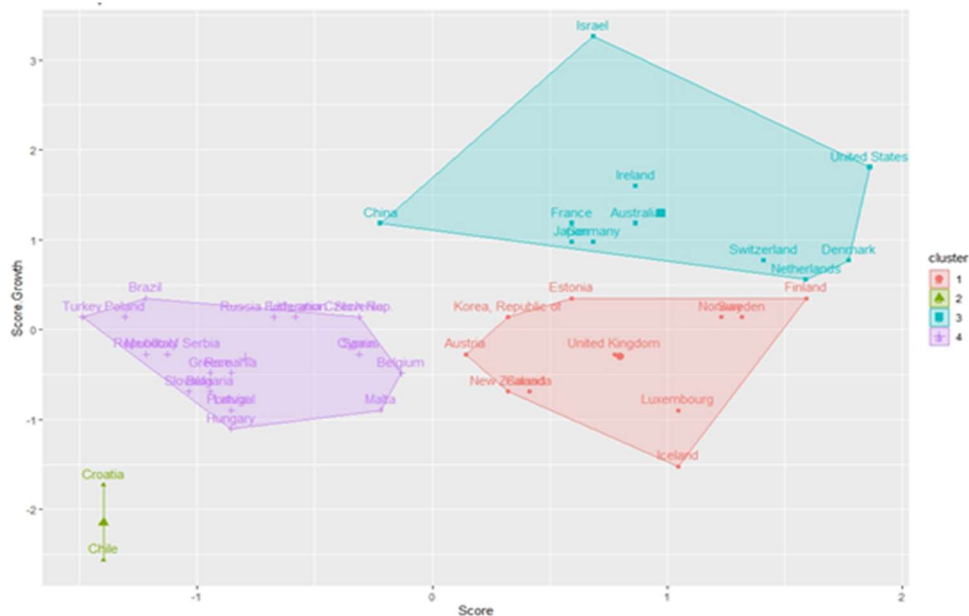


Figure 8 K-Means Clusters of I-DESI Countries (Year 2018). (It is originated with the help of Rstudio).

The resulting clusters are arranged below based on decreasing performance:

- Cluster 1: (11 countries), Finland, Estonia, Korea Republic, Norway, Sweden, United Kingdom, Austria, New Zealand, Canada, Luxembourg, and Iceland.
- Cluster 2: (2 countries), Croatia and Chile.
- Cluster 3: (11 countries), United States, Denmark, Netherlands, Switzerland, Ireland, Australia, Israel, Germany, Japan, France and China.
- Cluster 4: (21 countries), Belgium, Bulgaria, Cyprus, Czech Republic, Greece, Hungary, Italy, Lithuania, Latvia, Malta, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Serbia Republic, Brazil, Mexico, Russia, and Türkiye.

I. Turkey's Digital Economy Forecasting

The forecasting figures for Turkey and the I-DESI-45 member states are computed by using (Equation 16). The final results for the proposed values (e.g., values of S, A, b) by country and indicator are reported in Appendices H.1, H.2, and H.3. Taking into account the progress and data values from 2015 to 2018, the Gompertz II diffusion model is applied to the values of sixteen (16) forecastable indicators (white rows in Table 2). The remaining eight (08) indicators are kept constant.

1. Connectivity

Forecasted values are generated for each indicator, and each indicator contributes to a single sub-dimension (column "Indicator Weight"). The weighted average of the normalized indicators is used to compute each of the four I-DESI Connectivity subdimensions. Finally, the I-DESI "Connectivity dimension" score is estimated as the weighted average of four subdimensions: (1) Fixed broadband (33%), (2) mobile broadband (22%), (3) speed (33%), and (4) affordability (11 %).

The plot (Figure 3) below displays the Connectivity dimension for Turkey and the I-DESI-45 average. The proposed method predicts a consolidated and unchanged gap between Turkey and the IDESI-45 average until at least 2030. In terms of connectivity, Turkey appears to be at a standstill, scores from 2015 to 2018 were ranging horizontally and forecasted scores are plummeting. Fixed broadband and speed seem to be the subdimensions that require the most effort.

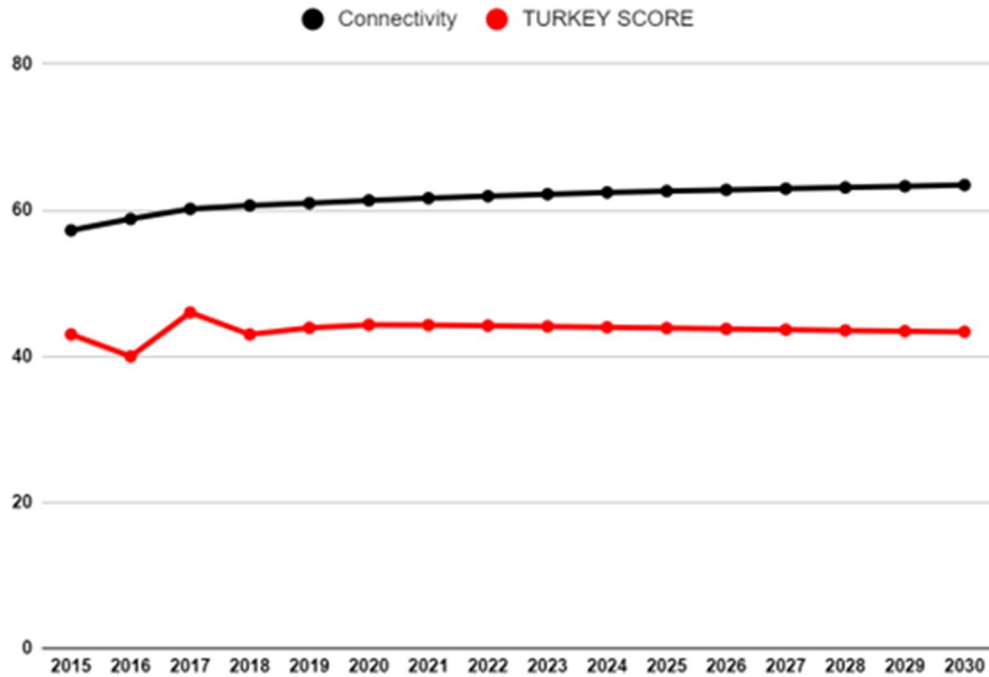


Figure 9 Forecast of I-DESI Connectivity Dimension 2019-2030

2. Human Capital

Forecasted values are produced for each indicator, with each indicator contributing to a single sub-dimension (column "Indicator Weight"). The weighted average of the normalized indicators is used to construct each of the two DESI Human Capital subdimensions.

Finally, the I-DESI "Human Capital" dimension is computed as the weighted average of two subdimensions: (1) Internet user skills (50%) and (2) Advanced skills and development (50%).

The plot (Figure 10) displays the I-DESI Human Capital dimensions for Turkey as well as the IDESI-45 average. The results suggest that Turkey is slightly diverging from the other countries, implying that a more effective strategy is required for Turkey to reach the IDESI-45 average. Regarding the human capital dimension, the required strategy should enhance "Internet User Skills" as it appears from data to be the sub-dimension that requires the most effort. Such strategy should boost training for people to acquire basic and advanced IT skills (word, spreadsheets, coding) and increase the number of ICT graduates from educational institutions.

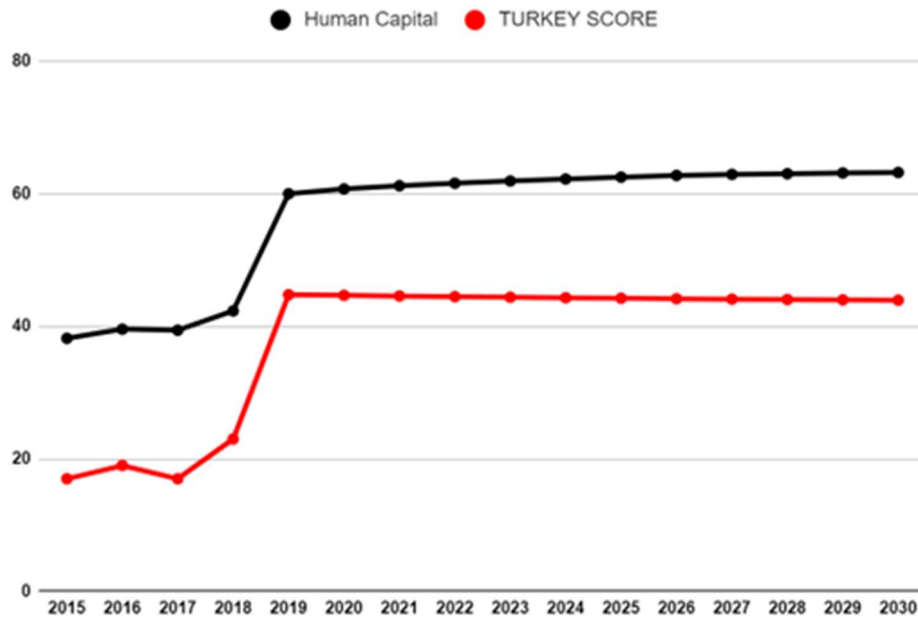


Figure 10 Forecast of I-DESI Human Capital Dimension 2019-2030

3. Use of Internet Services

Forecasted values are performed for each indicator, with each indicator contributing to a single sub-dimension (column "Indicators Weight"). The weighted average of the normalized indicators is employed to compute each of the three I-DESI Use of Internet sub-dimensions. Finally, the I-DESI "Use of Internet" dimension is constructed as the weighted average of three subdimensions: (1) Internet use (33.5 %), (2) Online Activities (33.5 %), and (3) Transactions (33.5 %).

Figure 11 illustrates the I-DESI Use of Internet dimension for Turkey as well as the IDESI-45 average. According to the estimates, Turkey's scores are converging from 2015 to 2020. After that year, Turkey is expected to the IDESI-45 average. This forecast cannot be confirmed since relevant data for 2020 is not yet available. It is the only dimension in which there is a convergence. By 2018, the sustained significant increase of Turkey score is mostly due, according to data, to the rapid expansion of internet use for video calls and social networks among people in Turkey.

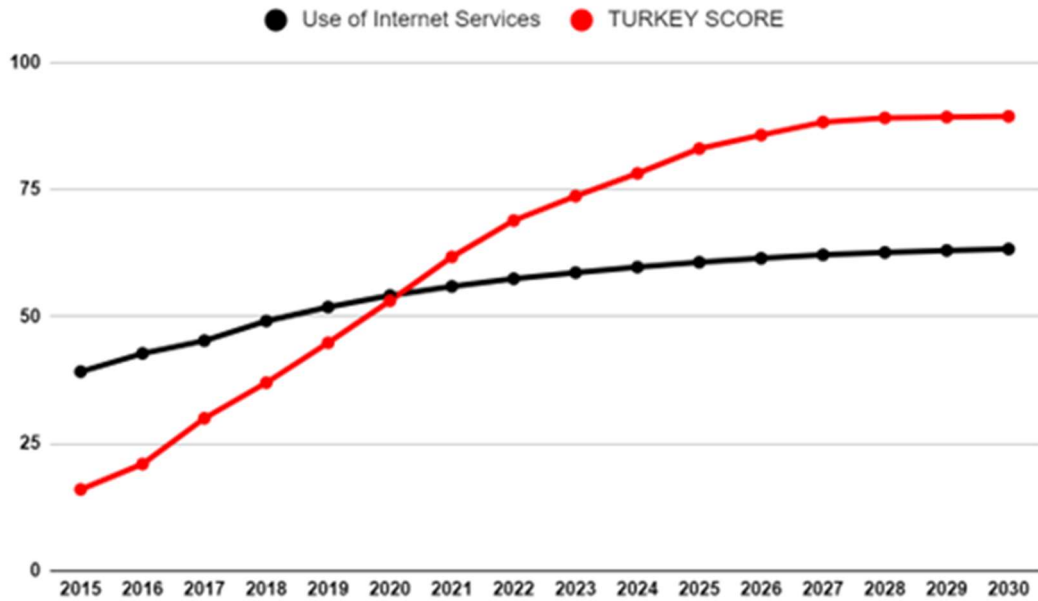


Figure 11 Forecast of I-DESI “Use of Internet Services” Dimension 2019-2030.

4. Integration of Digital Technology

Forecasted values are performed for each indicator, with each indicator contributing to a single sub-dimension (column "Indicator Weight"). The weighted average of the normalized indicators is used to determine each of the two I-DESI Integration of Digital Technologies subdimensions. Finally, the weighted average of the two subdimensions: (1) Business digitization (60%) and (2) E-commerce is used to construct the "Integration of Digital Technologies" dimension (40%).

Figure 12 illustrates the I-DESI Integration of Digital Technology dimension for Turkey as well as the IDESI-45 average. A cointegration developed between 2017 and 2019, as Turkey is following the dimension average. Starting 2019, a consolidated unchanging gap appears and lasts at least until 2030.

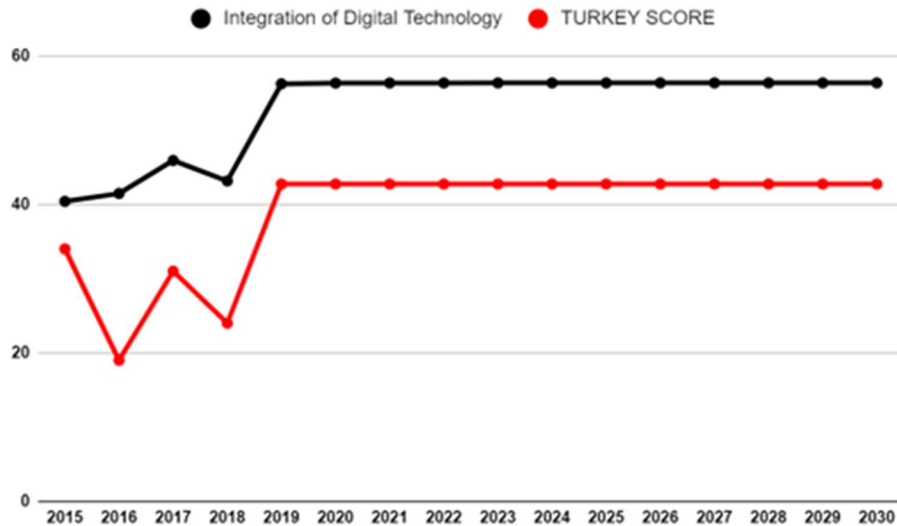


Figure 12 Forecast of I-DESI “Integration of Digital Technology” Dimension 2019-2030.

5. Digital Public Services

Forecasting techniques are applied to the values of the indicator "E Government Users" for Turkey and the IDESI-45 average, taking into account progress and data values for the period 2015-2018. The remaining indicators' values are kept constant.

Figure 13 shows the I-DESI "Digital Public Services" dimension for Turkey and the IDESI-45 average. The projections indicate that the IDESI-45 average is rising away from Turkey, whose dimension score remains almost constant until 2030. Turkey strategy regarding this dimension should enhance e-government services to comparable leading countries; make it possible to complete each step of key services completely online.

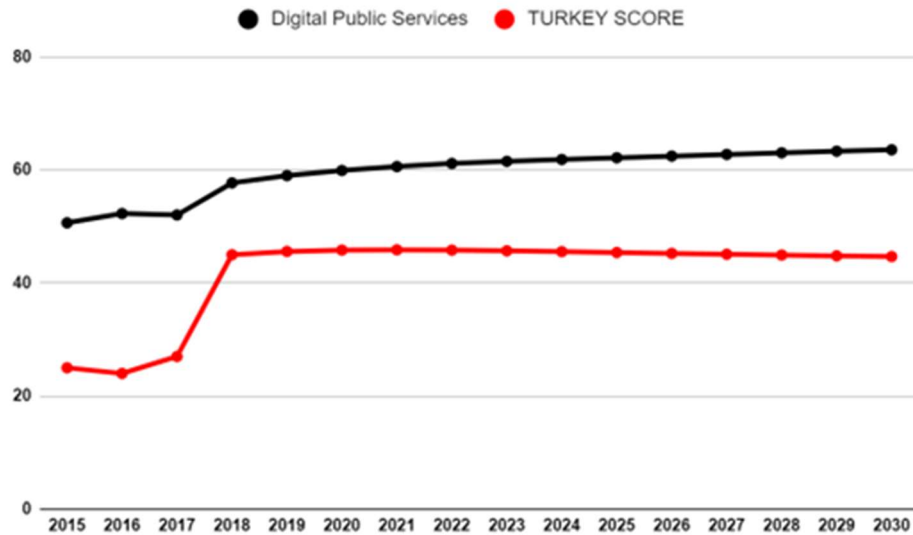


Figure 13 Forecast of I-DESI “Digital Public Services” Dimension 2019-2030.

6. Overall I-DESI Index

The overall results (Figure 14) shows that Turkey’s score will remain 12 points lower than the I-DESI average, at least until 2030. The current projection implies that six (06) indicators out of twenty-four (24) are treated as constant values and that the remaining I-DESI member countries will show progress as predicted. To score and rank higher in the I-DESI index, Turkish policymakers should undertake significant initiatives as detailed above in the Connectivity and "Human Capital" dimensions, as well as the sub-dimensions identified in this study. Limitations to this study and the forecasting outcomes may be caused by the events that occurred beginning in 2020 (Covid-19, working from home measures, Russia-Ukraine war, record inflation, etc.). Covid-19 and stay home policy boosted use of internet and technology at all society levels in general. War may hinder IT infrastructure and inflation may decrease access to IT equipment and services.

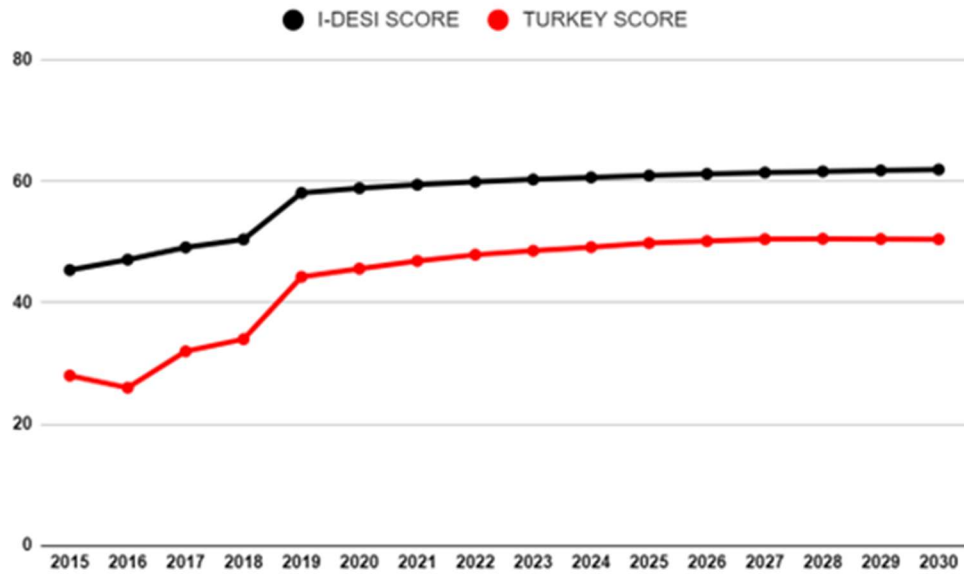


Figure 14 Forecast Of The Overall I-DESI Index 2019-2030.

VI. CONCLUSION

This study assesses the methodology and outcomes of the International Digital Economy and Society Index (I-DESI), employs two digital economy clustering methods, forecasts the overall and dimension scores of the I-DESI 45 countries, and compares their forecasted average to Turkey's results.

The first objective is to compare criteria weights by using an objective method, which is called the Entropy. The results demonstrate that the Entropy method gives the highest weights to "Connectivity" (27%) and "Integration of Digital Technology and Business" (28%) dimensions, whereas the I-DESI scoring model gives it to "Connectivity" (25%) and "Human Capital" (25%) dimensions. The Entropy method, on average, gives nearly double the weight to the "Use of Internet Services by Citizens" dimension (20%) than to the "Digital Public Services" (9%) dimension, whereas the I-DESI scoring model gives both the same weight (15%). The differences found mean that countries (mostly non-EU) who are doing well in "Use of Internet Services" dimension, like Turkey, get penalized in the I-DESI computation as the subjectively fixed weight is almost half what the entropy generated.

The second objective is to compare the I-DESI initial ranking model with three alternative Entropy-based, a TOPSIS-based, and Entropy-based TOPSIS models. The result revealed a very strong significant correlation between the I-DESI initial model and the TOPSIS-based model ($r_s = 0.96$) and the Entropy-based model ($r_s = 0.82$). While a moderate positive correlation is found with the Entropy-based TOPSIS model ($r_s = 0.66$) for the period 2015 to 2018. Finally, for the same period, the four ranking models agree to a considerable extent (Kendall's $W=0.87$). This agreement means that the I-DESI ranking computation is similar to the models compared to.

The third objective is to cluster I-DESI countries by using two methods. A hierarchical clustering method, named DIvise Analysis (DIANA) is a top-down clustering method. A variance walk of EU countries from DESI clusters to I-DESI clusters is performed. The major findings are listed as follow:

- The higher average levels of development (+2%) and rate of growth (+0.7%) found in DESI compared to the I-DESI means the European countries are better developed and progress faster than the remaining non-EU 18 countries.
- "Running ahead" cluster: only two countries downgraded. Meaning this cluster EU countries tend to keep their leading position even compared to other selected non-EU 18 countries.
- Sweden, Estonia, Denmark, Finland, and Ireland have been promoted to the "Running ahead" cluster; meaning they rank higher compared to non-EU 18 countries.
- "Catching up" cluster: all five (05) countries dropped to the last cluster "Falling behind", i.e. Spain, Latvia, Italy, Croatia, Romania; meaning these countries performance is less than some non-EU countries, thus being replaced by them.

Furthermore, the I-DESI countries were clustered using the K-mean clustering method. Computed K-mean clusters compared to clusters found above share some major findings:

- Cluster 3 (United States, Denmark, Netherlands, Switzerland, Ireland, Australia, Israel, Germany, Japan, France, and China.) is quite similar to "Running ahead" cluster above.
- Cluster 1 (Finland, Estonia, Korea Republic, Norway, Sweden, United Kingdom, Austria, New Zealand, Canada, Luxembourg, and Iceland) is quite similar to "Lagging ahead" cluster.
- Cluster 2: Croatia and Chile are isolated. Meaning their scores are too close to each other but also far away from other countries scores. Meaning that is K-mean clustering is more precise than the hierarchical one.

Finally, the final objective is to forecast the forty-five (45) digital economies covered by the I-DESI index. Forecasting a digital competitiveness index, such as the I-DESI, builds on previous regional studies (Laitsou et al., 2020) and extends them to a global scale. The Gompertz model is implemented on the composite index, and the findings show the areas of convergence and divergence between Turkey and the I-DESI average scores. This primary result demonstrates that Turkey's scores are significantly lower than the overall index average score and dimensions scores. The overall results shows that Turkey's score will remain 12 points lower than the I-DESI

average, at least until 2030. Results mean either other 44 countries are progressing in most dimensions faster than Turkey despite the latter efforts or Turkey plan described in the literature chapter is not performing well or both assumptions. Predictions till 2030 reveal that Turkey will face substantial challenges in four (04) of the five (05) dimensions, particularly in the "fixed broadband," "Speed," and "Internet User Skills" sub-dimensions. This study findings and recommendations could be used to adapt existing policies and strategies and identify areas for future improvement to reach high levels of digital competitiveness and Industry 4.0's framework. Such strategies should include the following recommendations:

- **I-DESI index:** Turkish policymakers, if they are willing to score higher and faster in the I-DESI, should give more importance to two dimensions: Connectivity and "Human Capital", because they weight together 50%. Added to that, maintaining the rising performance of Use of Internet Services dimension, this strategy orientation will prove effective and straightforward.
- **Connectivity:** working on fixed broadband expansion and internet speed increase.
- **Human Capital:** The required strategy should enhance "Internet User Skills". Such strategy should boost training for people to acquire basic and advanced IT skills (word, spreadsheets, coding) and increase the number of ICT graduates from educational institutions.
- **Use of Internet Services:** capitalizing on the relatively good progress by increasing the use of technology related to banking and shopping transactions and increasing the number of internet users in rural areas in particular.

Digital Public Services: enhance e-government services to comparable leading countries; make it possible to complete each step of key services completely online.

Few challenges were encountered in this study; firstly, the I-DESI and DESI indexes are quite recent with data available starting from 201 to 2018. The assessment and forecasting results of the I-DESI could be more accurate if more years of data were available. Secondly, as the indices are recent in their invention and use, the literature available focusing on the I-DESI is quite rare.

However, at the same time, the digital economy is an interesting new field of study presenting more opportunities for avid researchers as it is growing in size in the global GDP and reshaping more and more world economies.

Further research could be done by using different MCDM methods and forecasting models in order to compare studies results and findings. Also, researchers could approach the digital economy field in general and of Turkey in particular using different Index or metric and compare findings.

The rate at which digital technologies continue to infiltrate communities is increasing all the time. And the distinctions between the old and new digital economies are getting increasingly indistinct.

Against this outlook, further research should investigate the digital economy's prospects and challenges for a wide sustainability agenda, and therefore for people, communities and the planet.

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APPENDIX A.1: I-DESI Data - Year 2018

	AT	BE	BG	HR	CY	CZ	DK	EE	FI	FR	DE	EL	HU	IE	IT	LT	LV	LU	MT	NL	PL	
C11	0.200	0.322	0.189	0.189	0.289	0.222	0.378	0.256	0.233	0.389	0.344	0.311	0.244	0.222	0.200	0.200	0.189	0.300	0.378	0.367	0.100	
C12	0.960	1.000	0.900	1.000	1.000	0.920	0.980	0.720	0.880	0.960	0.960	0.900	0.880	0.920	0.980	0.700	0.880	1.000	1.000	1.000	1.000	0.380
C21	0.980	1.000	1.000	0.990	0.980	1.000	1.000	0.990	1.000	0.990	0.980	0.990	0.990	0.900	0.990	0.980	1.000	0.970	1.000	0.995	1.000	
C22	0.378	0.309	0.457	0.331	0.445	0.378	0.648	0.704	0.758	0.398	0.342	0.344	0.266	0.466	0.414	0.448	0.612	0.411	0.503	0.335	0.843	
C31	0.583	0.640	0.504	0.253	0.268	0.660	0.748	0.542	0.705	0.753	0.638	0.409	0.418	0.611	0.286	0.826	0.486	0.824	0.732	0.508	0.496	
C41	0.385	0.574	0.328	0.319	0.184	0.696	0.204	0.370	0.415	0.307	0.366	0.010	0.023	0.412	0.764	0.902	0.611	0.021	0.623	0.609	0.690	
H11	0.555	0.516	0.259	0.353	0.428	0.451	0.693	0.552	0.722	0.465	0.628	0.311	0.423	0.624	0.429	0.411	0.465	0.796	0.455	0.751	0.347	
H12	0.467	0.311	0.464	0.260	0.405	0.410	0.645	0.428	0.581	0.614	0.695	0.367	0.290	0.659	0.224	0.369	0.299	0.733	0.468	0.613	0.176	
H13	0.246	0.336	0.222	0.139	0.415	0.162	0.882	0.382	0.827	0.362	0.511	0.419	0.154	0.646	0.226	0.374	0.259	0.887	0.242	0.548	0.071	
H21	0.471	0.274	0.463	0.343	0.455	0.373	0.451	0.428	0.364	0.455	0.288	0.401	0.343	0.357	0.365	0.187	0.418	0.289	0.369	0.437	0.344	
H22	0.689	0.259	0.387	0.228	0.357	0.553	0.399	0.635	0.600	0.579	0.469	0.253	0.298	0.638	0.113	0.124	0.555	0.380	0.431	0.550	0.460	
U11	0.795	0.811	0.413	0.545	0.741	0.678	0.961	0.823	0.815	0.701	0.829	0.549	0.601	0.742	0.573	0.662	0.726	0.951	0.690	0.912	0.626	
U12	0.417	0.386	0.068	0.113	0.226	0.183	0.498	0.181	0.405	0.357	0.413	0.161	0.126	0.642	0.296	0.148	0.137	0.953	0.237	0.433	0.130	
U21	0.327	0.323	0.375	0.285	0.552	0.361	0.638	0.380	0.375	0.228	0.473	0.379	0.392	0.308	0.278	0.546	0.466	0.415	0.230	0.528	0.268	
U22	0.376	0.635	0.139	0.302	0.476	0.408	0.715	0.494	0.559	0.226	0.369	0.374	0.538	0.468	0.286	0.439	0.486	0.517	0.217	0.543	0.332	
U31	0.584	0.687	0.295	0.251	0.457	0.624	0.895	0.804	0.887	0.635	0.588	0.273	0.413	0.577	0.338	0.606	0.663	0.677	0.595	0.889	0.440	
U32	0.603	0.605	0.335	0.275	0.489	0.586	0.844	0.613	0.699	0.671	0.768	0.359	0.412	0.590	0.357	0.434	0.449	0.718	0.664	0.799	0.478	
I11	0.671	0.800	0.106	0.131	0.123	0.524	0.729	0.579	1.000	0.723	0.741	0.166	0.344	0.511	0.302	0.529	0.403	0.848	0.586	0.902	0.143	
I12	0.457	0.506	0.160	0.531	0.395	0.309	0.667	0.370	0.864	0.506	0.840	0.148	0.642	0.568	0.062	0.420	0.123	0.716	0.272	0.864	0.000	
I21	0.242	0.427	0.180	0.114	0.137	0.280	0.632	0.373	0.733	0.187	0.241	0.118	0.181	0.498	0.239	0.221	0.150	0.252	0.060	0.530	0.103	
I22	0.221	0.185	0.507	0.259	0.084	0.561	0.570	0.649	0.450	0.270	0.747	0.067	0.255	0.925	0.162	0.243	0.192	0.572	0.191	0.973	0.215	
P11	0.661	0.565	0.424	0.376	0.521	0.532	0.915	0.789	0.825	0.710	0.568	0.498	0.529	0.537	0.243	0.508	0.656	0.630	0.614	0.815	0.355	
P12	0.525	0.342	0.492	0.203	0.509	0.460	0.949	0.755	1.000	0.908	0.785	0.663	0.203	0.817	0.877	0.464	0.142	0.831	0.586	0.970	0.709	
P13	0.517	0.397	0.560	0.212	0.884	0.448	0.622	0.759	0.407	0.948	0.259	0.603	0.368	0.724	0.431	0.100	0.328	0.310	0.495	0.517	0.483	

APPENDIX A.1 (Cont.): I-DESI Data - Year 2018

	PT	RO	SK	SI	ES	SE	UK	IS	NO	CH	RS	AU	BR	CA	CL	CN	IL	JP	KR	MX	NZ	RU	TR	US
C11	0.300	0.178	0.200	0.211	0.244	0.322	0.333	0.344	0.344	0.400	0.078	0.267	0.056	0.322	0.078	0.211	0.211	0.244	0.356	0.056	0.278	0.133	0.067	0.289
C12	0.840	0.880	0.720	0.960	0.920	0.920	0.980	1.000	0.940	1.000	0.849	0.840	0.792	0.909	0.883	0.840	0.984	0.880	0.980	0.872	0.820	0.756	0.612	1.000
C21	0.990	0.930	0.940	1.000	0.980	1.000	1.000	0.980	1.000	0.990	0.970	0.990	0.830	0.990	0.876	0.990	0.675	0.954	1.000	0.778	0.970	0.700	0.930	1.000
C22	0.299	0.378	0.367	0.321	0.436	0.572	0.427	0.586	0.443	0.434	0.261	0.650	0.378	0.315	0.398	0.419	0.344	0.938	0.520	0.278	0.525	0.374	0.301	0.681
C31	0.559	0.328	0.650	0.588	0.394	0.763	0.773	0.838	0.859	0.802	0.380	0.530	0.154	0.517	0.447	0.290	0.585	0.829	0.646	0.117	0.612	0.264	0.300	0.405
C41	0.113	0.007	0.361	0.027	0.280	0.942	0.616	0.181	0.159	0.633	0.001	0.505	0.440	0.069	0.065	0.651	0.961	0.392	0.443	0.071	0.771	0.847	0.084	0.088
H11	0.383	0.405	0.396	0.489	0.490	0.625	0.636	0.733	0.695	0.705	0.474	0.582	0.292	0.634	0.396	0.339	0.528	0.432	0.489	0.377	0.476	0.282	0.327	0.560
H12	0.342	0.276	0.270	0.468	0.296	0.621	0.503	0.504	0.417	0.709	0.400	0.569	0.268	0.304	0.327	0.544	0.437	0.632	0.395	0.320	0.513	0.306	0.087	0.591
H13	0.284	0.099	0.155	0.436	0.295	0.602	0.584	0.886	0.842	0.720	0.028	0.381	0.206	0.647	0.560	0.528	0.506	0.906	0.405	0.601	0.465	0.268	0.150	0.696
H21	0.232	0.538	0.220	0.281	0.315	0.531	0.175	0.304	0.243	0.457	0.580	0.647	0.401	0.106	0.257	0.460	0.318	0.233	0.364	0.201	0.433	0.287	0.217	0.562
H22	0.042	0.569	0.397	0.451	0.533	0.618	0.383	0.311	0.313	0.352	0.427	0.628	0.518	0.298	0.050	0.478	0.570	0.140	0.237	0.305	0.440	0.631	0.329	0.835
U11	0.578	0.511	0.678	0.663	0.769	0.869	0.915	0.984	0.942	0.744	0.556	0.694	0.466	0.869	0.343	0.178	0.856	0.902	0.932	0.430	0.740	0.681	0.517	0.927
U12	0.186	0.098	0.151	0.205	0.257	0.444	0.369	0.593	0.666	0.676	0.052	0.472	0.142	0.385	0.127	0.297	0.337	0.361	0.267	0.116	0.337	0.137	0.097	0.631
U21	0.269	0.477	0.347	0.333	0.254	0.482	0.429	0.501	0.511	0.505	0.411	0.408	0.497	0.442	0.312	0.691	0.678	0.576	0.361	0.449	0.483	0.670	0.437	0.531
U22	0.456	0.552	0.465	0.317	0.441	0.605	0.597	0.878	0.757	0.482	0.210	0.380	0.439	0.635	0.367	0.514	0.617	0.476	0.545	0.431	0.404	0.436	0.463	0.653
U31	0.386	0.630	0.498	0.419	0.487	0.839	0.739	0.943	0.931	0.884	0.327	0.746	0.226	0.759	0.132	0.316	0.617	0.180	0.645	0.102	0.512	0.324	0.281	0.742
U32	0.367	0.406	0.590	0.507	0.533	0.777	0.828	0.753	0.790	0.860	0.403	0.691	0.277	0.764	0.055	0.501	0.719	0.578	0.620	0.160	0.562	0.468	0.251	0.774
I11	0.714	0.085	0.413	0.574	0.439	0.901	0.849	0.852	0.970	0.954	0.251	0.558	0.005	0.772	0.535	0.288	0.938	0.836	0.617	0.238	0.732	0.453	0.194	0.540
I12	0.259	0.123	0.210	0.247	0.099	0.926	0.765	0.481	0.617	0.889	0.148	0.481	0.025	0.531	0.012	0.383	1.000	0.728	0.370	0.037	0.531	0.198	0.506	0.877
I21	0.255	0.371	0.222	0.265	0.217	0.636	0.454	0.713	0.562	0.637	0.209	0.479	0.446	0.418	0.500	0.059	0.789	0.380	0.233	0.541	0.307	0.347	0.100	0.675
I22	0.212	0.211	0.172	0.439	0.150	0.246	0.361	0.856	0.277	0.903	0.091	0.436	0.027	0.410	0.107	0.006	0.127	0.154	0.027	0.003	0.234	0.069	0.057	0.872
P11	0.416	0.644	0.513	0.540	0.567	0.832	0.591	0.905	0.896	0.810	0.407	0.724	0.300	0.695	0.299	0.458	0.652	0.161	0.560	0.257	0.537	0.448	0.456	0.818
P12	0.724	0.203	0.479	0.495	0.954	0.831	0.954	0.142	0.939	0.571	0.495	0.954	0.715	0.755	0.509	0.740	0.541	0.954	1.000	0.847	0.954	0.577	0.513	0.954
P13	0.276	0.579	0.241	0.552	0.603	0.052	0.379	0.106	0.483	0.121	0.462	0.638	0.674	0.655	0.240	0.677	0.414	0.690	1.000	0.621	0.517	0.789	0.384	0.670

APPENDIX A.2: I-DESI Data - Year 2017

	AT	BE	BG	HR	CY	CZ	DK	EE	FI	FR	DE	EL	HU	IE	IT	LT	LV	LU	MT	NL	PL
C11	0.200	0.311	0.167	0.178	0.278	0.222	0.378	0.233	0.233	0.378	0.333	0.289	0.222	0.211	0.189	0.200	0.189	0.289	0.344	0.356	0.111
C12	0.958	0.998	0.900	0.974	1.000	0.922	0.984	0.698	0.930	0.950	0.942	0.900	0.896	0.924	0.970	0.640	0.852	1.000	1.000	1.000	0.366
C21	0.980	1.000	0.990	0.980	0.960	1.000	1.000	0.990	1.000	0.980	0.970	0.980	0.990	0.900	0.980	0.980	0.950	0.960	1.000	0.990	1.000
C22	0.374	0.307	0.396	0.332	0.480	0.343	0.608	0.624	0.751	0.371	0.329	0.261	0.226	0.456	0.367	0.366	0.533	0.371	0.348	0.394	0.750
C31	0.782	0.774	0.518	0.603	0.771	0.609	0.794	0.688	0.774	0.771	0.712	0.626	0.444	0.691	0.524	0.726	0.556	0.782	0.529	0.735	0.515
C41	0.197	0.498	0.297	0.036	0.046	0.197	0.247	0.096	0.096	0.147	0.157	0.036	0.498	1.000	0.066	1.000	0.096	0.197	0.699	0.197	0.799
H11	0.655	0.570	0.450	0.395	0.528	0.582	0.614	0.540	0.703	0.545	0.616	0.509	0.496	0.456	0.479	0.468	0.429	0.821	0.377	0.764	0.421
H12	0.497	0.333	0.505	0.467	0.518	0.285	0.450	0.422	0.510	0.406	0.502	0.271	0.360	0.296	0.250	0.388	0.316	0.753	0.492	0.544	0.199
H13	0.485	0.349	0.301	0.222	0.339	0.286	0.923	0.463	0.689	0.412	0.369	0.450	0.269	0.317	0.404	0.298	0.132	0.718	0.099	0.576	0.214
H21	0.224	0.261	0.490	0.316	0.474	0.258	0.304	0.328	0.495	0.301	0.244	0.336	0.293	0.279	0.220	0.261	0.346	0.479	0.603	0.325	0.229
H22	0.395	0.185	0.374	0.552	0.272	0.455	0.476	0.744	0.630	0.303	0.470	0.289	0.431	0.728	0.105	0.275	0.496	0.594	0.793	0.251	0.353
U11	0.798	0.795	0.390	0.452	0.678	0.645	0.952	0.802	0.792	0.675	0.740	0.508	0.613	0.735	0.385	0.627	0.668	0.957	0.683	0.887	0.600
U12	0.384	0.358	0.059	0.101	0.207	0.161	0.463	0.157	0.372	0.334	0.385	0.149	0.112	0.566	0.279	0.129	0.118	0.876	0.214	0.396	0.117
U21	0.301	0.339	0.224	0.020	0.221	0.285	0.556	0.380	0.273	0.206	0.429	0.261	0.394	0.326	0.196	0.499	0.354	0.504	0.347	0.381	0.242
U22	0.349	0.627	0.153	0.209	0.341	0.311	0.673	0.471	0.547	0.237	0.341	0.333	0.528	0.451	0.245	0.381	0.465	0.574	0.242	0.554	0.307
U31	0.575	0.666	0.390	0.381	0.439	0.566	0.898	0.792	0.874	0.620	0.556	0.251	0.377	0.576	0.308	0.562	0.612	0.764	0.693	0.889	0.398
U32	0.616	0.596	0.281	0.320	0.503	0.556	0.802	0.582	0.708	0.667	0.749	0.321	0.386	0.531	0.322	0.381	0.456	0.800	0.582	0.789	0.450
I11	0.978	0.975	0.538	0.613	0.810	0.846	0.720	0.571	0.935	0.731	0.818	0.972	0.925	0.545	0.617	0.818	0.414	0.866	0.383	0.967	0.338
I12	0.672	0.574	0.258	0.465	0.370	0.228	0.507	0.405	0.571	0.340	0.536	0.092	0.595	0.393	0.023	0.597	0.247	0.912	0.470	0.880	0.038
I21	0.226	0.432	0.391	0.268	0.254	0.235	0.574	0.252	0.733	0.173	0.080	0.105	0.172	0.362	0.202	0.234	0.124	0.306	0.124	0.589	0.090
I22	0.098	0.110	0.428	0.193	0.230	0.337	0.580	0.386	0.296	0.196	0.453	0.049	0.180	0.511	0.102	0.173	0.158	0.570	0.187	0.933	0.086
P11	0.620	0.551	0.501	0.496	0.536	0.456	0.892	0.780	0.830	0.679	0.535	0.474	0.471	0.553	0.246	0.484	0.685	0.751	0.805	0.791	0.308
P12	0.606	0.491	0.284	0.397	0.179	0.365	0.710	0.720	0.863	0.770	0.719	0.539	0.471	0.778	0.809	0.629	0.253	0.588	0.666	0.758	0.583
P13	0.281	0.278	0.282	0.268	0.419	0.423	0.571	0.510	0.432	0.631	0.283	0.260	0.216	0.435	0.410	0.071	0.418	0.290	0.428	0.439	0.355

APPENDIX A.2 (Cont.): I-DESI Data - Year 2017

	PT	RO	SK	SI	ES	SE	UK	IS	NO	CH	RS	AU	BR	CA	CL	CN	IL	JP	KR	MX	NZ	RU	TR	US
C11	0.278	0.156	0.178	0.211	0.233	0.322	0.322	0.333	0.344	0.400	0.078	0.244	0.044	0.311	0.078	0.200	0.200	0.244	0.344	0.044	0.267	0.122	0.056	0.267
C12	0.828	0.884	0.774	0.954	0.914	0.944	0.982	0.992	0.888	0.996	0.969	0.816	0.813	0.962	0.984	0.987	0.819	0.693	0.972	0.890	0.825	0.828	0.667	0.949
C21	0.990	0.890	0.920	0.990	0.980	1.000	0.990	0.980	1.000	0.990	0.940	0.990	0.830	0.990	0.880	0.980	0.820	0.990	1.000	0.710	0.940	0.620	0.870	1.000
C22	0.273	0.350	0.348	0.278	0.408	0.570	0.374	0.519	0.433	0.439	0.226	0.634	0.394	0.289	0.368	0.349	0.478	0.894	0.514	0.250	0.454	0.344	0.279	0.632
C31	0.574	0.785	0.671	0.474	0.676	0.741	0.732	0.779	0.829	0.829	0.115	0.662	0.329	0.544	0.171	0.388	0.771	0.738	0.594	0.300	0.476	0.897	0.782	0.729
C41	0.116	1.000	0.036	0.096	0.006	1.000	0.810	0.498	0.056	0.046	0.096	0.147	0.001	0.026	0.297	1.000	0.147	0.006	1.000	0.096	0.237	0.297	0.006	1.000
H11	0.500	0.276	0.558	0.545	0.508	0.699	0.649	0.823	0.715	0.743	0.434	0.569	0.298	0.658	0.586	0.347	0.428	0.333	0.444	0.366	0.665	0.317	0.335	0.539
H12	0.486	0.508	0.326	0.491	0.340	0.419	0.508	0.747	0.493	0.626	0.236	0.465	0.304	0.385	0.429	0.515	0.129	0.460	0.231	0.348	0.406	0.367	0.287	0.637
H13	0.532	0.004	0.276	0.270	0.395	0.763	0.698	0.855	0.821	0.673	0.048	0.627	0.195	0.662	0.782	0.213	0.469	0.752	0.327	0.587	0.566	0.106	0.189	0.425
H21	0.272	0.588	0.257	0.414	0.231	0.338	0.158	0.397	0.281	0.422	0.324	0.453	0.432	0.216	0.370	0.591	0.031	0.267	0.268	0.232	0.279	0.350	0.182	0.570
H22	0.192	0.452	0.334	0.367	0.397	0.428	0.363	0.426	0.369	0.247	0.539	0.413	0.294	0.295	0.292	0.421	0.051	0.089	0.449	0.238	0.670	0.480	0.227	0.409
U11	0.563	0.395	0.693	0.648	0.743	0.925	0.910	0.972	0.940	0.828	0.505	0.775	0.458	0.850	0.705	0.238	0.693	0.743	0.918	0.398	0.847	0.600	0.412	0.788
U12	0.170	0.085	0.135	0.183	0.238	0.436	0.347	0.578	0.614	0.657	0.043	0.445	0.149	0.375	0.120	0.586	0.327	0.353	0.254	0.113	0.340	0.132	0.106	0.607
U21	0.246	0.294	0.388	0.298	0.220	0.507	0.443	0.483	0.477	0.369	0.244	0.517	0.440	0.492	0.251	0.177	0.323	0.489	0.413	0.387	0.426	0.362	0.331	0.325
U22	0.415	0.156	0.450	0.269	0.429	0.610	0.616	0.859	0.768	0.370	0.426	0.396	0.411	0.719	0.487	0.109	0.691	0.411	0.574	0.387	0.613	0.385	0.389	0.495
U31	0.313	0.449	0.511	0.391	0.462	0.865	0.684	0.930	0.923	0.661	0.290	0.542	0.219	0.792	0.238	0.234	0.459	0.159	0.630	0.084	0.921	0.474	0.229	0.554
U32	0.341	0.217	0.585	0.458	0.499	0.809	0.820	0.762	0.770	0.771	0.305	0.666	0.271	0.724	0.358	0.293	0.424	0.484	0.584	0.131	0.795	0.466	0.207	0.571
I11	0.800	0.452	0.583	0.632	0.774	0.913	0.821	0.860	0.934	0.971	0.439	0.479	0.041	0.830	0.486	0.337	0.683	0.605	0.676	0.352	0.499	0.412	0.631	0.823
I12	0.373	0.423	0.252	0.332	0.333	0.779	0.787	0.928	0.697	0.639	0.263	0.271	0.102	0.686	0.383	0.360	0.307	0.579	0.357	0.278	0.491	0.411	0.253	0.922
I21	0.231	0.356	0.243	0.218	0.245	0.567	0.549	0.701	0.539	0.707	0.344	0.158	0.447	0.594	0.858	0.188	0.475	0.565	0.191	0.643	0.492	0.539	0.162	0.462
I22	0.165	0.162	0.092	0.260	0.096	0.180	0.281	0.764	0.193	0.437	0.077	0.285	0.021	0.352	0.096	0.003	0.092	0.079	0.016	0.002	0.198	0.047	0.044	0.402
P11	0.460	0.514	0.475	0.499	0.524	0.842	0.490	0.853	0.841	0.747	0.305	0.546	0.286	0.706	0.288	0.347	0.395	0.228	0.536	0.227	0.873	0.648	0.424	0.537
P12	0.671	0.473	0.408	0.517	0.781	0.956	0.979	0.342	0.737	0.582	0.546	0.762	0.387	0.580	0.638	0.586	0.618	0.879	0.862	0.727	0.740	0.286	0.295	0.793
P13	0.199	0.465	0.400	0.424	0.487	0.279	0.438	0.279	0.432	0.279	0.420	0.724	0.468	0.444	0.383	0.502	0.279	0.666	0.815	0.437	0.446	0.413	0.081	0.437

APPENDIX A.3: I-DESI Data - Year 2016

	AT	BE	BG	HR	CY	CZ	DK	EE	FI	FR	DE	EL	HU	IE	IT	LT	LV	LU	MT	NL	PL
C11	0.211	0.311	0.156	0.167	0.256	0.211	0.367	0.222	0.233	0.367	0.322	0.267	0.211	0.211	0.178	0.222	0.178	0.278	0.322	0.356	0.100
C12	0.980	1.000	0.900	0.940	1.000	1.000	0.980	0.820	0.940	1.000	0.980	0.980	0.900	0.920	0.980	0.920	0.860	1.000	1.000	1.000	0.720
C21	0.980	1.000	0.870	0.970	0.730	1.000	1.000	0.990	1.000	0.900	0.960	0.930	0.980	0.900	0.960	0.980	0.950	0.950	1.000	0.990	1.000
C22	0.371	0.255	0.373	0.318	0.426	0.335	0.571	0.562	0.736	0.343	0.316	0.200	0.206	0.453	0.368	0.290	0.312	0.351	0.304	0.380	0.574
C31	0.850	0.782	0.562	0.606	0.776	0.744	0.812	0.688	0.782	0.821	0.721	0.665	0.482	0.659	0.541	0.726	0.562	0.797	0.697	0.738	0.679
C41	0.076	0.498	0.197	0.036	0.026	0.016	0.046	0.096	0.096	0.147	0.157	0.036	0.096	1.000	0.066	1.000	0.096	0.197	0.147	0.197	0.799
H11	0.627	0.577	0.481	0.560	0.432	0.522	0.685	0.555	0.692	0.533	0.620	0.518	0.510	0.419	0.420	0.450	0.462	0.832	0.564	0.744	0.407
H12	0.463	0.327	0.263	0.417	0.399	0.240	0.535	0.431	0.533	0.414	0.469	0.250	0.364	0.262	0.309	0.370	0.309	0.720	0.516	0.531	0.193
H13	0.407	0.339	0.018	0.357	0.238	0.212	0.933	0.462	0.613	0.335	0.376	0.590	0.229	0.301	0.290	0.265	0.149	0.731	0.388	0.561	0.174
H21	0.222	0.268	0.512	0.321	0.473	0.244	0.317	0.323	0.564	0.308	0.253	0.328	0.260	0.282	0.228	0.271	0.338	0.472	0.357	0.386	0.228
H22	0.405	0.155	0.287	0.471	0.236	0.393	0.453	0.635	0.706	0.303	0.455	0.316	0.432	0.698	0.101	0.202	0.481	0.577	0.505	0.349	0.312
U11	0.738	0.775	0.330	0.545	0.598	0.608	0.950	0.787	0.795	0.655	0.737	0.485	0.655	0.750	0.355	0.573	0.663	0.968	0.635	0.840	0.555
U12	0.366	0.340	0.053	0.092	0.192	0.145	0.442	0.140	0.352	0.319	0.368	0.142	0.100	0.513	0.267	0.114	0.106	0.850	0.197	0.375	0.106
U21	0.188	0.309	0.184	0.246	0.390	0.257	0.534	0.348	0.240	0.208	0.200	0.245	0.361	0.274	0.152	0.463	0.340	0.473	0.224	0.296	0.202
U22	0.320	0.591	0.282	0.430	0.371	0.267	0.658	0.433	0.489	0.198	0.338	0.289	0.542	0.439	0.221	0.338	0.428	0.561	0.245	0.491	0.256
U31	0.533	0.645	0.534	0.586	0.520	0.514	0.879	0.786	0.864	0.594	0.530	0.192	0.353	0.523	0.290	0.542	0.621	0.709	0.658	0.847	0.391
U32	0.576	0.568	0.348	0.415	0.565	0.474	0.815	0.565	0.674	0.658	0.741	0.311	0.388	0.592	0.290	0.334	0.444	0.784	0.625	0.739	0.419
I11	0.797	0.854	0.491	0.641	0.432	0.400	0.838	0.640	0.782	0.816	0.769	0.668	0.796	0.600	0.649	0.612	0.341	0.983	0.690	0.845	0.411
I12	0.502	0.605	0.168	0.551	0.274	0.245	0.699	0.591	0.528	0.402	0.545	0.351	0.459	0.416	0.484	0.475	0.211	0.838	0.489	0.681	0.173
I21	0.184	0.295	0.473	0.382	0.460	0.195	0.465	0.245	0.628	0.171	0.172	0.087	0.124	0.382	0.235	0.164	0.082	0.197	0.187	0.377	0.074
I22	0.059	0.040	0.053	0.023	0.060	0.159	0.318	0.143	0.094	0.088	0.154	0.018	0.054	0.155	0.017	0.058	0.039	0.152	0.043	0.320	0.033
P11	0.600	0.549	0.517	0.594	0.615	0.359	0.883	0.769	0.816	0.659	0.546	0.489	0.482	0.518	0.241	0.449	0.695	0.764	0.728	0.761	0.302
P12	0.854	0.469	0.198	0.542	0.135	0.388	0.594	0.813	0.917	0.917	0.719	0.219	0.313	0.604	0.771	0.688	0.281	0.479	0.635	0.885	0.458
P13	0.300	0.350	0.230	0.130	0.560	0.320	0.580	0.798	0.650	0.660	0.340	0.250	0.312	0.610	0.270	0.150	0.560	0.340	0.460	0.390	0.300

APPENDIX A.3 (Cont.): I-DESI Data - Year 2016

	PT	RO	SK	SI	ES	SE	UK	IS	NO	CH	RS	AU	BR	CA	CL	CN	IL	JP	KR	MX	NZ	RU	TR	US
C11	0.256	0.133	0.167	0.200	0.222	0.300	0.311	0.322	0.333	0.389	0.067	0.222	0.033	0.300	0.067	0.144	0.200	0.233	0.333	0.033	0.256	0.100	0.033	0.256
C12	1.000	0.780	0.760	0.960	0.920	0.980	1.000	0.980	0.900	1.000	1.000	0.820	0.860	0.680	0.900	0.860	0.660	0.860	0.980	0.940	0.800	0.640	0.520	1.000
C21	0.990	0.750	0.870	0.970	0.960	1.000	0.990	0.960	0.990	0.990	0.780	0.980	0.750	0.990	0.790	0.970	0.700	0.990	1.000	0.580	0.900	0.590	0.830	1.000
C22	0.237	0.334	0.328	0.233	0.383	0.574	0.378	0.481	0.497	0.449	0.208	0.611	0.384	0.270	0.283	0.271	0.403	0.617	0.496	0.227	0.449	0.294	0.249	0.607
C31	0.579	0.774	0.685	0.491	0.688	0.750	0.962	0.797	0.862	0.856	0.165	0.665	0.350	0.585	0.291	0.344	0.715	0.841	0.594	0.326	0.500	0.815	0.759	0.794
C41	0.116	1.000	0.016	0.096	0.006	1.000	0.167	0.498	0.056	0.016	0.096	0.076	0.036	0.147	0.076	0.498	0.147	0.116	1.000	0.096	0.237	0.297	0.006	0.147
H11	0.475	0.300	0.514	0.544	0.516	0.656	0.622	0.738	0.678	0.709	0.590	0.651	0.427	0.717	0.601	0.417	0.536	0.495	0.469	0.384	0.551	0.472	0.293	0.619
H12	0.444	0.194	0.282	0.479	0.370	0.405	0.449	0.593	0.447	0.654	0.320	0.473	0.359	0.395	0.444	0.321	0.296	0.512	0.294	0.282	0.455	0.294	0.235	0.631
H13	0.430	0.019	0.207	0.362	0.425	0.724	0.567	0.508	0.698	0.766	0.249	0.500	0.244	0.374	0.841	0.541	0.522	0.993	0.291	0.194	0.492	0.213	0.169	0.989
H21	0.229	0.588	0.245	0.418	0.234	0.241	0.176	0.416	0.324	0.413	0.327	0.518	0.411	0.167	0.349	0.089	0.107	0.079	0.279	0.249	0.289	0.264	0.071	0.344
H22	0.117	0.492	0.242	0.387	0.388	0.373	0.362	0.766	0.322	0.235	0.509	0.377	0.318	0.291	0.318	0.008	0.048	0.084	0.217	0.151	0.681	0.523	0.227	0.378
U11	0.507	0.325	0.675	0.592	0.677	0.828	0.913	0.970	0.955	0.818	0.452	0.775	0.348	0.853	0.727	0.220	0.662	0.887	0.880	0.325	0.808	0.552	0.305	0.758
U12	0.158	0.075	0.127	0.168	0.225	0.422	0.353	0.499	0.573	0.654	0.039	0.411	0.139	0.352	0.109	0.578	0.300	0.357	0.236	0.108	0.321	0.116	0.108	0.589
U21	0.196	0.122	0.396	0.241	0.169	0.421	0.405	0.451	0.408	0.342	0.187	0.452	0.302	0.466	0.287	0.252	0.301	0.429	0.382	0.159	0.283	0.466	0.157	0.382
U22	0.362	0.198	0.427	0.177	0.384	0.602	0.583	0.517	0.682	0.490	0.325	0.647	0.291	0.743	0.474	0.350	0.652	0.375	0.513	0.323	0.408	0.488	0.307	0.341
U31	0.289	0.489	0.454	0.352	0.432	0.832	0.642	0.819	0.912	0.701	0.191	0.735	0.178	0.754	0.256	0.141	0.426	0.146	0.566	0.076	0.562	0.591	0.181	0.470
U32	0.310	0.401	0.563	0.403	0.438	0.756	0.826	0.931	0.775	0.741	0.265	0.667	0.256	0.723	0.308	0.150	0.416	0.482	0.550	0.088	0.517	0.544	0.173	0.625
I11	0.494	0.383	0.546	0.534	0.777	0.903	0.993	0.802	0.773	0.935	0.685	0.700	0.306	0.873	0.515	0.514	0.663	0.683	0.659	0.459	0.618	0.323	0.374	0.728
I12	0.342	0.134	0.243	0.328	0.708	0.552	0.681	0.701	0.520	0.772	0.427	0.598	0.165	0.660	0.374	0.365	0.411	0.437	0.545	0.252	0.483	0.258	0.187	0.614
I21	0.184	0.385	0.197	0.236	0.178	0.536	0.376	0.316	0.437	0.263	0.499	0.508	0.494	0.274	0.957	0.062	0.626	0.329	0.186	0.782	0.250	0.613	0.107	0.311
I22	0.042	0.045	0.043	0.074	0.036	0.082	0.115	0.473	0.093	0.228	0.007	0.130	0.005	0.135	0.016	0.000	0.028	0.028	0.009	0.001	0.085	0.015	0.017	0.151
P11	0.447	0.468	0.479	0.454	0.501	0.779	0.526	0.875	0.847	0.876	0.328	0.603	0.242	0.569	0.291	0.154	0.378	0.309	0.447	0.164	0.648	0.619	0.367	0.574
P12	0.542	0.255	0.193	0.729	0.854	0.792	1.000	0.302	0.646	0.260	0.677	0.979	0.510	0.938	0.594	0.583	0.760	0.792	0.917	0.729	0.917	0.311	0.260	0.885
P13	0.100	0.340	0.270	0.300	0.800	0.370	0.820	0.280	0.650	0.080	0.170	0.820	0.630	0.650	0.350	0.380	0.170	0.510	0.660	0.580	0.630	0.200	0.100	0.580

APPENDIX A.4: I-DESI Data - Year 2015

	AT	BE	BG	HR	CY	CZ	DK	EE	FI	FR	DE	EL	HU	IE	IT	LT	LV	LU	MT	NL	PL
C11	0.200	0.300	0.133	0.144	0.233	0.200	0.356	0.211	0.244	0.356	0.311	0.244	0.200	0.200	0.167	0.200	0.167	0.267	0.311	0.344	0.100
C12	0.980	1.000	0.900	0.940	1.000	0.980	0.980	0.740	0.940	1.000	0.960	0.980	0.900	0.920	0.980	0.860	0.920	1.000	1.000	1.000	0.720
C21	0.980	1.000	0.570	0.980	0.600	0.990	1.000	1.000	1.000	0.800	0.960	0.830	0.970	0.900	0.930	0.910	0.900	0.960	1.000	0.990	1.000
C22	0.275	0.231	0.335	0.297	0.309	0.296	0.539	0.499	0.686	0.307	0.286	0.153	0.171	0.426	0.349	0.273	0.268	0.357	0.235	0.340	0.209
C31	0.856	0.794	0.553	0.626	0.788	0.756	0.806	0.691	0.806	0.829	0.732	0.691	0.462	0.679	0.735	0.732	0.744	0.871	0.656	0.774	0.679
C41	0.076	0.498	0.197	0.036	0.026	0.016	0.247	0.096	0.096	0.147	0.157	0.036	0.009	1.000	0.066	1.000	0.046	0.076	0.297	0.197	0.096
H11	0.635	0.559	0.367	0.485	0.395	0.563	0.698	0.594	0.706	0.537	0.620	0.508	0.492	0.417	0.429	0.466	0.471	0.824	0.513	0.699	0.340
H12	0.483	0.319	0.315	0.343	0.396	0.262	0.543	0.482	0.508	0.392	0.483	0.235	0.289	0.288	0.315	0.410	0.287	0.724	0.453	0.505	0.144
H13	0.527	0.340	0.034	0.212	0.144	0.233	0.880	0.453	0.507	0.327	0.387	0.633	0.213	0.253	0.320	0.287	0.087	0.853	0.097	0.473	0.147
H21	0.225	0.272	0.511	0.336	0.490	0.231	0.316	0.430	0.569	0.316	0.261	0.344	0.271	0.242	0.205	0.290	0.337	0.479	0.556	0.340	0.219
H22	0.402	0.113	0.312	0.406	0.302	0.392	0.436	0.492	0.666	0.306	0.454	0.437	0.237	0.647	0.111	0.182	0.442	0.467	0.647	0.322	0.305
U11	0.732	0.752	0.278	0.497	0.528	0.595	0.938	0.807	0.773	0.633	0.793	0.447	0.547	0.725	0.302	0.523	0.653	0.940	0.600	0.862	0.467
U12	0.357	0.332	0.049	0.088	0.182	0.139	0.431	0.134	0.344	0.316	0.359	0.143	0.097	0.503	0.261	0.107	0.103	0.826	0.188	0.368	0.107
U21	0.180	0.287	0.252	0.167	0.348	0.253	0.380	0.342	0.186	0.174	0.187	0.216	0.332	0.209	0.139	0.454	0.373	0.402	0.173	0.237	0.196
U22	0.271	0.556	0.188	0.183	0.337	0.208	0.532	0.411	0.443	0.169	0.427	0.252	0.476	0.368	0.227	0.284	0.433	0.577	0.253	0.457	0.219
U31	0.510	0.623	0.309	0.368	0.438	0.484	0.849	0.807	0.857	0.583	0.510	0.139	0.338	0.515	0.281	0.502	0.643	0.651	0.677	0.845	0.312
U32	0.577	0.552	0.313	0.417	0.410	0.453	0.789	0.589	0.693	0.646	0.731	0.317	0.358	0.514	0.264	0.318	0.381	0.779	0.555	0.712	0.369
I11	0.760	0.788	0.379	0.465	0.519	0.639	0.728	0.677	0.895	0.750	0.796	0.470	0.512	0.765	0.501	0.675	0.677	0.789	0.567	0.816	0.380
I12	0.593	0.579	0.194	0.245	0.426	0.368	0.603	0.502	0.641	0.522	0.612	0.239	0.288	0.556	0.121	0.493	0.380	0.685	0.446	0.577	0.135
I21	0.214	0.259	0.675	0.097	0.471	0.158	0.413	0.466	0.596	0.217	0.264	0.092	0.108	0.373	0.121	0.175	0.082	0.308	0.160	0.354	0.066
I22	0.041	0.027	0.009	0.008	0.031	0.027	0.079	0.041	0.045	0.025	0.057	0.005	0.012	0.042	0.008	0.015	0.017	0.073	0.047	0.129	0.012
P11	0.567	0.521	0.459	0.416	0.625	0.323	0.881	0.813	0.786	0.628	0.533	0.464	0.422	0.498	0.240	0.437	0.521	0.703	0.768	0.749	0.266
P12	0.635	0.063	0.198	0.542	0.083	0.396	0.458	0.771	0.885	0.573	0.552	0.292	0.490	0.844	0.250	0.354	0.302	0.000	0.510	0.521	0.219
P13	0.450	0.350	0.540	0.620	0.510	0.480	0.740	0.740	0.690	0.640	0.440	0.300	0.440	0.400	0.520	0.430	0.400	0.330	0.520	0.650	0.600

APPENDIX A.4 (Cont.): I-DESI Data - Year 2015

	PT	RO	SK	SI	ES	SE	UK	IS	NO	CH	RS	AU	BR	CA	CL	CN	IL	JP	KR	MX	NZ	RU	TR	US
C11	0.222	0.122	0.144	0.189	0.211	0.289	0.300	0.311	0.322	0.389	0.056	0.211	0.022	0.289	0.056	0.111	0.189	0.222	0.322	0.022	0.233	0.100	0.022	0.244
C12	1.000	0.780	0.720	0.920	0.900	0.980	1.000	0.960	0.900	1.000	0.860	0.640	0.920	0.920	0.960	0.800	0.880	1.000	0.920	0.960	0.940	0.820	0.760	0.940
C21	0.940	0.660	0.750	0.960	0.910	1.000	0.980	0.930	0.990	0.980	0.570	0.940	0.720	0.970	0.760	0.850	0.600	0.990	0.990	0.580	0.880	0.500	0.800	1.000
C22	0.185	0.272	0.266	0.156	0.353	0.562	0.360	0.418	0.501	0.451	0.207	0.591	0.379	0.229	0.200	0.196	0.356	0.596	0.486	0.181	0.521	0.277	0.165	0.539
C31	0.609	0.762	0.694	0.694	0.697	0.765	0.909	0.829	0.874	0.885	0.185	0.812	0.718	0.662	0.382	0.171	0.703	0.865	0.653	0.265	0.635	0.832	0.768	0.926
C41	0.116	1.000	0.016	0.006	0.006	1.000	0.167	0.116	0.056	0.046	0.096	0.076	0.006	0.147	0.076	0.016	0.147	0.116	0.498	0.046	0.225	0.297	0.006	0.016
H11	0.485	0.262	0.518	0.515	0.524	0.684	0.598	0.755	0.725	0.647	0.478	0.690	0.292	0.608	0.523	0.478	0.557	0.443	0.491	0.452	0.704	0.388	0.233	0.538
H12	0.462	0.159	0.278	0.486	0.356	0.333	0.451	0.601	0.451	0.582	0.164	0.503	0.276	0.339	0.232	0.299	0.364	0.582	0.363	0.292	0.371	0.297	0.185	0.527
H13	0.433	0.035	0.173	0.280	0.400	0.693	0.447	0.568	0.680	0.643	0.201	0.456	0.233	0.534	0.394	0.443	0.700	0.911	0.320	0.245	0.462	0.187	0.127	0.638
H21	0.239	0.527	0.248	0.432	0.247	0.238	0.236	0.531	0.333	0.419	0.274	0.491	0.238	0.179	0.027	0.088	0.030	0.090	0.274	0.236	0.390	0.268	0.080	0.345
H22	0.115	0.535	0.287	0.347	0.395	0.352	0.361	0.431	0.313	0.238	0.496	0.368	0.319	0.270	0.326	0.120	0.065	0.294	0.214	0.168	0.654	0.481	0.227	0.364
U11	0.477	0.263	0.627	0.552	0.645	0.843	0.867	0.970	0.947	0.792	0.422	0.743	0.305	0.833	0.610	0.172	0.623	0.852	0.832	0.290	0.803	0.502	0.228	0.577
U12	0.152	0.070	0.125	0.162	0.219	0.417	0.385	0.422	0.605	0.670	0.037	0.467	0.139	0.361	0.108	0.575	0.287	0.322	0.232	0.114	0.309	0.120	0.109	0.579
U21	0.173	0.078	0.359	0.181	0.139	0.324	0.327	0.421	0.386	0.171	0.290	0.342	0.247	0.369	0.153	0.221	0.291	0.268	0.127	0.121	0.299	0.358	0.106	0.222
U22	0.308	0.062	0.381	0.165	0.345	0.500	0.543	0.535	0.643	0.413	0.412	0.524	0.271	0.499	0.347	0.450	0.584	0.335	0.475	0.260	0.520	0.266	0.220	0.424
U31	0.282	0.371	0.373	0.337	0.394	0.796	0.584	0.740	0.904	0.644	0.445	0.766	0.166	0.526	0.217	0.136	0.406	0.110	0.518	0.070	0.901	0.361	0.150	0.523
U32	0.310	0.366	0.496	0.389	0.423	0.711	0.811	0.787	0.757	0.710	0.268	0.712	0.251	0.560	0.267	0.156	0.400	0.526	0.500	0.071	0.776	0.497	0.154	0.552
I11	0.764	0.381	0.598	0.596	0.610	0.864	0.862	0.847	0.872	0.847	0.221	0.713	0.334	0.801	0.630	0.290	0.831	0.778	0.642	0.462	0.709	0.269	0.474	0.880
I12	0.573	0.209	0.323	0.365	0.352	0.680	0.606	0.745	0.708	0.706	0.023	0.571	0.312	0.517	0.443	0.277	0.707	0.717	0.520	0.260	0.630	0.150	0.454	0.712
I21	0.321	0.347	0.238	0.184	0.141	0.434	0.260	0.416	0.415	0.261	0.761	0.383	0.499	0.121	0.479	0.143	0.834	0.319	0.142	0.748	0.616	0.575	0.279	0.339
I22	0.012	0.005	0.014	0.029	0.012	0.056	0.058	0.101	0.054	0.092	0.002	0.060	0.002	0.045	0.003	0.000	0.017	0.020	0.007	0.001	0.052	0.004	0.005	0.084
P11	0.431	0.447	0.507	0.452	0.494	0.728	0.490	0.825	0.813	0.723	0.587	0.734	0.240	0.618	0.233	0.223	0.350	0.326	0.503	0.147	0.755	0.560	0.284	0.550
P12	0.469	0.125	0.177	0.563	0.719	1.000	0.531	0.667	0.854	0.479	0.417	0.469	0.427	0.938	0.875	0.344	0.813	0.569	0.700	0.677	0.854	0.010	0.208	0.688
P13	0.230	0.570	0.240	0.460	0.520	0.420	0.820	0.420	0.640	0.410	0.590	0.690	0.610	0.520	0.410	0.423	0.280	0.400	0.450	0.570	0.650	0.170	0.270	0.650

APPENDIX B.1: Entropy Data Matrix - Year 2018

	AT	BE	BG	HR	CY	CZ	DK	EE	FI	FR	DE	EL	HU	IE	IT	LT	LV	LU	MT	NL	PL
C11	-0.073	-0.103	-0.070	-0.070	-0.095	-0.079	-0.115	-0.087	-0.081	-0.118	-0.108	-0.101	-0.084	-0.079	-0.073	-0.073	-0.070	-0.098	-0.115	-0.113	-0.043
C12	-0.089	-0.092	-0.085	-0.092	-0.092	-0.087	-0.091	-0.072	-0.084	-0.089	-0.089	-0.085	-0.084	-0.087	-0.091	-0.071	-0.084	-0.092	-0.092	-0.092	-0.044
C21	-0.086	-0.087	-0.087	-0.087	-0.086	-0.087	-0.087	-0.087	-0.087	-0.087	-0.086	-0.087	-0.087	-0.081	-0.087	-0.086	-0.087	-0.085	-0.087	-0.087	-0.087
C22	-0.074	-0.063	-0.085	-0.067	-0.083	-0.074	-0.109	-0.116	-0.122	-0.077	-0.068	-0.069	-0.056	-0.086	-0.079	-0.084	-0.105	-0.079	-0.091	-0.067	-0.131
C31	-0.089	-0.095	-0.080	-0.047	-0.049	-0.097	-0.106	-0.084	-0.102	-0.107	-0.095	-0.068	-0.069	-0.092	-0.052	-0.114	-0.078	-0.114	-0.105	-0.080	-0.079
C41	-0.084	-0.112	-0.075	-0.073	-0.048	-0.128	-0.052	-0.081	-0.089	-0.071	-0.081	-0.004	-0.009	-0.088	-0.137	-0.153	-0.117	-0.008	-0.119	-0.117	-0.127
H11	-0.092	-0.087	-0.052	-0.065	-0.076	-0.079	-0.108	-0.091	-0.111	-0.080	-0.100	-0.059	-0.075	-0.100	-0.076	-0.073	-0.081	-0.119	-0.079	-0.114	-0.065
H12	-0.089	-0.066	-0.089	-0.057	-0.080	-0.081	-0.112	-0.084	-0.104	-0.109	-0.119	-0.074	-0.062	-0.114	-0.051	-0.075	-0.064	-0.123	-0.089	-0.109	-0.042
H13	-0.055	-0.070	-0.051	-0.035	-0.082	-0.040	-0.140	-0.077	-0.134	-0.074	-0.095	-0.082	-0.038	-0.113	-0.052	-0.076	-0.057	-0.140	-0.054	-0.100	-0.020
H21	-0.103	-0.069	-0.101	-0.081	-0.100	-0.087	-0.100	-0.096	-0.085	-0.100	-0.072	-0.091	-0.082	-0.084	-0.085	-0.051	-0.094	-0.072	-0.086	-0.097	-0.082
H22	-0.121	-0.059	-0.080	-0.053	-0.075	-0.104	-0.082	-0.114	-0.110	-0.107	-0.092	-0.058	-0.066	-0.115	-0.031	-0.033	-0.104	-0.079	-0.087	-0.103	-0.091
U11	-0.092	-0.093	-0.056	-0.070	-0.087	-0.082	-0.106	-0.094	-0.094	-0.084	-0.095	-0.070	-0.075	-0.088	-0.072	-0.080	-0.086	-0.105	-0.083	-0.102	-0.077
U12	-0.105	-0.099	-0.026	-0.039	-0.067	-0.057	-0.119	-0.057	-0.103	-0.094	-0.104	-0.051	-0.043	-0.142	-0.082	-0.048	-0.045	-0.184	-0.069	-0.108	-0.044
U21	-0.069	-0.069	-0.077	-0.063	-0.102	-0.075	-0.113	-0.078	-0.077	-0.053	-0.091	-0.078	-0.079	-0.066	-0.061	-0.101	-0.090	-0.083	-0.053	-0.099	-0.060
U22	-0.072	-0.106	-0.033	-0.061	-0.086	-0.076	-0.115	-0.088	-0.096	-0.049	-0.071	-0.072	-0.094	-0.085	-0.059	-0.081	-0.087	-0.091	-0.047	-0.094	-0.065
U31	-0.088	-0.099	-0.053	-0.046	-0.073	-0.093	-0.120	-0.111	-0.119	-0.094	-0.089	-0.050	-0.068	-0.087	-0.059	-0.091	-0.097	-0.098	-0.089	-0.119	-0.071
U32	-0.090	-0.090	-0.058	-0.050	-0.077	-0.088	-0.114	-0.091	-0.100	-0.097	-0.107	-0.061	-0.068	-0.088	-0.061	-0.070	-0.072	-0.102	-0.096	-0.110	-0.076
I11	-0.098	-0.112	-0.023	-0.028	-0.027	-0.082	-0.104	-0.088	-0.130	-0.104	-0.106	-0.034	-0.060	-0.081	-0.054	-0.083	-0.067	-0.116	-0.089	-0.121	-0.030
I12	-0.087	-0.094	-0.039	-0.097	-0.078	-0.065	-0.114	-0.074	-0.136	-0.094	-0.134	-0.037	-0.111	-0.102	-0.018	-0.082	-0.032	-0.120	-0.059	-0.136	0.000
I21	-0.064	-0.098	-0.051	-0.036	-0.041	-0.072	-0.129	-0.089	-0.143	-0.053	-0.064	-0.037	-0.051	-0.109	-0.064	-0.060	-0.044	-0.066	-0.021	-0.114	-0.033
I22	-0.063	-0.055	-0.116	-0.071	-0.030	-0.124	-0.126	-0.137	-0.107	-0.073	-0.151	-0.024	-0.070	-0.174	-0.050	-0.068	-0.057	-0.126	-0.056	-0.179	-0.062
P11	-0.094	-0.084	-0.068	-0.062	-0.079	-0.080	-0.119	-0.107	-0.110	-0.099	-0.084	-0.076	-0.080	-0.081	-0.044	-0.077	-0.094	-0.091	-0.089	-0.109	-0.059
P12	-0.071	-0.051	-0.067	-0.034	-0.069	-0.064	-0.109	-0.093	-0.113	-0.106	-0.095	-0.084	-0.034	-0.098	-0.103	-0.064	-0.025	-0.099	-0.077	-0.111	-0.089
P13	-0.088	-0.072	-0.093	-0.044	-0.128	-0.079	-0.100	-0.115	-0.073	-0.135	-0.052	-0.098	-0.068	-0.112	-0.077	-0.024	-0.062	-0.060	-0.085	-0.088	-0.083

APPENDIX B.1 (Cont.): Entropy Data Matrix - Year 2018

	PT	RO	SK	SI	ES	SE	UK	IS	NO	CH	RS	AU	BR	CA	CL	CN	IL	JP	KR	MX	NZ	RU	TR	US
C11	-0.098	-0.066	-0.073	-0.076	-0.084	-0.103	-0.106	-0.108	-0.108	-0.120	-0.035	-0.090	-0.027	-0.103	-0.035	-0.076	-0.076	-0.084	-0.111	-0.027	-0.093	-0.053	-0.031	-0.095
C12	-0.081	-0.084	-0.072	-0.089	-0.087	-0.087	-0.091	-0.092	-0.088	-0.092	-0.082	-0.081	-0.078	-0.086	-0.084	-0.081	-0.091	-0.084	-0.091	-0.083	-0.080	-0.075	-0.064	-0.092
C21	-0.087	-0.083	-0.083	-0.087	-0.086	-0.087	-0.087	-0.086	-0.087	-0.087	-0.085	-0.087	-0.076	-0.087	-0.079	-0.087	-0.065	-0.084	-0.087	-0.072	-0.085	-0.067	-0.083	-0.087
C22	-0.062	-0.074	-0.072	-0.065	-0.082	-0.100	-0.081	-0.102	-0.083	-0.082	-0.056	-0.110	-0.074	-0.064	-0.077	-0.080	-0.069	-0.141	-0.093	-0.058	-0.094	-0.073	-0.062	-0.113
C31	-0.086	-0.058	-0.096	-0.089	-0.066	-0.108	-0.109	-0.115	-0.117	-0.112	-0.065	-0.083	-0.032	-0.081	-0.073	-0.052	-0.089	-0.115	-0.096	-0.026	-0.092	-0.049	-0.054	-0.068
C41	-0.032	-0.003	-0.080	-0.010	-0.066	-0.157	-0.118	-0.047	-0.043	-0.120	0.000	-0.102	-0.092	-0.022	-0.021	-0.122	-0.159	-0.085	-0.093	-0.022	-0.138	-0.146	-0.026	-0.027
H11	-0.070	-0.073	-0.071	-0.084	-0.084	-0.100	-0.101	-0.112	-0.108	-0.109	-0.082	-0.095	-0.057	-0.101	-0.071	-0.063	-0.088	-0.076	-0.084	-0.069	-0.082	-0.055	-0.062	-0.092
H12	-0.071	-0.060	-0.059	-0.089	-0.063	-0.110	-0.094	-0.094	-0.082	-0.120	-0.080	-0.103	-0.059	-0.065	-0.068	-0.100	-0.085	-0.111	-0.079	-0.067	-0.095	-0.065	-0.024	-0.106
H13	-0.061	-0.027	-0.038	-0.085	-0.063	-0.107	-0.105	-0.140	-0.135	-0.122	-0.009	-0.077	-0.048	-0.113	-0.102	-0.097	-0.095	-0.142	-0.080	-0.107	-0.089	-0.059	-0.037	-0.119
H21	-0.061	-0.113	-0.058	-0.070	-0.077	-0.112	-0.049	-0.075	-0.063	-0.100	-0.119	-0.128	-0.091	-0.033	-0.066	-0.101	-0.077	-0.061	-0.085	-0.054	-0.097	-0.071	-0.058	-0.116
H22	-0.014	-0.106	-0.081	-0.089	-0.101	-0.112	-0.079	-0.068	-0.068	-0.074	-0.086	-0.114	-0.099	-0.066	-0.016	-0.093	-0.106	-0.036	-0.055	-0.067	-0.088	-0.114	-0.071	-0.138
U11	-0.073	-0.066	-0.082	-0.080	-0.090	-0.098	-0.102	-0.107	-0.104	-0.088	-0.071	-0.083	-0.062	-0.098	-0.049	-0.029	-0.097	-0.101	-0.103	-0.058	-0.087	-0.082	-0.067	-0.103
U12	-0.058	-0.035	-0.049	-0.062	-0.074	-0.110	-0.096	-0.135	-0.145	-0.147	-0.021	-0.115	-0.047	-0.099	-0.043	-0.082	-0.090	-0.095	-0.076	-0.040	-0.090	-0.045	-0.035	-0.140
U21	-0.060	-0.092	-0.073	-0.070	-0.057	-0.093	-0.085	-0.095	-0.097	-0.096	-0.082	-0.082	-0.095	-0.087	-0.067	-0.120	-0.118	-0.105	-0.075	-0.088	-0.093	-0.117	-0.086	-0.099
U22	-0.083	-0.096	-0.084	-0.063	-0.081	-0.102	-0.101	-0.133	-0.120	-0.087	-0.046	-0.072	-0.081	-0.106	-0.071	-0.091	-0.104	-0.086	-0.095	-0.080	-0.076	-0.080	-0.084	-0.108
U31	-0.065	-0.093	-0.078	-0.069	-0.077	-0.114	-0.105	-0.124	-0.123	-0.119	-0.057	-0.105	-0.043	-0.107	-0.028	-0.056	-0.092	-0.036	-0.095	-0.022	-0.080	-0.057	-0.051	-0.105
U32	-0.062	-0.067	-0.088	-0.079	-0.082	-0.108	-0.113	-0.106	-0.109	-0.116	-0.067	-0.099	-0.050	-0.107	-0.013	-0.078	-0.102	-0.087	-0.092	-0.032	-0.085	-0.075	-0.046	-0.108
I11	-0.103	-0.020	-0.069	-0.088	-0.072	-0.121	-0.116	-0.117	-0.128	-0.126	-0.047	-0.086	-0.002	-0.109	-0.083	-0.052	-0.125	-0.115	-0.093	-0.045	-0.105	-0.074	-0.038	-0.084
I12	-0.057	-0.032	-0.048	-0.055	-0.026	-0.143	-0.125	-0.090	-0.108	-0.139	-0.037	-0.090	-0.008	-0.097	-0.005	-0.076	-0.150	-0.121	-0.074	-0.012	-0.097	-0.046	-0.094	-0.138
I21	-0.067	-0.088	-0.060	-0.069	-0.059	-0.130	-0.102	-0.140	-0.119	-0.130	-0.058	-0.106	-0.101	-0.097	-0.110	-0.021	-0.150	-0.090	-0.062	-0.116	-0.077	-0.084	-0.032	-0.135
I22	-0.061	-0.061	-0.052	-0.105	-0.047	-0.068	-0.091	-0.165	-0.075	-0.171	-0.031	-0.104	-0.011	-0.100	-0.036	-0.003	-0.041	-0.048	-0.012	-0.002	-0.066	-0.025	-0.022	-0.167
P11	-0.067	-0.092	-0.078	-0.081	-0.084	-0.111	-0.087	-0.118	-0.117	-0.109	-0.066	-0.100	-0.052	-0.097	-0.052	-0.072	-0.093	-0.032	-0.083	-0.046	-0.081	-0.071	-0.071	-0.110
P12	-0.090	-0.034	-0.066	-0.068	-0.110	-0.099	-0.110	-0.025	-0.108	-0.075	-0.068	-0.110	-0.089	-0.093	-0.069	-0.091	-0.072	-0.110	-0.113	-0.101	-0.110	-0.076	-0.070	-0.110
P13	-0.055	-0.095	-0.049	-0.092	-0.098	-0.014	-0.069	-0.025	-0.083	-0.028	-0.081	-0.102	-0.106	-0.104	-0.049	-0.106	-0.074	-0.108	-0.140	-0.100	-0.088	-0.119	-0.070	-0.106

APPENDIX B.2: Entropy Data Matrix - Year 2017

	AT	BE	BG	HR	CY	CZ	DK	EE	FI	FR	DE	EL	HU	IE	IT	LT	LV	LU	MT	NL	PL
C11	-0.075	-0.104	-0.065	-0.069	-0.096	-0.081	-0.119	-0.084	-0.084	-0.119	-0.109	-0.098	-0.081	-0.078	-0.072	-0.075	-0.072	-0.098	-0.111	-0.114	-0.048
C12	-0.089	-0.092	-0.085	-0.090	-0.092	-0.087	-0.091	-0.070	-0.087	-0.089	-0.088	-0.085	-0.085	-0.087	-0.090	-0.066	-0.082	-0.092	-0.092	-0.092	-0.043
C21	-0.086	-0.088	-0.087	-0.086	-0.085	-0.088	-0.088	-0.087	-0.088	-0.086	-0.086	-0.086	-0.087	-0.081	-0.086	-0.086	-0.084	-0.085	-0.088	-0.087	-0.088
C22	-0.077	-0.066	-0.080	-0.071	-0.093	-0.072	-0.110	-0.112	-0.127	-0.077	-0.070	-0.059	-0.053	-0.089	-0.076	-0.076	-0.100	-0.077	-0.073	-0.080	-0.127
C31	-0.099	-0.098	-0.073	-0.082	-0.098	-0.082	-0.100	-0.090	-0.098	-0.098	-0.092	-0.084	-0.065	-0.090	-0.073	-0.094	-0.077	-0.099	-0.074	-0.094	-0.072
C41	-0.058	-0.115	-0.079	-0.015	-0.018	-0.058	-0.069	-0.033	-0.033	-0.046	-0.049	-0.015	-0.115	-0.183	-0.024	-0.183	-0.033	-0.058	-0.145	-0.058	-0.159
H11	-0.099	-0.089	-0.075	-0.068	-0.085	-0.091	-0.094	-0.086	-0.104	-0.087	-0.095	-0.082	-0.081	-0.076	-0.079	-0.077	-0.072	-0.116	-0.066	-0.111	-0.072
H12	-0.096	-0.071	-0.097	-0.091	-0.099	-0.063	-0.089	-0.085	-0.098	-0.082	-0.096	-0.061	-0.076	-0.065	-0.057	-0.080	-0.068	-0.128	-0.095	-0.102	-0.048
H13	-0.092	-0.072	-0.064	-0.051	-0.070	-0.062	-0.144	-0.089	-0.118	-0.081	-0.075	-0.087	-0.059	-0.067	-0.080	-0.064	-0.034	-0.121	-0.027	-0.104	-0.049
H21	-0.063	-0.071	-0.112	-0.081	-0.109	-0.070	-0.079	-0.084	-0.113	-0.078	-0.067	-0.085	-0.077	-0.074	-0.062	-0.071	-0.087	-0.110	-0.129	-0.083	-0.064
H22	-0.085	-0.048	-0.082	-0.109	-0.064	-0.094	-0.098	-0.134	-0.119	-0.070	-0.097	-0.067	-0.091	-0.132	-0.031	-0.065	-0.101	-0.114	-0.140	-0.061	-0.078
U11	-0.094	-0.094	-0.055	-0.062	-0.084	-0.081	-0.107	-0.095	-0.094	-0.083	-0.089	-0.068	-0.078	-0.089	-0.055	-0.079	-0.083	-0.108	-0.084	-0.102	-0.076
U12	-0.102	-0.097	-0.024	-0.037	-0.065	-0.053	-0.117	-0.052	-0.100	-0.092	-0.102	-0.050	-0.040	-0.134	-0.081	-0.045	-0.042	-0.179	-0.066	-0.105	-0.042
U21	-0.076	-0.083	-0.061	-0.008	-0.060	-0.073	-0.119	-0.090	-0.071	-0.057	-0.099	-0.068	-0.093	-0.081	-0.055	-0.110	-0.086	-0.111	-0.085	-0.091	-0.064
U22	-0.071	-0.109	-0.038	-0.048	-0.070	-0.065	-0.115	-0.089	-0.099	-0.053	-0.070	-0.069	-0.097	-0.086	-0.054	-0.076	-0.088	-0.103	-0.054	-0.100	-0.065
U31	-0.089	-0.099	-0.067	-0.065	-0.073	-0.088	-0.122	-0.112	-0.120	-0.094	-0.087	-0.047	-0.065	-0.089	-0.056	-0.087	-0.093	-0.109	-0.102	-0.121	-0.068
U32	-0.095	-0.093	-0.053	-0.058	-0.082	-0.088	-0.115	-0.091	-0.105	-0.100	-0.109	-0.058	-0.067	-0.085	-0.058	-0.066	-0.076	-0.114	-0.091	-0.113	-0.075
I11	-0.111	-0.110	-0.071	-0.079	-0.097	-0.100	-0.089	-0.075	-0.107	-0.090	-0.097	-0.110	-0.106	-0.072	-0.079	-0.097	-0.059	-0.101	-0.055	-0.110	-0.050
I12	-0.112	-0.101	-0.055	-0.086	-0.073	-0.050	-0.092	-0.078	-0.100	-0.068	-0.096	-0.024	-0.103	-0.076	-0.008	-0.103	-0.053	-0.139	-0.087	-0.136	-0.012
I21	-0.059	-0.096	-0.089	-0.067	-0.065	-0.061	-0.117	-0.064	-0.139	-0.048	-0.026	-0.032	-0.048	-0.084	-0.054	-0.061	-0.037	-0.074	-0.037	-0.119	-0.028
I22	-0.043	-0.047	-0.130	-0.073	-0.083	-0.110	-0.159	-0.121	-0.100	-0.074	-0.135	-0.025	-0.069	-0.146	-0.045	-0.067	-0.063	-0.157	-0.071	-0.214	-0.039
P11	-0.092	-0.084	-0.078	-0.078	-0.082	-0.073	-0.119	-0.108	-0.113	-0.098	-0.082	-0.075	-0.075	-0.084	-0.045	-0.076	-0.098	-0.105	-0.111	-0.109	-0.054
P12	-0.084	-0.072	-0.047	-0.062	-0.033	-0.058	-0.095	-0.096	-0.109	-0.101	-0.096	-0.077	-0.070	-0.101	-0.104	-0.087	-0.043	-0.083	-0.091	-0.099	-0.082
P13	-0.065	-0.065	-0.065	-0.063	-0.088	-0.089	-0.110	-0.101	-0.090	-0.118	-0.066	-0.061	-0.053	-0.090	-0.087	-0.022	-0.088	-0.067	-0.089	-0.091	-0.078

APPENDIX B.2 (Cont.): Entropy Data Matrix - Year 2017

	PT	RO	SK	SI	ES	SE	UK	IS	NO	CH	RS	AU	BR	CA	CL	CN	IL	JP	KR	MX	NZ	RU	TR	US
C11	-0.096	-0.062	-0.069	-0.078	-0.084	-0.106	-0.106	-0.109	-0.111	-0.124	-0.036	-0.087	-0.023	-0.104	-0.036	-0.075	-0.075	-0.087	-0.111	-0.023	-0.093	-0.051	-0.028	-0.093
C12	-0.080	-0.084	-0.076	-0.089	-0.086	-0.088	-0.091	-0.091	-0.084	-0.092	-0.090	-0.079	-0.079	-0.089	-0.091	-0.091	-0.079	-0.070	-0.090	-0.084	-0.080	-0.080	-0.068	-0.089
C21	-0.087	-0.080	-0.082	-0.087	-0.086	-0.088	-0.087	-0.086	-0.088	-0.087	-0.084	-0.087	-0.076	-0.087	-0.080	-0.086	-0.076	-0.087	-0.088	-0.068	-0.084	-0.061	-0.079	-0.088
C22	-0.061	-0.073	-0.073	-0.062	-0.082	-0.105	-0.077	-0.098	-0.086	-0.087	-0.053	-0.113	-0.080	-0.063	-0.076	-0.073	-0.092	-0.143	-0.097	-0.057	-0.089	-0.072	-0.062	-0.113
C31	-0.079	-0.099	-0.088	-0.068	-0.089	-0.095	-0.094	-0.098	-0.103	-0.103	-0.022	-0.087	-0.052	-0.076	-0.031	-0.059	-0.098	-0.095	-0.081	-0.048	-0.068	-0.109	-0.099	-0.094
C41	-0.038	-0.183	-0.015	-0.033	-0.003	-0.183	-0.160	-0.115	-0.021	-0.018	-0.033	-0.046	-0.001	-0.011	-0.079	-0.183	-0.046	-0.003	-0.183	-0.033	-0.067	-0.079	-0.003	-0.183
H11	-0.081	-0.052	-0.088	-0.087	-0.082	-0.104	-0.098	-0.116	-0.105	-0.108	-0.073	-0.089	-0.055	-0.099	-0.091	-0.062	-0.072	-0.060	-0.074	-0.064	-0.100	-0.058	-0.060	-0.086
H12	-0.094	-0.097	-0.070	-0.095	-0.072	-0.084	-0.097	-0.128	-0.095	-0.113	-0.055	-0.091	-0.066	-0.079	-0.086	-0.098	-0.034	-0.090	-0.054	-0.074	-0.082	-0.076	-0.064	-0.114
H13	-0.098	-0.002	-0.060	-0.059	-0.079	-0.127	-0.119	-0.137	-0.133	-0.116	-0.015	-0.110	-0.046	-0.115	-0.129	-0.049	-0.089	-0.125	-0.068	-0.105	-0.103	-0.028	-0.045	-0.083
H21	-0.073	-0.127	-0.070	-0.099	-0.064	-0.085	-0.048	-0.096	-0.075	-0.100	-0.083	-0.106	-0.102	-0.061	-0.091	-0.128	-0.013	-0.072	-0.072	-0.064	-0.074	-0.088	-0.054	-0.124
H22	-0.049	-0.094	-0.075	-0.081	-0.085	-0.090	-0.080	-0.090	-0.081	-0.060	-0.107	-0.088	-0.068	-0.068	-0.068	-0.089	-0.017	-0.027	-0.094	-0.058	-0.124	-0.098	-0.056	-0.087
U11	-0.073	-0.056	-0.085	-0.081	-0.090	-0.105	-0.104	-0.109	-0.106	-0.097	-0.067	-0.092	-0.062	-0.099	-0.086	-0.037	-0.085	-0.090	-0.104	-0.056	-0.098	-0.076	-0.057	-0.094
U12	-0.056	-0.032	-0.047	-0.059	-0.072	-0.112	-0.095	-0.136	-0.142	-0.148	-0.019	-0.113	-0.050	-0.100	-0.042	-0.137	-0.091	-0.096	-0.075	-0.040	-0.093	-0.046	-0.038	-0.141
U21	-0.065	-0.075	-0.092	-0.075	-0.060	-0.111	-0.101	-0.107	-0.106	-0.088	-0.065	-0.113	-0.100	-0.109	-0.066	-0.051	-0.080	-0.108	-0.096	-0.092	-0.098	-0.087	-0.082	-0.080
U22	-0.081	-0.038	-0.086	-0.058	-0.083	-0.107	-0.108	-0.136	-0.126	-0.074	-0.083	-0.078	-0.080	-0.121	-0.091	-0.029	-0.117	-0.080	-0.103	-0.077	-0.108	-0.077	-0.077	-0.092
U31	-0.056	-0.074	-0.081	-0.067	-0.076	-0.119	-0.101	-0.125	-0.125	-0.098	-0.053	-0.085	-0.043	-0.112	-0.045	-0.045	-0.075	-0.033	-0.095	-0.020	-0.124	-0.077	-0.044	-0.086
U32	-0.061	-0.043	-0.091	-0.076	-0.081	-0.115	-0.116	-0.110	-0.111	-0.111	-0.056	-0.100	-0.051	-0.107	-0.063	-0.054	-0.072	-0.079	-0.091	-0.029	-0.114	-0.077	-0.041	-0.090
I11	-0.096	-0.063	-0.076	-0.080	-0.093	-0.105	-0.097	-0.101	-0.107	-0.110	-0.061	-0.065	-0.009	-0.098	-0.066	-0.050	-0.085	-0.078	-0.085	-0.052	-0.067	-0.058	-0.080	-0.098
I12	-0.073	-0.080	-0.054	-0.067	-0.067	-0.125	-0.126	-0.141	-0.115	-0.109	-0.056	-0.057	-0.027	-0.114	-0.075	-0.071	-0.063	-0.101	-0.071	-0.059	-0.090	-0.079	-0.055	-0.140
I21	-0.060	-0.083	-0.062	-0.057	-0.063	-0.116	-0.114	-0.135	-0.112	-0.136	-0.081	-0.045	-0.098	-0.120	-0.154	-0.051	-0.103	-0.116	-0.052	-0.127	-0.105	-0.112	-0.046	-0.101
I22	-0.065	-0.064	-0.041	-0.091	-0.043	-0.069	-0.096	-0.190	-0.073	-0.131	-0.036	-0.097	-0.012	-0.113	-0.043	-0.002	-0.041	-0.037	-0.010	-0.002	-0.074	-0.024	-0.023	-0.124
P11	-0.073	-0.080	-0.075	-0.078	-0.081	-0.114	-0.077	-0.115	-0.114	-0.105	-0.054	-0.083	-0.051	-0.101	-0.051	-0.059	-0.065	-0.043	-0.082	-0.043	-0.117	-0.095	-0.069	-0.082
P12	-0.091	-0.070	-0.063	-0.075	-0.102	-0.117	-0.119	-0.055	-0.097	-0.082	-0.078	-0.100	-0.060	-0.082	-0.088	-0.082	-0.086	-0.111	-0.109	-0.096	-0.098	-0.048	-0.049	-0.103
P13	-0.050	-0.095	-0.085	-0.089	-0.098	-0.065	-0.091	-0.065	-0.090	-0.065	-0.088	-0.130	-0.095	-0.092	-0.082	-0.100	-0.065	-0.122	-0.141	-0.091	-0.092	-0.087	-0.024	-0.091

APPENDIX B.3: Entropy Data Matrix - Year 2016

	AT	BE	BG	HR	CY	CZ	DK	EE	FI	FR	DE	EL	HU	IE	IT	LT	LV	LU	MT	NL	PL
C11	-0.081	-0.108	-0.064	-0.068	-0.093	-0.081	-0.121	-0.084	-0.087	-0.121	-0.110	-0.096	-0.081	-0.081	-0.071	-0.084	-0.071	-0.099	-0.110	-0.118	-0.046
C12	-0.090	-0.091	-0.084	-0.087	-0.091	-0.091	-0.090	-0.079	-0.087	-0.091	-0.090	-0.090	-0.084	-0.086	-0.090	-0.086	-0.082	-0.091	-0.091	-0.091	-0.071
C21	-0.089	-0.090	-0.081	-0.088	-0.071	-0.090	-0.090	-0.089	-0.090	-0.083	-0.087	-0.085	-0.089	-0.083	-0.087	-0.089	-0.087	-0.087	-0.090	-0.089	-0.090
C22	-0.082	-0.062	-0.083	-0.073	-0.091	-0.076	-0.112	-0.111	-0.134	-0.078	-0.073	-0.052	-0.053	-0.095	-0.082	-0.069	-0.072	-0.079	-0.071	-0.084	-0.113
C31	-0.101	-0.095	-0.075	-0.079	-0.095	-0.092	-0.098	-0.087	-0.095	-0.099	-0.090	-0.085	-0.067	-0.084	-0.073	-0.090	-0.075	-0.097	-0.088	-0.091	-0.086
C41	-0.035	-0.140	-0.072	-0.019	-0.014	-0.010	-0.023	-0.042	-0.042	-0.058	-0.061	-0.019	-0.042	-0.218	-0.031	-0.218	-0.042	-0.072	-0.058	-0.072	-0.191
H11	-0.094	-0.088	-0.077	-0.086	-0.071	-0.082	-0.100	-0.086	-0.101	-0.083	-0.093	-0.081	-0.080	-0.069	-0.070	-0.073	-0.075	-0.115	-0.087	-0.106	-0.068
H12	-0.094	-0.073	-0.062	-0.087	-0.085	-0.058	-0.105	-0.090	-0.104	-0.087	-0.095	-0.060	-0.079	-0.062	-0.070	-0.080	-0.070	-0.129	-0.102	-0.104	-0.049
H13	-0.081	-0.071	-0.006	-0.074	-0.054	-0.050	-0.147	-0.089	-0.110	-0.070	-0.077	-0.107	-0.053	-0.065	-0.063	-0.059	-0.038	-0.124	-0.079	-0.103	-0.042
H21	-0.067	-0.077	-0.122	-0.088	-0.116	-0.071	-0.087	-0.088	-0.131	-0.085	-0.073	-0.089	-0.075	-0.080	-0.068	-0.077	-0.091	-0.115	-0.095	-0.100	-0.068
H22	-0.092	-0.044	-0.071	-0.102	-0.061	-0.090	-0.100	-0.126	-0.136	-0.074	-0.100	-0.076	-0.096	-0.135	-0.032	-0.054	-0.104	-0.118	-0.108	-0.082	-0.076
U11	-0.092	-0.095	-0.050	-0.073	-0.078	-0.079	-0.110	-0.096	-0.097	-0.084	-0.091	-0.067	-0.084	-0.093	-0.053	-0.076	-0.085	-0.111	-0.082	-0.101	-0.074
U12	-0.103	-0.098	-0.023	-0.036	-0.064	-0.051	-0.118	-0.050	-0.100	-0.093	-0.103	-0.051	-0.038	-0.130	-0.082	-0.042	-0.040	-0.182	-0.065	-0.105	-0.040
U21	-0.059	-0.085	-0.058	-0.072	-0.101	-0.074	-0.126	-0.093	-0.071	-0.063	-0.061	-0.072	-0.095	-0.078	-0.050	-0.114	-0.091	-0.116	-0.067	-0.082	-0.062
U22	-0.069	-0.109	-0.063	-0.086	-0.077	-0.060	-0.117	-0.087	-0.095	-0.048	-0.072	-0.064	-0.102	-0.088	-0.052	-0.072	-0.086	-0.105	-0.056	-0.095	-0.058
U31	-0.086	-0.099	-0.087	-0.093	-0.085	-0.084	-0.124	-0.114	-0.122	-0.093	-0.086	-0.039	-0.063	-0.085	-0.055	-0.087	-0.097	-0.106	-0.101	-0.120	-0.069
U32	-0.092	-0.091	-0.063	-0.072	-0.090	-0.079	-0.118	-0.090	-0.103	-0.101	-0.110	-0.058	-0.068	-0.094	-0.055	-0.061	-0.076	-0.114	-0.097	-0.110	-0.072
I11	-0.098	-0.103	-0.069	-0.084	-0.062	-0.059	-0.102	-0.084	-0.097	-0.100	-0.096	-0.086	-0.098	-0.080	-0.084	-0.081	-0.052	-0.114	-0.088	-0.102	-0.060
I12	-0.091	-0.104	-0.039	-0.097	-0.058	-0.053	-0.115	-0.102	-0.094	-0.077	-0.097	-0.070	-0.085	-0.079	-0.089	-0.087	-0.047	-0.131	-0.089	-0.113	-0.040
I21	-0.055	-0.079	-0.111	-0.095	-0.109	-0.057	-0.109	-0.068	-0.135	-0.052	-0.052	-0.031	-0.040	-0.095	-0.066	-0.050	-0.029	-0.058	-0.056	-0.094	-0.027
I22	-0.063	-0.047	-0.058	-0.030	-0.064	-0.129	-0.203	-0.120	-0.089	-0.085	-0.127	-0.025	-0.059	-0.128	-0.024	-0.062	-0.045	-0.126	-0.049	-0.204	-0.040
P11	-0.091	-0.086	-0.082	-0.091	-0.093	-0.062	-0.121	-0.109	-0.114	-0.098	-0.085	-0.079	-0.078	-0.082	-0.046	-0.074	-0.102	-0.109	-0.105	-0.109	-0.055
P12	-0.108	-0.070	-0.036	-0.078	-0.026	-0.060	-0.083	-0.105	-0.114	-0.114	-0.096	-0.039	-0.051	-0.084	-0.101	-0.093	-0.047	-0.071	-0.088	-0.111	-0.069
P13	-0.066	-0.074	-0.053	-0.034	-0.104	-0.069	-0.107	-0.133	-0.115	-0.117	-0.072	-0.057	-0.067	-0.110	-0.060	-0.038	-0.104	-0.072	-0.090	-0.080	-0.066

APPENDIX B.3 (Cont.): Entropy Data Matrix - Year 2016

	PT	RO	SK	SI	ES	SE	UK	IS	NO	CH	RS	AU	BR	CA	CL	CN	IL	JP	KR	MX	NZ	RU	TR	US
C11	-0.093	-0.057	-0.068	-0.078	-0.084	-0.105	-0.108	-0.110	-0.113	-0.126	-0.033	-0.084	-0.019	-0.105	-0.033	-0.061	-0.078	-0.087	-0.113	-0.019	-0.093	-0.046	-0.019	-0.093
C12	-0.091	-0.076	-0.074	-0.089	-0.086	-0.090	-0.091	-0.090	-0.084	-0.091	-0.091	-0.079	-0.082	-0.068	-0.084	-0.082	-0.067	-0.082	-0.090	-0.087	-0.077	-0.065	-0.056	-0.091
C21	-0.089	-0.073	-0.081	-0.088	-0.087	-0.090	-0.089	-0.087	-0.089	-0.089	-0.075	-0.089	-0.073	-0.089	-0.076	-0.088	-0.069	-0.089	-0.090	-0.060	-0.083	-0.061	-0.078	-0.090
C22	-0.059	-0.076	-0.075	-0.058	-0.084	-0.113	-0.084	-0.100	-0.102	-0.095	-0.053	-0.118	-0.084	-0.065	-0.067	-0.065	-0.088	-0.119	-0.102	-0.057	-0.095	-0.069	-0.061	-0.118
C31	-0.076	-0.095	-0.087	-0.068	-0.087	-0.092	-0.111	-0.097	-0.102	-0.102	-0.029	-0.085	-0.052	-0.077	-0.045	-0.051	-0.089	-0.101	-0.078	-0.049	-0.068	-0.098	-0.093	-0.096
C41	-0.048	-0.218	-0.010	-0.042	-0.004	-0.218	-0.064	-0.140	-0.027	-0.010	-0.042	-0.035	-0.019	-0.058	-0.035	-0.140	-0.058	-0.048	-0.218	-0.042	-0.083	-0.098	-0.004	-0.058
H11	-0.076	-0.054	-0.081	-0.084	-0.081	-0.097	-0.093	-0.105	-0.099	-0.102	-0.090	-0.096	-0.070	-0.103	-0.091	-0.069	-0.083	-0.079	-0.076	-0.065	-0.085	-0.076	-0.053	-0.093
H12	-0.091	-0.049	-0.065	-0.097	-0.080	-0.086	-0.092	-0.113	-0.092	-0.121	-0.072	-0.096	-0.078	-0.084	-0.092	-0.072	-0.068	-0.101	-0.067	-0.065	-0.093	-0.067	-0.057	-0.118
H13	-0.085	-0.007	-0.049	-0.075	-0.084	-0.123	-0.104	-0.096	-0.120	-0.128	-0.056	-0.095	-0.055	-0.077	-0.137	-0.100	-0.098	-0.153	-0.063	-0.046	-0.094	-0.050	-0.041	-0.152
H21	-0.068	-0.135	-0.072	-0.106	-0.069	-0.071	-0.056	-0.106	-0.088	-0.105	-0.089	-0.123	-0.105	-0.053	-0.093	-0.033	-0.038	-0.029	-0.079	-0.073	-0.081	-0.076	-0.027	-0.092
H22	-0.035	-0.106	-0.062	-0.089	-0.089	-0.086	-0.085	-0.144	-0.078	-0.061	-0.108	-0.087	-0.077	-0.072	-0.077	-0.004	-0.017	-0.027	-0.058	-0.043	-0.133	-0.110	-0.060	-0.087
U11	-0.069	-0.049	-0.086	-0.078	-0.086	-0.100	-0.107	-0.111	-0.110	-0.099	-0.063	-0.095	-0.052	-0.102	-0.091	-0.036	-0.085	-0.105	-0.104	-0.049	-0.098	-0.074	-0.047	-0.093
U12	-0.055	-0.031	-0.046	-0.058	-0.072	-0.114	-0.100	-0.128	-0.141	-0.154	-0.018	-0.112	-0.050	-0.100	-0.041	-0.141	-0.089	-0.101	-0.075	-0.041	-0.094	-0.043	-0.041	-0.143
U21	-0.060	-0.042	-0.102	-0.071	-0.054	-0.107	-0.104	-0.112	-0.104	-0.092	-0.058	-0.112	-0.084	-0.115	-0.081	-0.073	-0.084	-0.108	-0.099	-0.051	-0.080	-0.114	-0.051	-0.099
U22	-0.076	-0.048	-0.086	-0.044	-0.079	-0.110	-0.108	-0.099	-0.120	-0.095	-0.070	-0.116	-0.064	-0.128	-0.093	-0.074	-0.116	-0.078	-0.098	-0.070	-0.083	-0.095	-0.067	-0.073
U31	-0.054	-0.081	-0.077	-0.063	-0.074	-0.119	-0.099	-0.118	-0.127	-0.105	-0.039	-0.109	-0.037	-0.111	-0.050	-0.031	-0.073	-0.032	-0.090	-0.019	-0.090	-0.093	-0.038	-0.079
U32	-0.058	-0.070	-0.090	-0.070	-0.075	-0.111	-0.119	-0.129	-0.113	-0.110	-0.051	-0.102	-0.050	-0.108	-0.057	-0.033	-0.072	-0.080	-0.089	-0.021	-0.085	-0.088	-0.037	-0.097
I11	-0.069	-0.057	-0.074	-0.073	-0.096	-0.107	-0.115	-0.098	-0.096	-0.110	-0.088	-0.089	-0.048	-0.105	-0.071	-0.071	-0.086	-0.088	-0.085	-0.065	-0.081	-0.050	-0.056	-0.092
I12	-0.068	-0.033	-0.053	-0.066	-0.116	-0.098	-0.113	-0.116	-0.093	-0.124	-0.081	-0.103	-0.039	-0.111	-0.073	-0.072	-0.079	-0.082	-0.097	-0.054	-0.088	-0.055	-0.043	-0.105
I21	-0.055	-0.095	-0.058	-0.066	-0.054	-0.121	-0.094	-0.083	-0.105	-0.072	-0.115	-0.116	-0.114	-0.074	-0.178	-0.023	-0.134	-0.085	-0.055	-0.156	-0.069	-0.133	-0.036	-0.082
I22	-0.048	-0.051	-0.049	-0.075	-0.043	-0.081	-0.103	-0.254	-0.088	-0.165	-0.011	-0.112	-0.009	-0.116	-0.023	-0.001	-0.035	-0.035	-0.014	-0.003	-0.083	-0.021	-0.023	-0.125
P11	-0.074	-0.076	-0.077	-0.074	-0.080	-0.110	-0.083	-0.120	-0.117	-0.120	-0.058	-0.092	-0.046	-0.088	-0.053	-0.032	-0.065	-0.056	-0.074	-0.034	-0.097	-0.094	-0.063	-0.088
P12	-0.078	-0.044	-0.035	-0.097	-0.108	-0.103	-0.121	-0.050	-0.089	-0.044	-0.092	-0.119	-0.074	-0.116	-0.083	-0.082	-0.100	-0.103	-0.114	-0.097	-0.114	-0.051	-0.044	-0.111
P13	-0.028	-0.072	-0.060	-0.066	-0.133	-0.077	-0.136	-0.062	-0.115	-0.023	-0.042	-0.136	-0.113	-0.115	-0.074	-0.078	-0.042	-0.097	-0.117	-0.107	-0.113	-0.048	-0.028	-0.107

APPENDIX B.4: Entropy Data Matrix - Year 2015

	AT	BE	BG	HR	CY	CZ	DK	EE	FI	FR	DE	EL	HU	IE	IT	LT	LV	LU	MT	NL	PL
C11	-0.081	-0.109	-0.060	-0.064	-0.091	-0.081	-0.123	-0.085	-0.094	-0.123	-0.112	-0.094	-0.081	-0.081	-0.071	-0.081	-0.071	-0.100	-0.112	-0.120	-0.048
C12	-0.089	-0.090	-0.084	-0.086	-0.090	-0.089	-0.089	-0.072	-0.086	-0.090	-0.088	-0.089	-0.084	-0.085	-0.089	-0.081	-0.085	-0.090	-0.090	-0.090	-0.071
C21	-0.092	-0.093	-0.061	-0.092	-0.064	-0.092	-0.093	-0.093	-0.093	-0.079	-0.090	-0.081	-0.091	-0.086	-0.088	-0.087	-0.086	-0.090	-0.093	-0.092	-0.093
C22	-0.072	-0.063	-0.084	-0.077	-0.079	-0.076	-0.118	-0.112	-0.139	-0.079	-0.074	-0.046	-0.050	-0.100	-0.086	-0.072	-0.071	-0.088	-0.064	-0.085	-0.059
C31	-0.098	-0.093	-0.071	-0.078	-0.092	-0.089	-0.094	-0.084	-0.094	-0.096	-0.087	-0.084	-0.062	-0.083	-0.088	-0.087	-0.088	-0.099	-0.081	-0.091	-0.083
C41	-0.041	-0.164	-0.086	-0.023	-0.017	-0.012	-0.101	-0.050	-0.050	-0.069	-0.072	-0.023	-0.007	-0.248	-0.037	-0.248	-0.028	-0.041	-0.115	-0.086	-0.050
H11	-0.096	-0.088	-0.064	-0.079	-0.068	-0.088	-0.103	-0.092	-0.104	-0.085	-0.095	-0.082	-0.080	-0.071	-0.072	-0.077	-0.077	-0.116	-0.082	-0.103	-0.060
H12	-0.101	-0.074	-0.073	-0.078	-0.087	-0.064	-0.109	-0.100	-0.104	-0.086	-0.101	-0.059	-0.069	-0.069	-0.073	-0.089	-0.068	-0.134	-0.096	-0.104	-0.040
H13	-0.105	-0.076	-0.012	-0.053	-0.039	-0.057	-0.150	-0.094	-0.102	-0.074	-0.084	-0.120	-0.053	-0.061	-0.073	-0.067	-0.026	-0.147	-0.029	-0.097	-0.040
H21	-0.067	-0.078	-0.123	-0.091	-0.119	-0.069	-0.087	-0.109	-0.132	-0.087	-0.076	-0.092	-0.078	-0.071	-0.063	-0.082	-0.091	-0.117	-0.130	-0.092	-0.066
H22	-0.093	-0.035	-0.077	-0.094	-0.076	-0.092	-0.099	-0.108	-0.133	-0.076	-0.102	-0.099	-0.063	-0.131	-0.035	-0.051	-0.100	-0.104	-0.131	-0.079	-0.076
U11	-0.095	-0.097	-0.046	-0.071	-0.075	-0.081	-0.113	-0.102	-0.099	-0.085	-0.101	-0.066	-0.077	-0.094	-0.049	-0.074	-0.087	-0.113	-0.082	-0.107	-0.068
U12	-0.102	-0.097	-0.022	-0.035	-0.062	-0.050	-0.117	-0.049	-0.099	-0.093	-0.103	-0.051	-0.038	-0.130	-0.081	-0.041	-0.040	-0.180	-0.063	-0.104	-0.041
U21	-0.065	-0.092	-0.084	-0.062	-0.106	-0.084	-0.113	-0.105	-0.067	-0.064	-0.067	-0.075	-0.103	-0.073	-0.053	-0.128	-0.112	-0.118	-0.063	-0.080	-0.069
U22	-0.067	-0.113	-0.050	-0.049	-0.079	-0.054	-0.110	-0.091	-0.096	-0.046	-0.093	-0.063	-0.101	-0.084	-0.058	-0.069	-0.095	-0.116	-0.063	-0.098	-0.057
U31	-0.087	-0.101	-0.060	-0.068	-0.078	-0.084	-0.126	-0.121	-0.127	-0.096	-0.087	-0.032	-0.064	-0.088	-0.056	-0.086	-0.103	-0.104	-0.107	-0.125	-0.060
U32	-0.095	-0.092	-0.060	-0.075	-0.074	-0.079	-0.119	-0.096	-0.108	-0.103	-0.112	-0.061	-0.067	-0.087	-0.053	-0.061	-0.070	-0.118	-0.092	-0.110	-0.068
I11	-0.096	-0.098	-0.057	-0.067	-0.072	-0.084	-0.093	-0.088	-0.108	-0.095	-0.099	-0.067	-0.072	-0.096	-0.070	-0.088	-0.088	-0.098	-0.077	-0.101	-0.057
I12	-0.102	-0.100	-0.044	-0.052	-0.080	-0.072	-0.103	-0.090	-0.107	-0.093	-0.104	-0.051	-0.059	-0.097	-0.030	-0.089	-0.073	-0.113	-0.082	-0.100	-0.033
I21	-0.061	-0.070	-0.140	-0.033	-0.109	-0.048	-0.099	-0.108	-0.129	-0.062	-0.071	-0.031	-0.036	-0.092	-0.039	-0.052	-0.029	-0.080	-0.049	-0.089	-0.024
I22	-0.099	-0.073	-0.030	-0.029	-0.081	-0.073	-0.157	-0.100	-0.106	-0.069	-0.125	-0.020	-0.039	-0.101	-0.028	-0.048	-0.052	-0.148	-0.109	-0.212	-0.040
P11	-0.089	-0.084	-0.076	-0.071	-0.096	-0.059	-0.123	-0.116	-0.113	-0.096	-0.086	-0.077	-0.072	-0.081	-0.047	-0.074	-0.084	-0.105	-0.111	-0.109	-0.050
P12	-0.101	-0.016	-0.042	-0.090	-0.021	-0.071	-0.079	-0.116	-0.127	-0.093	-0.091	-0.056	-0.083	-0.123	-0.050	-0.065	-0.058	0.000	-0.086	-0.087	-0.045
P13	-0.079	-0.065	-0.090	-0.100	-0.087	-0.083	-0.113	-0.113	-0.108	-0.102	-0.078	-0.058	-0.078	-0.072	-0.088	-0.076	-0.072	-0.063	-0.088	-0.103	-0.098

APPENDIX B.4 (Cont.): Entropy Data Matrix - Year 2015

	PT	RO	SK	SI	ES	SE	UK	IS	NO	CH	RS	AU	BR	CA	CL	CN	IL	JP	KR	MX	NZ	RU	TR	US
C11	-0.088	-0.056	-0.064	-0.078	-0.085	-0.106	-0.109	-0.112	-0.115	-0.131	-0.030	-0.085	-0.014	-0.106	-0.030	-0.052	-0.078	-0.088	-0.115	-0.014	-0.091	-0.048	-0.014	-0.094
C12	-0.090	-0.075	-0.071	-0.085	-0.084	-0.089	-0.090	-0.088	-0.084	-0.090	-0.081	-0.065	-0.085	-0.085	-0.088	-0.077	-0.082	-0.090	-0.085	-0.088	-0.086	-0.078	-0.074	-0.086
C21	-0.089	-0.068	-0.075	-0.090	-0.087	-0.093	-0.092	-0.088	-0.092	-0.092	-0.061	-0.089	-0.073	-0.091	-0.076	-0.083	-0.064	-0.092	-0.092	-0.062	-0.085	-0.055	-0.079	-0.093
C22	-0.053	-0.072	-0.070	-0.047	-0.087	-0.121	-0.088	-0.098	-0.112	-0.104	-0.058	-0.126	-0.092	-0.063	-0.057	-0.056	-0.087	-0.126	-0.110	-0.052	-0.115	-0.073	-0.049	-0.118
C31	-0.076	-0.090	-0.084	-0.084	-0.084	-0.090	-0.102	-0.096	-0.099	-0.100	-0.030	-0.094	-0.086	-0.081	-0.053	-0.028	-0.085	-0.099	-0.080	-0.040	-0.079	-0.096	-0.090	-0.104
C41	-0.058	-0.248	-0.012	-0.005	-0.005	-0.248	-0.076	-0.058	-0.033	-0.028	-0.050	-0.041	-0.005	-0.069	-0.041	-0.012	-0.069	-0.058	-0.164	-0.028	-0.095	-0.115	-0.005	-0.012
H11	-0.079	-0.049	-0.083	-0.083	-0.084	-0.102	-0.092	-0.109	-0.106	-0.098	-0.078	-0.102	-0.054	-0.093	-0.084	-0.078	-0.088	-0.074	-0.080	-0.075	-0.104	-0.067	-0.045	-0.085
H12	-0.098	-0.043	-0.067	-0.101	-0.081	-0.077	-0.096	-0.118	-0.096	-0.115	-0.044	-0.104	-0.067	-0.078	-0.058	-0.071	-0.082	-0.115	-0.082	-0.069	-0.083	-0.070	-0.049	-0.107
H13	-0.091	-0.012	-0.045	-0.066	-0.086	-0.127	-0.093	-0.111	-0.126	-0.121	-0.051	-0.095	-0.057	-0.106	-0.085	-0.093	-0.128	-0.153	-0.073	-0.059	-0.095	-0.048	-0.035	-0.120
H21	-0.071	-0.125	-0.073	-0.109	-0.072	-0.070	-0.070	-0.126	-0.090	-0.107	-0.078	-0.119	-0.070	-0.057	-0.012	-0.032	-0.013	-0.033	-0.078	-0.070	-0.101	-0.077	-0.030	-0.093
H22	-0.036	-0.115	-0.073	-0.084	-0.092	-0.085	-0.086	-0.098	-0.078	-0.063	-0.109	-0.087	-0.079	-0.069	-0.080	-0.037	-0.023	-0.074	-0.058	-0.048	-0.132	-0.106	-0.061	-0.087
U11	-0.069	-0.044	-0.085	-0.077	-0.086	-0.105	-0.107	-0.116	-0.114	-0.100	-0.063	-0.096	-0.049	-0.104	-0.083	-0.031	-0.084	-0.106	-0.104	-0.047	-0.101	-0.072	-0.039	-0.080
U12	-0.054	-0.029	-0.046	-0.057	-0.071	-0.114	-0.108	-0.115	-0.147	-0.158	-0.017	-0.123	-0.050	-0.103	-0.041	-0.142	-0.087	-0.095	-0.074	-0.043	-0.092	-0.045	-0.042	-0.143
U21	-0.063	-0.034	-0.108	-0.066	-0.053	-0.101	-0.101	-0.121	-0.114	-0.063	-0.093	-0.105	-0.083	-0.111	-0.058	-0.076	-0.093	-0.088	-0.050	-0.048	-0.095	-0.108	-0.043	-0.076
U22	-0.073	-0.021	-0.086	-0.046	-0.080	-0.105	-0.111	-0.110	-0.125	-0.091	-0.091	-0.108	-0.067	-0.105	-0.080	-0.097	-0.117	-0.078	-0.101	-0.065	-0.108	-0.066	-0.057	-0.093
U31	-0.056	-0.069	-0.069	-0.064	-0.072	-0.120	-0.096	-0.114	-0.131	-0.104	-0.079	-0.117	-0.037	-0.089	-0.046	-0.032	-0.074	-0.027	-0.088	-0.018	-0.131	-0.068	-0.034	-0.089
U32	-0.060	-0.068	-0.085	-0.071	-0.075	-0.110	-0.121	-0.118	-0.115	-0.110	-0.053	-0.110	-0.051	-0.093	-0.053	-0.035	-0.072	-0.089	-0.085	-0.018	-0.117	-0.085	-0.034	-0.092
I11	-0.096	-0.057	-0.080	-0.080	-0.082	-0.105	-0.105	-0.104	-0.106	-0.104	-0.037	-0.092	-0.052	-0.100	-0.084	-0.046	-0.102	-0.098	-0.085	-0.066	-0.091	-0.044	-0.068	-0.107
I12	-0.099	-0.046	-0.065	-0.071	-0.069	-0.112	-0.103	-0.119	-0.115	-0.115	-0.008	-0.099	-0.063	-0.092	-0.082	-0.058	-0.115	-0.116	-0.092	-0.055	-0.106	-0.036	-0.084	-0.116
I21	-0.083	-0.087	-0.066	-0.054	-0.044	-0.103	-0.071	-0.100	-0.100	-0.071	-0.152	-0.094	-0.114	-0.039	-0.110	-0.045	-0.161	-0.082	-0.044	-0.150	-0.132	-0.125	-0.074	-0.086
I22	-0.038	-0.018	-0.044	-0.077	-0.038	-0.123	-0.127	-0.183	-0.121	-0.172	-0.007	-0.131	-0.008	-0.106	-0.012	0.000	-0.051	-0.057	-0.026	-0.003	-0.117	-0.016	-0.018	-0.163
P11	-0.073	-0.075	-0.082	-0.076	-0.081	-0.107	-0.080	-0.117	-0.116	-0.107	-0.092	-0.108	-0.047	-0.095	-0.046	-0.044	-0.062	-0.059	-0.082	-0.032	-0.110	-0.089	-0.053	-0.087
P12	-0.081	-0.029	-0.038	-0.092	-0.110	-0.138	-0.088	-0.104	-0.124	-0.082	-0.074	-0.081	-0.075	-0.132	-0.126	-0.064	-0.120	-0.093	-0.108	-0.105	-0.124	-0.004	-0.043	-0.107
P13	-0.047	-0.094	-0.049	-0.080	-0.088	-0.075	-0.122	-0.075	-0.102	-0.074	-0.096	-0.108	-0.099	-0.088	-0.074	-0.075	-0.055	-0.072	-0.079	-0.094	-0.103	-0.037	-0.054	-0.103

APPENDIX C.1: ENTROPY - Weight calculations (2015-2017)

Dimension (Dim)	Indicators	2015				2016				2017			
		Ej	Dj	Wj	Wj/ Dim	Ej	Dj	Wj	Wj/ Dim	Ej	Dj	Wj	Wj/ Dim
Connectivity	C11	0.969	0.031	3.88%	31%	0.973	0.027	3.59%	29%	0.977	0.023	3.48%	29%
	C12	0.999	0.001	0.17%		0.998	0.002	0.30%		0.997	0.003	0.42%	
	C21	0.996	0.004	0.50%		0.998	0.002	0.27%		0.999	0.001	0.14%	
	C22	0.980	0.020	2.55%		0.986	0.014	1.90%		0.986	0.014	2.15%	
	C31	0.990	0.010	1.19%		0.990	0.010	1.31%		0.988	0.012	1.76%	
	C41	0.814	0.186	23.21%		0.839	0.161	21.40%		0.859	0.141	21.00%	
Human Capital	H11	0.992	0.008	1.03%	15%	0.994	0.006	0.81%	15%	0.991	0.009	1.36%	16%
	H12	0.985	0.015	1.90%		0.988	0.012	1.61%		0.987	0.013	1.96%	
	H13	0.956	0.044	5.54%		0.958	0.042	5.54%		0.959	0.041	6.15%	
	H21	0.971	0.029	3.59%		0.979	0.021	2.76%		0.982	0.018	2.70%	
	H22	0.976	0.024	3.04%		0.965	0.035	4.59%		0.976	0.024	3.64%	
Use of Internet Services	U11	0.983	0.017	2.08%	20%	0.987	0.013	1.70%	19%	0.990	0.010	1.47%	21%
	U12	0.944	0.056	6.96%		0.945	0.055	7.24%		0.948	0.052	7.82%	
	U21	0.981	0.019	2.34%		0.984	0.016	2.17%		0.985	0.015	2.30%	
	U22	0.981	0.019	2.38%		0.985	0.015	2.01%		0.980	0.020	2.91%	
	U31	0.969	0.031	3.90%		0.973	0.027	3.58%		0.975	0.025	3.74%	
	U32	0.978	0.022	2.76%		0.979	0.021	2.76%		0.981	0.019	2.79%	
Integration of Digital Technology	I11	0.988	0.012	1.49%	24%	0.989	0.011	1.43%	26%	0.984	0.016	2.42%	27%
	I12	0.974	0.026	3.25%		0.978	0.022	2.90%		0.964	0.036	5.44%	
	I21	0.955	0.045	5.56%		0.956	0.044	5.83%		0.960	0.040	5.94%	
	I22	0.891	0.109	13.58%		0.879	0.121	16.07%		0.912	0.088	13.19%	
Digital Public Services	P11	0.982	0.018	2.21%	9%	0.982	0.018	2.34%	10%	0.985	0.015	2.30%	7%
	P12	0.957	0.043	5.36%		0.975	0.025	3.33%		0.985	0.015	2.19%	
	P13	0.988	0.012	1.53%		0.966	0.034	4.57%		0.982	0.018	2.72%	

APPENDIX D.1: Entropy-based TOPSIS - Normalized Weighted Decision Matrix 2018

	AT	BE	BG	HR	CY	CZ	DK	EE	FI	FR	DE	EL	HU	IE	IT	LT	LV	LU	MT	NL	PL
C11	0.113	0.183	0.107	0.107	0.164	0.126	0.214	0.145	0.132	0.221	0.195	0.176	0.139	0.126	0.113	0.113	0.107	0.170	0.214	0.208	0.057
C12	0.159	0.166	0.149	0.166	0.166	0.153	0.162	0.119	0.146	0.159	0.159	0.149	0.146	0.153	0.162	0.116	0.146	0.166	0.166	0.166	0.063
C21	0.152	0.155	0.155	0.153	0.152	0.155	0.155	0.153	0.155	0.153	0.152	0.153	0.153	0.139	0.153	0.152	0.155	0.150	0.155	0.154	0.155
C22	0.117	0.096	0.142	0.103	0.138	0.118	0.202	0.219	0.236	0.124	0.106	0.107	0.083	0.145	0.129	0.139	0.190	0.128	0.156	0.104	0.262
C31	0.150	0.165	0.130	0.065	0.069	0.170	0.192	0.140	0.181	0.194	0.164	0.105	0.108	0.157	0.074	0.213	0.125	0.212	0.188	0.131	0.128
C41	0.119	0.178	0.102	0.099	0.057	0.216	0.063	0.115	0.129	0.095	0.113	0.003	0.007	0.128	0.237	0.280	0.189	0.006	0.193	0.189	0.214
H11	0.160	0.149	0.075	0.102	0.124	0.130	0.200	0.159	0.208	0.134	0.181	0.090	0.122	0.180	0.124	0.119	0.134	0.230	0.132	0.217	0.100
H12	0.151	0.101	0.150	0.084	0.131	0.133	0.208	0.138	0.188	0.198	0.225	0.119	0.094	0.213	0.073	0.119	0.097	0.237	0.151	0.198	0.057
H13	0.074	0.101	0.066	0.042	0.124	0.048	0.264	0.114	0.247	0.108	0.153	0.125	0.046	0.193	0.068	0.112	0.077	0.265	0.072	0.164	0.021
H21	0.185	0.108	0.182	0.135	0.179	0.146	0.177	0.168	0.143	0.179	0.113	0.158	0.135	0.140	0.143	0.074	0.164	0.113	0.145	0.172	0.135
H22	0.226	0.085	0.127	0.075	0.117	0.182	0.131	0.208	0.197	0.190	0.154	0.083	0.098	0.210	0.037	0.041	0.182	0.125	0.142	0.181	0.151
U11	0.162	0.165	0.084	0.111	0.151	0.138	0.196	0.168	0.166	0.143	0.169	0.112	0.123	0.151	0.117	0.135	0.148	0.194	0.141	0.186	0.128
U12	0.170	0.157	0.028	0.046	0.092	0.075	0.202	0.074	0.165	0.145	0.168	0.065	0.051	0.261	0.121	0.060	0.056	0.387	0.097	0.176	0.053
U21	0.110	0.109	0.126	0.096	0.186	0.122	0.215	0.128	0.126	0.077	0.159	0.128	0.132	0.104	0.094	0.184	0.157	0.140	0.078	0.178	0.090
U22	0.114	0.193	0.042	0.092	0.145	0.124	0.218	0.151	0.170	0.069	0.113	0.114	0.164	0.143	0.087	0.134	0.148	0.157	0.066	0.166	0.101
U31	0.146	0.171	0.074	0.063	0.114	0.156	0.223	0.200	0.221	0.158	0.147	0.068	0.103	0.144	0.084	0.151	0.165	0.169	0.148	0.222	0.110
U32	0.153	0.154	0.085	0.070	0.124	0.149	0.214	0.155	0.177	0.170	0.195	0.091	0.104	0.150	0.090	0.110	0.114	0.182	0.169	0.203	0.121
I11	0.163	0.194	0.026	0.032	0.030	0.127	0.177	0.141	0.243	0.176	0.180	0.040	0.084	0.124	0.073	0.129	0.098	0.206	0.143	0.219	0.035
I12	0.130	0.144	0.046	0.151	0.112	0.088	0.190	0.105	0.246	0.144	0.239	0.042	0.183	0.162	0.018	0.119	0.035	0.204	0.077	0.246	0.000
I21	0.090	0.159	0.067	0.042	0.051	0.104	0.235	0.139	0.272	0.070	0.090	0.044	0.067	0.185	0.089	0.082	0.056	0.094	0.022	0.197	0.038
I22	0.078	0.065	0.178	0.091	0.030	0.197	0.200	0.228	0.158	0.095	0.263	0.023	0.090	0.325	0.057	0.085	0.067	0.201	0.067	0.342	0.075
P11	0.164	0.140	0.105	0.093	0.129	0.132	0.227	0.196	0.205	0.176	0.141	0.123	0.131	0.133	0.060	0.126	0.163	0.156	0.152	0.202	0.088
P12	0.110	0.071	0.103	0.042	0.107	0.096	0.199	0.158	0.209	0.190	0.164	0.139	0.042	0.171	0.183	0.097	0.030	0.174	0.123	0.203	0.148
P13	0.143	0.110	0.155	0.058	0.244	0.124	0.172	0.210	0.112	0.262	0.072	0.167	0.102	0.200	0.119	0.028	0.091	0.086	0.137	0.143	0.133

APPENDIX D.1 (Cont.): Entropy-based TOPSIS - Normalized Weighted Decision Matrix 2018

	PT	RO	SK	SI	ES	SE	UK	IS	NO	CH	RS	AU	BR	CA	CL	CN	IL	JP	KR	MX	NZ	RU	TR	US
C11	0.170	0.101	0.113	0.120	0.139	0.183	0.189	0.195	0.195	0.227	0.044	0.151	0.032	0.183	0.044	0.120	0.120	0.139	0.202	0.032	0.158	0.076	0.038	0.164
C12	0.139	0.146	0.119	0.159	0.153	0.153	0.162	0.166	0.156	0.166	0.141	0.139	0.131	0.151	0.146	0.139	0.163	0.146	0.162	0.145	0.136	0.125	0.101	0.166
C21	0.153	0.144	0.146	0.155	0.152	0.155	0.155	0.152	0.155	0.153	0.150	0.153	0.129	0.153	0.136	0.153	0.105	0.148	0.155	0.121	0.150	0.108	0.144	0.155
C22	0.093	0.117	0.114	0.100	0.136	0.178	0.133	0.182	0.138	0.135	0.081	0.202	0.118	0.098	0.124	0.130	0.107	0.292	0.162	0.086	0.163	0.116	0.094	0.212
C31	0.144	0.085	0.167	0.151	0.101	0.196	0.199	0.216	0.221	0.206	0.098	0.136	0.040	0.133	0.115	0.075	0.150	0.213	0.166	0.030	0.157	0.068	0.077	0.104
C41	0.035	0.002	0.112	0.008	0.087	0.292	0.191	0.056	0.049	0.196	0.000	0.157	0.136	0.021	0.020	0.202	0.298	0.122	0.137	0.022	0.239	0.263	0.026	0.027
H11	0.111	0.117	0.115	0.141	0.142	0.181	0.184	0.212	0.201	0.204	0.137	0.168	0.084	0.183	0.114	0.098	0.152	0.125	0.141	0.109	0.137	0.081	0.094	0.162
H12	0.110	0.089	0.087	0.151	0.096	0.201	0.163	0.163	0.135	0.229	0.129	0.184	0.086	0.098	0.106	0.176	0.141	0.204	0.128	0.103	0.166	0.099	0.028	0.191
H13	0.085	0.030	0.046	0.130	0.088	0.180	0.175	0.265	0.252	0.216	0.008	0.114	0.062	0.194	0.167	0.158	0.151	0.271	0.121	0.180	0.139	0.080	0.045	0.208
H21	0.091	0.212	0.087	0.111	0.124	0.209	0.069	0.120	0.096	0.180	0.228	0.254	0.158	0.042	0.101	0.181	0.125	0.092	0.143	0.079	0.170	0.113	0.085	0.221
H22	0.014	0.187	0.130	0.148	0.175	0.203	0.126	0.102	0.103	0.116	0.140	0.206	0.170	0.098	0.017	0.157	0.187	0.046	0.078	0.100	0.145	0.207	0.108	0.274
U11	0.118	0.104	0.138	0.135	0.157	0.177	0.187	0.201	0.192	0.152	0.113	0.141	0.095	0.177	0.070	0.036	0.175	0.184	0.190	0.088	0.151	0.139	0.105	0.189
U12	0.076	0.040	0.062	0.083	0.105	0.180	0.150	0.241	0.271	0.275	0.021	0.192	0.058	0.156	0.052	0.121	0.137	0.147	0.109	0.047	0.137	0.056	0.039	0.257
U21	0.091	0.161	0.117	0.112	0.086	0.162	0.145	0.169	0.172	0.170	0.139	0.137	0.168	0.149	0.105	0.233	0.229	0.194	0.122	0.151	0.163	0.226	0.147	0.179
U22	0.139	0.168	0.142	0.097	0.134	0.184	0.182	0.268	0.231	0.147	0.064	0.116	0.134	0.193	0.112	0.157	0.188	0.145	0.166	0.131	0.123	0.133	0.141	0.199
U31	0.096	0.157	0.124	0.105	0.121	0.209	0.184	0.235	0.232	0.220	0.082	0.186	0.056	0.189	0.033	0.079	0.154	0.045	0.161	0.025	0.128	0.081	0.070	0.185
U32	0.093	0.103	0.150	0.129	0.135	0.197	0.210	0.191	0.200	0.218	0.102	0.175	0.070	0.194	0.014	0.127	0.183	0.147	0.157	0.041	0.143	0.119	0.064	0.196
I11	0.173	0.021	0.100	0.140	0.107	0.219	0.206	0.207	0.236	0.232	0.061	0.136	0.001	0.188	0.130	0.070	0.228	0.203	0.150	0.058	0.178	0.110	0.047	0.131
I12	0.074	0.035	0.060	0.070	0.028	0.264	0.218	0.137	0.176	0.253	0.042	0.137	0.007	0.151	0.004	0.109	0.285	0.207	0.105	0.011	0.151	0.056	0.144	0.250
I21	0.095	0.138	0.083	0.099	0.081	0.237	0.169	0.265	0.209	0.237	0.078	0.178	0.166	0.155	0.186	0.022	0.293	0.141	0.087	0.201	0.114	0.129	0.037	0.251
I22	0.074	0.074	0.060	0.154	0.053	0.086	0.127	0.301	0.097	0.317	0.032	0.153	0.009	0.144	0.038	0.002	0.045	0.054	0.010	0.001	0.082	0.024	0.020	0.306
P11	0.103	0.160	0.127	0.134	0.141	0.206	0.146	0.224	0.222	0.201	0.101	0.180	0.074	0.172	0.074	0.114	0.162	0.040	0.139	0.064	0.133	0.111	0.113	0.203
P12	0.151	0.042	0.100	0.104	0.200	0.174	0.200	0.030	0.196	0.119	0.104	0.200	0.149	0.158	0.107	0.155	0.113	0.200	0.209	0.177	0.200	0.121	0.107	0.200
P13	0.076	0.160	0.067	0.152	0.167	0.014	0.105	0.029	0.133	0.033	0.128	0.176	0.186	0.181	0.066	0.187	0.114	0.191	0.276	0.172	0.143	0.218	0.106	0.185

APPENDIX D.2: Entropy-based TOPSIS - Normalized Weighted Decision Matrix 2017

	AT	BE	BG	HR	CY	CZ	DK	EE	FI	FR	DE	EL	HU	IE	IT	LT	LV	LU	MT	NL	PL
C11	0.004	0.006	0.003	0.004	0.006	0.005	0.008	0.005	0.005	0.008	0.007	0.006	0.005	0.004	0.004	0.004	0.004	0.006	0.007	0.007	0.002
C12	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.000	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.000	0.001	0.001	0.001	0.001	0.000
C21	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
C22	0.003	0.002	0.003	0.002	0.003	0.002	0.004	0.004	0.005	0.003	0.002	0.002	0.002	0.003	0.003	0.003	0.004	0.003	0.002	0.003	0.005
C31	0.003	0.003	0.002	0.002	0.003	0.002	0.003	0.003	0.003	0.003	0.003	0.003	0.002	0.003	0.002	0.003	0.002	0.003	0.002	0.003	0.002
C41	0.013	0.033	0.020	0.002	0.003	0.013	0.016	0.006	0.006	0.010	0.010	0.002	0.033	0.066	0.004	0.066	0.006	0.013	0.046	0.013	0.052
H11	0.002	0.002	0.002	0.001	0.002	0.002	0.002	0.002	0.003	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.003	0.001	0.003	0.002
H12	0.003	0.002	0.003	0.003	0.003	0.002	0.003	0.003	0.003	0.003	0.003	0.002	0.002	0.002	0.002	0.003	0.002	0.005	0.003	0.004	0.001
H13	0.009	0.006	0.006	0.004	0.006	0.005	0.017	0.009	0.013	0.008	0.007	0.008	0.005	0.006	0.008	0.006	0.002	0.013	0.002	0.011	0.004
H21	0.003	0.003	0.006	0.004	0.005	0.003	0.003	0.004	0.006	0.003	0.003	0.004	0.003	0.003	0.003	0.003	0.004	0.005	0.007	0.004	0.003
H22	0.005	0.002	0.005	0.007	0.003	0.006	0.006	0.010	0.008	0.004	0.006	0.004	0.006	0.009	0.001	0.004	0.006	0.008	0.010	0.003	0.005
U11	0.002	0.002	0.001	0.001	0.002	0.002	0.003	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.001	0.002	0.002	0.003	0.002	0.003	0.002
U12	0.013	0.012	0.002	0.003	0.007	0.005	0.015	0.005	0.012	0.011	0.013	0.005	0.004	0.019	0.009	0.004	0.004	0.029	0.007	0.013	0.004
U21	0.003	0.003	0.002	0.000	0.002	0.003	0.005	0.004	0.003	0.002	0.004	0.002	0.004	0.003	0.002	0.005	0.003	0.005	0.003	0.004	0.002
U22	0.003	0.006	0.001	0.002	0.003	0.003	0.006	0.004	0.005	0.002	0.003	0.003	0.005	0.004	0.002	0.004	0.004	0.005	0.002	0.005	0.003
U31	0.005	0.006	0.004	0.004	0.004	0.005	0.009	0.008	0.008	0.006	0.005	0.002	0.004	0.006	0.003	0.005	0.006	0.007	0.007	0.008	0.004
U32	0.005	0.004	0.002	0.002	0.004	0.004	0.006	0.004	0.005	0.005	0.006	0.002	0.003	0.004	0.002	0.003	0.003	0.006	0.004	0.006	0.003
I11	0.005	0.005	0.003	0.003	0.004	0.004	0.004	0.003	0.005	0.004	0.004	0.005	0.005	0.003	0.003	0.004	0.002	0.004	0.002	0.005	0.002
I12	0.011	0.009	0.004	0.007	0.006	0.004	0.008	0.006	0.009	0.005	0.009	0.001	0.010	0.006	0.000	0.010	0.004	0.015	0.008	0.014	0.001
I21	0.005	0.009	0.008	0.006	0.005	0.005	0.012	0.005	0.016	0.004	0.002	0.002	0.004	0.008	0.004	0.005	0.003	0.007	0.003	0.013	0.002
I22	0.006	0.007	0.027	0.012	0.015	0.021	0.037	0.024	0.019	0.012	0.029	0.003	0.011	0.032	0.006	0.011	0.010	0.036	0.012	0.059	0.005
P11	0.004	0.003	0.003	0.003	0.003	0.003	0.005	0.005	0.005	0.004	0.003	0.003	0.003	0.003	0.001	0.003	0.004	0.004	0.005	0.005	0.002
P12	0.003	0.003	0.001	0.002	0.001	0.002	0.004	0.004	0.004	0.004	0.004	0.003	0.002	0.004	0.004	0.003	0.001	0.003	0.003	0.004	0.003
P13	0.003	0.003	0.003	0.003	0.004	0.004	0.005	0.005	0.004	0.006	0.003	0.002	0.002	0.004	0.004	0.001	0.004	0.003	0.004	0.004	0.003

APPENDIX D.2 (Cont.): Entropy-based TOPSIS - Normalized Weighted Decision Matrix 2017

	PT	RO	SK	SI	ES	SE	UK	IS	NO	CH	RS	AU	BR	CA	CL	CN	IL	JP	KR	MX	NZ	RU	TR	US
C11	0.006	0.003	0.004	0.004	0.005	0.007	0.007	0.007	0.007	0.008	0.002	0.005	0.001	0.006	0.002	0.004	0.004	0.005	0.007	0.001	0.005	0.003	0.001	0.005
C12	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.000	0.001	0.001	0.001	0.001	0.000	0.001
C21	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
C22	0.002	0.002	0.002	0.002	0.003	0.004	0.003	0.004	0.003	0.003	0.002	0.005	0.003	0.002	0.003	0.002	0.003	0.006	0.004	0.002	0.003	0.002	0.002	0.005
C31	0.002	0.003	0.003	0.002	0.003	0.003	0.003	0.003	0.003	0.003	0.000	0.003	0.001	0.002	0.001	0.002	0.003	0.003	0.002	0.001	0.002	0.004	0.003	0.003
C41	0.008	0.066	0.002	0.006	0.000	0.066	0.053	0.033	0.004	0.003	0.006	0.010	0.000	0.002	0.020	0.066	0.010	0.000	0.066	0.006	0.016	0.020	0.000	0.066
H11	0.002	0.001	0.002	0.002	0.002	0.003	0.002	0.003	0.003	0.003	0.002	0.002	0.001	0.002	0.002	0.001	0.002	0.001	0.002	0.001	0.002	0.001	0.001	0.002
H12	0.003	0.003	0.002	0.003	0.002	0.003	0.003	0.005	0.003	0.004	0.002	0.003	0.002	0.003	0.003	0.003	0.001	0.003	0.002	0.002	0.003	0.002	0.002	0.004
H13	0.010	0.000	0.005	0.005	0.007	0.014	0.013	0.016	0.015	0.013	0.001	0.012	0.004	0.012	0.015	0.004	0.009	0.014	0.006	0.011	0.011	0.002	0.004	0.008
H21	0.003	0.007	0.003	0.005	0.003	0.004	0.002	0.005	0.003	0.005	0.004	0.005	0.005	0.002	0.004	0.007	0.000	0.003	0.003	0.003	0.003	0.004	0.002	0.006
H22	0.002	0.006	0.004	0.005	0.005	0.005	0.005	0.005	0.005	0.003	0.007	0.005	0.004	0.004	0.004	0.005	0.001	0.001	0.006	0.003	0.009	0.006	0.003	0.005
U11	0.002	0.001	0.002	0.002	0.002	0.003	0.003	0.003	0.003	0.003	0.002	0.002	0.001	0.003	0.002	0.001	0.002	0.002	0.003	0.001	0.003	0.002	0.001	0.002
U12	0.006	0.003	0.004	0.006	0.008	0.014	0.011	0.019	0.020	0.022	0.001	0.015	0.005	0.012	0.004	0.019	0.011	0.012	0.008	0.004	0.011	0.004	0.004	0.020
U21	0.002	0.003	0.004	0.003	0.002	0.005	0.004	0.005	0.004	0.003	0.002	0.005	0.004	0.005	0.002	0.002	0.003	0.005	0.004	0.004	0.004	0.003	0.003	0.003
U22	0.004	0.001	0.004	0.002	0.004	0.006	0.006	0.008	0.007	0.003	0.004	0.004	0.004	0.007	0.004	0.001	0.006	0.004	0.005	0.004	0.006	0.004	0.004	0.005
U31	0.003	0.004	0.005	0.004	0.004	0.008	0.007	0.009	0.009	0.006	0.003	0.005	0.002	0.008	0.002	0.002	0.004	0.002	0.006	0.001	0.009	0.005	0.002	0.005
U32	0.003	0.002	0.004	0.003	0.004	0.006	0.006	0.006	0.006	0.006	0.002	0.005	0.002	0.005	0.003	0.002	0.003	0.004	0.004	0.001	0.006	0.003	0.002	0.004
I11	0.004	0.002	0.003	0.003	0.004	0.005	0.004	0.004	0.005	0.005	0.002	0.002	0.000	0.004	0.002	0.002	0.003	0.003	0.003	0.002	0.003	0.002	0.003	0.004
I12	0.006	0.007	0.004	0.005	0.005	0.012	0.013	0.015	0.011	0.010	0.004	0.004	0.002	0.011	0.006	0.006	0.005	0.009	0.006	0.004	0.008	0.007	0.004	0.015
I21	0.005	0.008	0.005	0.005	0.005	0.012	0.012	0.015	0.011	0.015	0.007	0.003	0.010	0.013	0.018	0.004	0.010	0.012	0.004	0.014	0.010	0.011	0.003	0.010
I22	0.010	0.010	0.006	0.016	0.006	0.011	0.018	0.048	0.012	0.028	0.005	0.018	0.001	0.022	0.006	0.000	0.006	0.005	0.001	0.000	0.013	0.003	0.003	0.025
P11	0.003	0.003	0.003	0.003	0.003	0.005	0.003	0.005	0.005	0.004	0.002	0.003	0.002	0.004	0.002	0.002	0.002	0.001	0.003	0.001	0.005	0.004	0.002	0.003
P12	0.003	0.002	0.002	0.003	0.004	0.005	0.005	0.002	0.004	0.003	0.003	0.004	0.002	0.003	0.003	0.003	0.003	0.004	0.004	0.004	0.004	0.001	0.002	0.004
P13	0.002	0.004	0.004	0.004	0.005	0.003	0.004	0.003	0.004	0.003	0.004	0.007	0.004	0.004	0.004	0.005	0.003	0.006	0.008	0.004	0.004	0.004	0.001	0.004

APPENDIX D.3: Entropy-based TOPSIS - Normalized Weighted Decision Matrix 2016

	AT	BE	BG	HR	CY	CZ	DK	EE	FI	FR	DE	EL	HU	IE	IT	LT	LV	LU	MT	NL	PL
C11	0.005	0.007	0.003	0.004	0.006	0.005	0.008	0.005	0.005	0.008	0.007	0.006	0.005	0.005	0.004	0.005	0.004	0.006	0.007	0.008	0.002
C12	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
C21	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
C22	0.003	0.002	0.003	0.002	0.003	0.002	0.004	0.004	0.005	0.002	0.002	0.001	0.001	0.003	0.003	0.002	0.002	0.002	0.002	0.003	0.004
C31	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.001	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002
C41	0.006	0.040	0.016	0.003	0.002	0.001	0.004	0.008	0.008	0.012	0.013	0.003	0.008	0.081	0.005	0.081	0.008	0.016	0.012	0.016	0.065
H11	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.002	0.001	0.002	0.001
H12	0.003	0.002	0.002	0.002	0.002	0.001	0.003	0.002	0.003	0.002	0.003	0.001	0.002	0.002	0.002	0.002	0.002	0.004	0.003	0.003	0.001
H13	0.007	0.006	0.000	0.006	0.004	0.004	0.016	0.008	0.010	0.006	0.006	0.010	0.004	0.005	0.005	0.004	0.003	0.012	0.007	0.009	0.003
H21	0.003	0.003	0.006	0.004	0.006	0.003	0.004	0.004	0.007	0.004	0.003	0.004	0.003	0.004	0.003	0.003	0.004	0.006	0.004	0.005	0.003
H22	0.007	0.003	0.005	0.008	0.004	0.007	0.008	0.011	0.012	0.005	0.008	0.005	0.007	0.012	0.002	0.003	0.008	0.010	0.009	0.006	0.005
U11	0.003	0.003	0.001	0.002	0.002	0.002	0.003	0.003	0.003	0.002	0.003	0.002	0.002	0.003	0.001	0.002	0.002	0.004	0.002	0.003	0.002
U12	0.012	0.011	0.002	0.003	0.006	0.005	0.014	0.005	0.011	0.010	0.012	0.005	0.003	0.017	0.009	0.004	0.003	0.027	0.006	0.012	0.003
U21	0.002	0.003	0.002	0.002	0.004	0.003	0.005	0.003	0.002	0.002	0.002	0.002	0.004	0.003	0.002	0.005	0.003	0.005	0.002	0.003	0.002
U22	0.002	0.004	0.002	0.003	0.003	0.002	0.004	0.003	0.003	0.001	0.002	0.002	0.004	0.003	0.001	0.002	0.003	0.004	0.002	0.003	0.002
U31	0.005	0.006	0.005	0.006	0.005	0.005	0.008	0.007	0.008	0.006	0.005	0.002	0.003	0.005	0.003	0.005	0.006	0.007	0.006	0.008	0.004
U32	0.004	0.004	0.003	0.003	0.004	0.004	0.006	0.004	0.005	0.005	0.006	0.002	0.003	0.004	0.002	0.002	0.003	0.006	0.005	0.006	0.003
I11	0.003	0.003	0.002	0.002	0.001	0.001	0.003	0.002	0.002	0.003	0.002	0.002	0.003	0.002	0.002	0.002	0.001	0.003	0.002	0.003	0.001
I12	0.004	0.005	0.001	0.005	0.002	0.002	0.006	0.005	0.005	0.004	0.005	0.003	0.004	0.004	0.004	0.004	0.002	0.007	0.004	0.006	0.002
I21	0.004	0.007	0.011	0.009	0.011	0.004	0.011	0.006	0.014	0.004	0.004	0.002	0.003	0.009	0.005	0.004	0.002	0.005	0.004	0.009	0.002
I22	0.011	0.007	0.010	0.004	0.011	0.030	0.059	0.027	0.018	0.016	0.029	0.003	0.010	0.029	0.003	0.011	0.007	0.028	0.008	0.060	0.006
P11	0.004	0.003	0.003	0.004	0.004	0.002	0.005	0.005	0.005	0.004	0.003	0.003	0.003	0.003	0.001	0.003	0.004	0.005	0.004	0.005	0.002
P12	0.006	0.004	0.001	0.004	0.001	0.003	0.004	0.006	0.007	0.007	0.005	0.002	0.002	0.005	0.006	0.005	0.002	0.004	0.005	0.007	0.003
P13	0.004	0.005	0.003	0.002	0.008	0.005	0.008	0.012	0.009	0.010	0.005	0.004	0.005	0.009	0.004	0.002	0.008	0.005	0.007	0.006	0.004

APPENDIX D.3 (Cont.): Entropy-based TOPSIS - Normalized Weighted Decision Matrix 2016

	PT	RO	SK	SI	ES	SE	UK	IS	NO	CH	RS	AU	BR	CA	CL	CN	IL	JP	KR	MX	NZ	RU	TR	US
C11	0.006	0.003	0.004	0.004	0.005	0.007	0.007	0.007	0.007	0.009	0.001	0.005	0.001	0.007	0.001	0.003	0.004	0.005	0.007	0.001	0.006	0.002	0.001	0.006
C12	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
C21	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
C22	0.002	0.002	0.002	0.002	0.003	0.004	0.003	0.003	0.003	0.003	0.001	0.004	0.003	0.002	0.002	0.002	0.003	0.004	0.003	0.002	0.003	0.002	0.002	0.004
C31	0.002	0.002	0.002	0.001	0.002	0.002	0.003	0.002	0.002	0.002	0.000	0.002	0.001	0.002	0.001	0.001	0.002	0.002	0.002	0.001	0.001	0.002	0.002	0.002
C41	0.009	0.081	0.001	0.008	0.000	0.081	0.014	0.040	0.005	0.001	0.008	0.006	0.003	0.012	0.006	0.040	0.012	0.009	0.081	0.008	0.019	0.024	0.000	0.012
H11	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.002	0.001	0.002	0.001	0.001	0.001	0.002	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
H12	0.003	0.001	0.002	0.003	0.002	0.002	0.003	0.003	0.003	0.004	0.002	0.003	0.002	0.002	0.003	0.002	0.002	0.003	0.002	0.002	0.003	0.002	0.001	0.004
H13	0.007	0.000	0.003	0.006	0.007	0.012	0.010	0.009	0.012	0.013	0.004	0.008	0.004	0.006	0.014	0.009	0.009	0.017	0.005	0.003	0.008	0.004	0.003	0.017
H21	0.003	0.007	0.003	0.005	0.003	0.003	0.002	0.005	0.004	0.005	0.004	0.006	0.005	0.002	0.004	0.001	0.001	0.001	0.003	0.003	0.004	0.003	0.001	0.004
H22	0.002	0.008	0.004	0.007	0.007	0.006	0.006	0.013	0.005	0.004	0.009	0.006	0.005	0.005	0.005	0.000	0.001	0.001	0.004	0.003	0.012	0.009	0.004	0.006
U11	0.002	0.001	0.002	0.002	0.002	0.003	0.003	0.004	0.003	0.003	0.002	0.003	0.001	0.003	0.003	0.001	0.002	0.003	0.003	0.001	0.003	0.002	0.001	0.003
U12	0.005	0.002	0.004	0.005	0.007	0.014	0.011	0.016	0.018	0.021	0.001	0.013	0.004	0.011	0.004	0.019	0.010	0.012	0.008	0.003	0.010	0.004	0.003	0.019
U21	0.002	0.001	0.004	0.002	0.002	0.004	0.004	0.004	0.004	0.003	0.002	0.005	0.003	0.005	0.003	0.003	0.003	0.004	0.004	0.002	0.003	0.005	0.002	0.004
U22	0.002	0.001	0.003	0.001	0.003	0.004	0.004	0.003	0.005	0.003	0.002	0.004	0.002	0.005	0.003	0.002	0.004	0.003	0.003	0.002	0.003	0.003	0.002	0.002
U31	0.003	0.005	0.004	0.003	0.004	0.008	0.006	0.008	0.009	0.007	0.002	0.007	0.002	0.007	0.002	0.001	0.004	0.001	0.005	0.001	0.005	0.006	0.002	0.004
U32	0.002	0.003	0.004	0.003	0.003	0.006	0.006	0.007	0.006	0.006	0.002	0.005	0.002	0.005	0.002	0.001	0.003	0.004	0.004	0.001	0.004	0.004	0.001	0.005
I11	0.002	0.001	0.002	0.002	0.002	0.003	0.003	0.003	0.002	0.003	0.002	0.002	0.001	0.003	0.002	0.002	0.002	0.002	0.002	0.001	0.002	0.001	0.001	0.002
I12	0.003	0.001	0.002	0.003	0.006	0.005	0.006	0.006	0.005	0.007	0.004	0.005	0.001	0.006	0.003	0.003	0.004	0.004	0.005	0.002	0.004	0.002	0.002	0.005
I21	0.004	0.009	0.004	0.005	0.004	0.012	0.009	0.007	0.010	0.006	0.011	0.012	0.011	0.006	0.022	0.001	0.014	0.008	0.004	0.018	0.006	0.014	0.002	0.007
I22	0.008	0.008	0.008	0.014	0.007	0.015	0.021	0.088	0.017	0.042	0.001	0.024	0.001	0.025	0.003	0.000	0.005	0.005	0.002	0.000	0.016	0.003	0.003	0.028
P11	0.003	0.003	0.003	0.003	0.003	0.005	0.003	0.005	0.005	0.005	0.002	0.004	0.001	0.003	0.002	0.001	0.002	0.002	0.003	0.001	0.004	0.004	0.002	0.003
P12	0.004	0.002	0.001	0.006	0.006	0.006	0.008	0.002	0.005	0.002	0.005	0.007	0.004	0.007	0.004	0.004	0.006	0.006	0.007	0.006	0.007	0.002	0.002	0.007
P13	0.001	0.005	0.004	0.004	0.012	0.005	0.012	0.004	0.009	0.001	0.002	0.012	0.009	0.009	0.005	0.005	0.002	0.007	0.010	0.008	0.009	0.003	0.001	0.008

APPENDIX D.4: Entropy-based TOPSIS - Normalized Weighted Decision Matrix 2015

	AT	BE	BG	HR	CY	CZ	DK	EE	FI	FR	DE	EL	HU	IE	IT	LT	LV	LU	MT	NL	PL
C11	0.005	0.008	0.003	0.004	0.006	0.005	0.009	0.005	0.006	0.009	0.008	0.006	0.005	0.005	0.004	0.005	0.004	0.007	0.008	0.009	0.003
C12	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
C21	0.001	0.001	0.000	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
C22	0.003	0.002	0.003	0.003	0.003	0.003	0.006	0.005	0.007	0.003	0.003	0.002	0.002	0.004	0.004	0.003	0.003	0.004	0.002	0.004	0.002
C31	0.002	0.002	0.001	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.001	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002
C41	0.008	0.051	0.020	0.004	0.003	0.002	0.025	0.010	0.010	0.015	0.016	0.004	0.001	0.103	0.007	0.103	0.005	0.008	0.031	0.020	0.010
H11	0.002	0.002	0.001	0.001	0.001	0.002	0.002	0.002	0.002	0.002	0.002	0.001	0.001	0.001	0.001	0.001	0.001	0.002	0.001	0.002	0.001
H12	0.003	0.002	0.002	0.002	0.003	0.002	0.004	0.003	0.004	0.003	0.003	0.002	0.002	0.002	0.002	0.003	0.002	0.005	0.003	0.004	0.001
H13	0.010	0.006	0.001	0.004	0.003	0.004	0.016	0.008	0.009	0.006	0.007	0.012	0.004	0.005	0.006	0.005	0.002	0.016	0.002	0.009	0.003
H21	0.004	0.004	0.008	0.005	0.008	0.004	0.005	0.007	0.009	0.005	0.004	0.006	0.004	0.004	0.003	0.005	0.005	0.008	0.009	0.005	0.004
H22	0.005	0.001	0.004	0.005	0.004	0.005	0.005	0.006	0.008	0.004	0.005	0.005	0.003	0.008	0.001	0.002	0.005	0.006	0.008	0.004	0.004
U11	0.003	0.004	0.001	0.002	0.002	0.003	0.004	0.004	0.004	0.003	0.004	0.002	0.003	0.003	0.001	0.002	0.003	0.004	0.003	0.004	0.002
U12	0.011	0.010	0.002	0.003	0.006	0.004	0.013	0.004	0.011	0.010	0.011	0.004	0.003	0.016	0.008	0.003	0.003	0.026	0.006	0.012	0.003
U21	0.002	0.004	0.003	0.002	0.004	0.003	0.005	0.004	0.002	0.002	0.002	0.003	0.004	0.003	0.002	0.006	0.005	0.005	0.002	0.003	0.003
U22	0.002	0.005	0.002	0.002	0.003	0.002	0.005	0.004	0.004	0.002	0.004	0.002	0.004	0.003	0.002	0.003	0.004	0.005	0.002	0.004	0.002
U31	0.005	0.007	0.003	0.004	0.005	0.005	0.009	0.009	0.009	0.006	0.005	0.001	0.004	0.006	0.003	0.005	0.007	0.007	0.007	0.009	0.003
U32	0.004	0.004	0.002	0.003	0.003	0.004	0.006	0.005	0.005	0.005	0.006	0.002	0.003	0.004	0.002	0.002	0.003	0.006	0.004	0.006	0.003
I11	0.003	0.003	0.001	0.002	0.002	0.002	0.002	0.002	0.003	0.003	0.003	0.002	0.002	0.003	0.002	0.002	0.002	0.003	0.002	0.003	0.001
I12	0.006	0.006	0.002	0.002	0.004	0.004	0.006	0.005	0.006	0.005	0.006	0.002	0.003	0.005	0.001	0.005	0.004	0.007	0.004	0.006	0.001
I21	0.005	0.006	0.015	0.002	0.010	0.003	0.009	0.010	0.013	0.005	0.006	0.002	0.002	0.008	0.003	0.004	0.002	0.007	0.003	0.008	0.001
I22	0.018	0.012	0.004	0.004	0.014	0.012	0.036	0.019	0.020	0.011	0.026	0.002	0.005	0.019	0.004	0.007	0.008	0.033	0.021	0.058	0.006
P11	0.003	0.003	0.003	0.002	0.004	0.002	0.005	0.005	0.005	0.004	0.003	0.003	0.002	0.003	0.001	0.003	0.003	0.004	0.005	0.004	0.002
P12	0.009	0.001	0.003	0.008	0.001	0.006	0.006	0.011	0.013	0.008	0.008	0.004	0.007	0.012	0.004	0.005	0.004	0.000	0.007	0.007	0.003
P13	0.002	0.002	0.002	0.003	0.002	0.002	0.003	0.003	0.003	0.003	0.002	0.001	0.002	0.002	0.002	0.002	0.002	0.001	0.002	0.003	0.003

APPENDIX D.4 (Cont.): Entropy-based TOPSIS - Normalized Weighted Decision Matrix 2015

	PT	RO	SK	SI	ES	SE	UK	IS	NO	CH	RS	AU	BR	CA	CL	CN	IL	JP	KR	MX	NZ	RU	TR	US
C11	0.006	0.003	0.004	0.005	0.005	0.007	0.008	0.008	0.008	0.010	0.001	0.005	0.001	0.007	0.001	0.003	0.005	0.006	0.008	0.001	0.006	0.003	0.001	0.006
C12	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
C21	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.000	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.000	0.001	0.000	0.001	0.001
C22	0.002	0.003	0.003	0.002	0.004	0.006	0.004	0.004	0.005	0.005	0.002	0.006	0.004	0.002	0.002	0.002	0.004	0.006	0.005	0.002	0.005	0.003	0.002	0.006
C31	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.000	0.002	0.002	0.002	0.001	0.000	0.002	0.002	0.002	0.001	0.002	0.002	0.002	0.002
C41	0.012	0.103	0.002	0.001	0.001	0.103	0.017	0.012	0.006	0.005	0.010	0.008	0.001	0.015	0.008	0.002	0.015	0.012	0.051	0.005	0.023	0.031	0.001	0.002
H11	0.001	0.001	0.001	0.001	0.001	0.002	0.002	0.002	0.002	0.002	0.001	0.002	0.001	0.002	0.001	0.001	0.002	0.001	0.001	0.001	0.001	0.002	0.001	0.001
H12	0.003	0.001	0.002	0.003	0.003	0.002	0.003	0.004	0.003	0.004	0.001	0.004	0.002	0.002	0.002	0.002	0.003	0.004	0.003	0.002	0.003	0.002	0.001	0.004
H13	0.008	0.001	0.003	0.005	0.007	0.013	0.008	0.010	0.012	0.012	0.004	0.008	0.004	0.010	0.007	0.008	0.013	0.017	0.006	0.004	0.008	0.003	0.002	0.012
H21	0.004	0.008	0.004	0.007	0.004	0.004	0.004	0.009	0.005	0.007	0.004	0.008	0.004	0.003	0.000	0.001	0.000	0.001	0.004	0.004	0.006	0.004	0.001	0.006
H22	0.001	0.006	0.003	0.004	0.005	0.004	0.004	0.005	0.004	0.003	0.006	0.004	0.004	0.003	0.004	0.001	0.001	0.003	0.003	0.002	0.008	0.006	0.003	0.004
U11	0.002	0.001	0.003	0.003	0.003	0.004	0.004	0.005	0.004	0.004	0.002	0.003	0.001	0.004	0.003	0.001	0.003	0.004	0.004	0.001	0.004	0.002	0.001	0.003
U12	0.005	0.002	0.004	0.005	0.007	0.013	0.012	0.013	0.019	0.021	0.001	0.015	0.004	0.011	0.003	0.018	0.009	0.010	0.007	0.004	0.010	0.004	0.003	0.018
U21	0.002	0.001	0.005	0.002	0.002	0.004	0.004	0.005	0.005	0.002	0.004	0.004	0.003	0.005	0.002	0.003	0.004	0.003	0.002	0.002	0.004	0.005	0.001	0.003
U22	0.003	0.001	0.003	0.001	0.003	0.004	0.005	0.005	0.006	0.004	0.004	0.005	0.002	0.004	0.003	0.004	0.005	0.003	0.004	0.002	0.005	0.002	0.002	0.004
U31	0.003	0.004	0.004	0.004	0.004	0.009	0.006	0.008	0.010	0.007	0.005	0.008	0.002	0.006	0.002	0.001	0.004	0.001	0.006	0.001	0.010	0.004	0.002	0.006
U32	0.002	0.003	0.004	0.003	0.003	0.006	0.006	0.006	0.006	0.006	0.002	0.006	0.002	0.004	0.002	0.001	0.003	0.004	0.004	0.001	0.006	0.004	0.001	0.004
I11	0.003	0.001	0.002	0.002	0.002	0.003	0.003	0.003	0.003	0.003	0.001	0.002	0.001	0.003	0.002	0.001	0.003	0.003	0.002	0.002	0.002	0.001	0.002	0.003
I12	0.006	0.002	0.003	0.004	0.003	0.007	0.006	0.007	0.007	0.007	0.000	0.006	0.003	0.005	0.004	0.003	0.007	0.007	0.005	0.003	0.006	0.001	0.004	0.007
I21	0.007	0.007	0.005	0.004	0.003	0.009	0.006	0.009	0.009	0.006	0.016	0.008	0.011	0.003	0.010	0.003	0.018	0.007	0.003	0.016	0.013	0.012	0.006	0.007
I22	0.005	0.002	0.006	0.013	0.005	0.025	0.026	0.046	0.024	0.041	0.001	0.027	0.001	0.020	0.001	0.000	0.008	0.009	0.003	0.000	0.023	0.002	0.002	0.038
P11	0.003	0.003	0.003	0.003	0.003	0.004	0.003	0.005	0.005	0.004	0.003	0.004	0.001	0.004	0.001	0.001	0.002	0.002	0.003	0.001	0.004	0.003	0.002	0.003
P12	0.007	0.002	0.003	0.008	0.010	0.014	0.008	0.009	0.012	0.007	0.006	0.007	0.006	0.013	0.012	0.005	0.012	0.008	0.010	0.010	0.012	0.000	0.003	0.010
P13	0.001	0.003	0.001	0.002	0.002	0.002	0.004	0.002	0.003	0.002	0.003	0.003	0.003	0.002	0.002	0.002	0.001	0.002	0.002	0.003	0.003	0.001	0.001	0.003

APPENDIX E: I-DESI 2020 Data Methodology Weights

Dimension & Weight	Sub-dimension & Weight	Indicator Weight	Indicator
Connectivity 25%	Fixed Broadband 33%	50%	Fixed Broadband Coverage
		50%	Fixed Broadband Take-Up
	Mobile broadband 22%	50%	4G Coverage
		50%	Fixed Broadband Take-Up
	Speed 33%	100%	Fixed (wired)-broadband speed; in Mbit/s
	Affordability 11%	100%	Broadband Price Index
Human Capital 25%	Basic skills & usage 50%	33%	At least basic skills (Word processing)
		33%	Above basic (advanced spreadsheet skills)
		33%	At least basic software (coding)
	Advanced skills 50%	50%	Telecommunication emps FTEs
		50%	ICT Graduates
		50%	Internet Users
Use of Internet Services 15%	Content 33.5%	50%	Fixed broadband traffic (GB/mth/person)
		50%	Video Calls
	Communications 33.5%	50%	Social Networks
		50%	Banking
	Transactions 33%	50%	Shopping
		50%	
Integration of Digital Technology 20%	Business Digitization 60%	50%	Availability latest technologies
		50%	Firm-level technology absorption
	eCommerce 40%	50%	SMEs Selling Online
		50%	Secure Internet Servers per million people
Digital Public Services 10%	eGovernment 100%	33%	eGovernment Users
		33%	Online Service Completion
		33%	Open Data OKF OECD

APPENDIX F.1: COMPARISON OF SCORES & RANKINGS (2017)

Country (2017)	I-DESI		TOPSIS		Entropy		Entropy- based TOPSIS	
	Score %	Rank	Score %	Rank	Score%	Rank	Score %	Rank
Austria	52	15	48	18	36	24	25	28
Belgium	50	21	47	23	42	18	37	16
Bulgaria	42	31	42	31	33	29	35	18
Croatia	42	31	41	34	25	39	17	37
Cyprus	47	23	46	24	29	33	21	34
Czech Rep.	45	26	42	29	32	30	28	27
Denmark	65	2	65	4	54	8	47	12
Estonia	54	13	54	12	38	22	30	24
Finland	65	2	63	6	46	11	32	20
France	50	21	48	20	34	27	24	30
Germany	52	15	51	17	39	20	35	19
Greece	41	35	38	37	22	42	13	43
Hungary	45	26	42	30	37	23	36	17
Ireland	51	18	55	11	59	4	69	1
Italy	38	40	32	42	22	41	15	40
Lithuania	42	31	44	25	48	10	54	7
Latvia	44	29	38	36	26	37	17	38
Luxembourg	65	2	67	2	55	7	48	11
Malta	51	18	52	15	44	16	45	13
Netherlands	64	5	65	3	56	6	54	6
Poland	34	43	31	43	36	25	44	14
Portugal	44	29	39	35	28	35	20	35
Romania	42	31	47	21	45	14	53	8
Slovakia	41	35	37	38	25	38	14	41
Slovenia	45	26	41	32	29	34	22	32
Spain	47	23	43	28	28	36	16	39
Sweden	63	6	60	7	64	2	59	4
United Kingdom	59	10	57	10	58	5	56	5
Iceland	68	1	69	1	65	1	65	3
Norway	62	7	58	9	46	13	31	22
Switzerland	61	8	59	8	46	12	37	15
Republic of Serbia	38	40	33	41	21	43	14	42
Australia	53	14	51	16	38	21	29	25
Brazil	34	43	30	45	18	44	12	44
Canada	57	11	52	13	42	19	31	21
Chile	46	25	41	33	35	26	29	26
China	41	35	43	27	44	15	51	9
Israel	41	35	37	39	30	32	21	33
Japan	51	18	47	22	33	28	23	31
Korea, Republic of	52	15	48	19	51	9	51	10
Mexico	37	42	33	40	24	40	18	36
New Zealand	56	12	52	14	43	17	30	23
Russia Federation	41	35	44	26	31	31	24	29
Turkey	32	45	31	44	17	45	9	45
United States	61	8	64	5	64	3	67	2

APPENDIX F.2: COMPARISON OF SCORES & RANKINGS (2016)

Country (2016)	I-DESI		TOPSIS		Entropy		Entropy-based TOPSIS	
	Score %	Rank	Score %	Rank	Score%	Rank	Score %	Rank
Austria	49	20	43	20	29	27	16	31
Belgium	48	23	41	22	37	15	32	12
Bulgaria	37	38	34	35	23	36	17	28
Croatia	46	24	38	27	25	33	12	40
Cyprus	43	26	40	25	25	31	15	33
Czech Rep.	39	33	35	31	23	37	23	23
Denmark	65	1	64	2	45	5	44	8
Estonia	56	12	52	12	36	19	26	19
Finland	64	2	59	4	42	9	25	21
France	51	15	45	17	32	22	21	25
Germany	50	16	46	16	33	21	28	15
Greece	39	33	33	36	20	43	11	42
Hungary	42	28	34	34	23	35	13	36
Ireland	49	20	51	13	54	2	58	2
Italy	39	33	29	42	21	40	10	43
Lithuania	40	31	38	29	43	8	49	4
Latvia	42	28	35	32	24	34	13	37
Luxembourg	62	3	59	5	44	6	34	11
Malta	50	16	44	18	31	24	17	30
Netherlands	59	6	59	3	43	7	47	7
Poland	35	41	30	39	34	20	42	9
Portugal	38	36	29	43	22	38	13	38
Romania	35	41	41	23	41	11	49	5
Slovakia	37	38	29	41	20	44	10	44
Slovenia	43	26	37	30	25	32	16	32
Spain	50	16	43	19	28	30	14	35
Sweden	59	6	53	9	58	1	53	3
United Kingdom	59	6	53	10	40	12	26	17
Iceland	61	4	67	1	53	3	68	1
Norway	59	6	52	11	40	13	24	22
Switzerland	57	11	54	8	37	17	35	10
Republic of Serbia	40	31	33	37	22	39	12	39
Australia	60	5	55	6	39	14	26	18
Brazil	36	40	31	38	21	42	12	41
Canada	53	13	46	15	37	18	26	16
Chile	45	25	39	26	29	28	19	26
China	34	43	25	44	30	25	31	14
Israel	41	30	35	33	29	29	17	29
Japan	49	20	40	24	31	23	18	27
Korea, Republic of	50	16	42	21	49	4	47	6
Mexico	34	43	30	40	21	41	15	34
New Zealand	52	14	48	14	37	16	25	20
Russia Federation	38	36	38	28	30	26	22	24
Turkey	26	45	22	45	12	45	5	45
United States	59	6	55	7	41	10	31	13

APPENDIX F.3: COMPARISON OF SCORES & RANKINGS (2015)

Country (2015)	I-DESI		TOPSIS		Entropy		Entropy- based TOPSIS		Country (2015)	I-DESI		TOPSIS		Entropy		Entropy- based TOPSIS	
	Score %	Rank	Score %	Rank	Score%	Rank	Score %	Rank		Score %	Rank	Score %	Rank	Score%	Rank	Score %	Rank
Austria	49	17	50	17	30	25	21	24	Slovakia	36	35	34	39	19	39	10	44
Belgium	44	23	44	24	36	14	42	6	Slovenia	42	25	43	27	22	33	15	31
Bulgaria	36	35	38	31	23	30	20	27	Spain	44	23	42	28	24	28	13	36
Croatia	40	31	37	35	20	36	10	42	Sweden	58	6	63	4	60	1	74	1
Cyprus	42	25	44	22	23	31	16	28	United Kingdom	54	12	55	14	35	16	29	15
Czech Rep.	41	27	39	30	21	35	13	35	Iceland	60	4	67	1	41	8	37	9
Denmark	61	2	65	3	44	4	39	8	Norway	61	2	62	6	41	6	28	16
Estonia	55	10	57	12	35	17	23	23	Switzerland	56	8	60	10	36	13	34	10
Finland	63	1	66	2	41	7	26	19	Republic of Serbia	35	37	35	36	22	32	16	29
France	48	19	49	19	30	24	21	26	Australia	54	12	58	11	36	15	27	18
Germany	50	14	53	16	33	21	28	17	Brazil	35	37	34	38	19	41	10	41
Greece	38	33	38	33	20	37	12	38	Canada	50	14	49	18	33	20	26	21
Hungary	38	33	32	40	19	40	10	43	Chile	39	32	35	37	23	29	15	32
Ireland	49	17	56	13	53	2	70	2	China	31	43	24	45	18	42	14	33
Italy	34	39	29	42	18	43	11	40	Israel	47	21	46	21	34	19	23	22
Lithuania	41	27	44	25	44	3	63	3	Japan	50	14	48	20	32	23	21	25
Latvia	41	27	40	29	22	34	12	37	Korea, Republic of	46	22	44	23	37	12	40	7
Luxembourg	57	7	60	9	38	10	32	11	Mexico	34	39	32	41	19	38	14	34
Malta	48	19	53	15	33	22	32	13	New Zealand	59	5	63	5	42	5	32	12
Netherlands	55	10	62	7	38	11	43	5	Russia Federation	33	41	37	34	26	26	26	20
Poland	31	43	28	43	17	44	11	39	Turkey	28	45	27	44	13	45	6	45
Portugal	41	27	38	32	24	27	15	30	United States	56	8	61	8	35	18	31	14
Romania	33	41	43	26	40	9	61	4									

APPENDIX G: LIST OF COUNTRY ACRONYMS

Code	Country	Code	Country	Code	Country	Code	Country
AT	Austria	HU	Hungary	SK	Slovakia	CA	Canada
BE	Belgium	IE	Ireland	SI	Slovenia	CL	Chile
BG	Bulgaria	IT	Italy	ES	Spain	CN	China
HR	Croatia	LT	Lithuania	SE	Sweden	IL	Israel
CY	Cyprus	LV	Latvia	UK	United Kingdom	JP	Japan
CZ	Czech Rep.	LU	Luxembourg	IS	Iceland	KR	Korea, Republic of
DK	Denmark	MT	Malta	NO	Norway	MX	Mexico
EE	Estonia	NL	Netherlands	CH	Switzerland	NZ	New Zealand
FI	Finland	PL	Poland	RS	Republic of Serbia	RU	Russia Federation
FR	France	PT	Portugal	AU	Australia		
DE	Germany	RO	Romania	BR	Brazil		
EL	Greece	US	United States	TR	Turkey		

APPENDIX H.1: GOMPertz II (PARAMETER “A”)

	AT	BE	BG	HR	CY	CZ	DK	EE	FI	FR	DE	EL
C11	6.366	6.366	1.108	0.524	6.37	6.366	6.366	3.112	1.148	- .000	0.357	1.205
C12	10.12	10.12	- .000	0.494	10.12	- .00	0.048	555.2	493.9	- .000	238.5	215.6
C21	0.058	0.032	2.311	- .000	1.173	0.070	0.045	- .000	0.015	0.019	0.305	0.468
C22	- .000	- .00	3.168	0.285	- .00	0.632	1.666	2.949	0.276	0.276	0.322	7.401
H11	- .000	- .00	96.25	- .000	0.804	- .000	- .000	- .000	0.661	0.672	0.369	0.222
H12	0.044	675.2	1.527	58.65	0.480	12.74	12.31	- .000	2.739	2.620	10.33	13.03
H13	- .000	0.061	752,267,637	326.2	2.313	- .000	1,594	- .000	5.440	4.656	7.797	9.226
H21	20.13	19.21	- .000	- .000	20.68	11.85	12.084	- .000	- .000	- .000	2.901	4.783
U11	0.201	0.14	0.251	- .000	1.256	0.946	0.897	0.008	0.177	0.160	1.289	2.306
U21	214,746,262	215,198,254	8.338	37.75	222,582,376	6.146	0.950	0.193	8.248	8.056	2.189	8.412
U22	0.370	0.226	- .000	959.3	4.446	4.464	0.590	0.707	0.324	0.324	- .000	0.450
U31	197.0	0.329	1,218	194.6	9,860	3.801	0.180	- .000	0.379	0.395	2.027	1.485
U32	0.176	0.335	- .000	- .000	10,522	2.046	1.778	- .000	0.372	0.394	0.731	3.120
I21	0.306	1.112	- .000	4,058	- .000	1.505	0.764	- .000	0.485	- .000	- .000	3.993
I22	25.93	21.41	345.8	133.9	3,367	5.842	9.026	6.496	6.784	6.785	6.642	8.324
P11	1.806	0.199	48.98	510.9	2.796	6.202	5.388	0.000	0.203	0.203	1.084	1.772

APPENDIX H.1 (Cont.): GOMPERTZ II (PARAMETER “A”)

	HU	IE	IT	LT	LV	LU	MT	NL	PL	PT	RO	SK	SI	ES
C11	2.946	2.946	- 1,314,659	0.002	0.260	- 19,424	- 19,424	0.476	6.366	6.366	5.253	1.275	6.366	6.366
C12	215.6	215.6	- 6,875,182	215.6	215.6	- 71,299	- 71,299	215.6	10.12	10.12	0.503	750.1	10.12	10.12
C21	0.038	0.038	- 6,537,541	1,214	0.150	- 68,281	- 68,281	0.259	- .00	0.854	0.746	0.628	0.254	0.241
C22	7.242	7.242	- 6,474,824	8.242	3.386	- 60,135	- 60,135	116.7	- .00	- .000	0.525	0.591	- .000	- .000
H11	0.225	0.225	- 3,288,448	0.000	- 115,148	- 58,868	- 58,868	- 115,148	4,827	4,151	8.532	- .000	4,151	4,151
H12	12.42	12.42	- 1,540,835	13.43	14.06	- 34,144	- 34,144	11.97	3,377	2,656	3.382	0.343	2,656	2,656
H13	10.191	10.19	- 363,742	11.39	15.86	- 8,642	- 8,642	10.12	- .000	- .000	59.85	5.474	7.463	3.766
H21	6.101	6.101	- 10,370	6.547	6.703	- 253	- 252.6	4.948	18.34	19.20	1,994	- .000	20.28	17.80
U11	2.269	2.269	- 4,518,624	3.624	3.717	- 69,152	- 69,152	2.323	0.293	0.217	3.399	0.273	0.210	0.567
U21	7.856	7.856	- 1,334,757	8.820	9.444	- 26,977	- 26,977	8.676	181,617,408	181,617,408	13.36	3,628	181,617,408	181,617,408
U22	1,053	1,053	- 2,389,423	1,060	850.54	- 37,532	- 37,532	850.5	0.467	0.534	15.08	0.242	4.156	0.289
U31	2.951	2.951	- 1,628,019	3.548	3.311	- 37,469	- 37,469	1.196	0.773	7.225	6.826	0.988	8.492	5.333
U32	2.390	2.390	- 1,583,290	4.280	89.58	- 43,225	- 43,225	55.42	0.525	3.442	- .000	0.653	4.798	3.044
I21	1.249	1.016	19,705	0.757	4.123	34,435	1,228	1.138	5.196	- .000	3,715	- .000	2.297	1.086
I22	17.55	17.55	36	11.66	85.11	97,259	5,533	723.7	26.76	18.33	37.54	5.897	8.480	6.210
P11	0.598	0.598	- 1,374,457	1.329	5,739	- 39,982	- 39,982	3,300	2.996	3.501	7.918	0.000	4.991	2.536

APPENDIX H.1 (Cont.): GOMPERTZ II (PARAMETER “A”)

	SE	UK	IS	NO	CH	RS	AU	BR	CA	CL	CN	IL	JP	KR	MX	NZ	RU	TR	US
C11	0.357	0.603	2.065	0.206	0.206	0.802	3.917	2.142	0.839	0.858	1.492	1.103	0.225	0.622	2.186	0.427	4.96	2.612	3
C12	- .000	354.2	1.016	1.230	1.230	6,323	6,388	- .000	- .000	- .000	0.631	- .000	- .0	189.5	- .000	- .000	- .0	- .000	167
C21	0.295	0.190	0.319	0.175	0.175	1.356	0.220	0.411	0.114	0.413	1.187	1.424	- .0	0.056	4.286	1.343	0.871	2.425	0.11
C22	0.106	3.057	3.620	- .000	- .000	3.365	0.552	0.129	0.545	1.134	1.392	1.831	1.663	0.221	0.685	- .000	2.23	1.091	0.47
H11	- .000	0.237	0.159	- .000	- .000	15,637	14,079	29,601	6,388	10,072	- .000	- .000	- .0	- .000	- .000	- .000	0.000	1.154	1478
H12	13.19	10.71	0.421	0.184	0.184	3,787	2,058	3,581	7,507	28,308	1.761	- .000	- .0	- .000	0.411	4.202	0.320	17,884	712
H13	2,733	1.728	5.592	1.291	1.291	- .000	3.861	- .000	7.068	44,588	- .000	- .000	- .0	7.371	2.791	0.790	7412	7.820	39193
H21	20.01	17.77	- .000	- .000	- .000	5.023	15.01	10.85	- .000	611,941	5,037,377,590	28.70	3.191	7.460	- .000	- .000	0.397	3.686	1.50
U11	0.162	0.171	1.084	0.043	0.043	1.313	42.39	0.450	0.243	- .000	1.961	4.236	- .000	0.163	0.833	0.479	1.679	2.323	0.577
U21	1.038	0.912	0.633	2.494	2.494	10.25	8.734	1.690	5.121	6.833	18.47	18.17	1.239	52.08	2.436	7.574	9.090	3.400	8
U22	1.621	0.262	2.702	0.327	0.327	- .000	- .000	1.558	5,371	2,933	- .000	0.792	2.218	0.284	0.802	- .000	1,724	1.242	7.06
U31	0.294	1.074	0.593	0.239	0.239	- .000	- .000	1.008	4.610	- .000	7.676	10.63	0.983	0.509	8.083	- .000	8,142	6.787	8.77
U32	0.369	0.072	10,528	0.415	0.415	11.06	- .000	1.083	1.577	- .000	12.16	15.81	- .0	0.524	3.212	- .000	-	8.461	6.23
I21	1.000	2.276	2.448	0.515	1.325	380.3	4.553	0.371	1.577	0.000	0.287	- .000	17,261	1.266	7.225	- .000	-	- .000	4.03
I22	3.735	4.806	7.763	3.935	3.935	403.9	4.553	29.08	10.504	524.8	3.699	6.581	10.81	4.890	1.110	3.902	10.51	8.487	14.43
P11	0.359	3.722	1.253	1.602	1.602	- .000	- .000	2.715	2.807	1.474	10.48	16.19	- .000	3.694	3.185	- .000	1568	1.138	9.29

APPENDIX H.2: GOMPertz II (PARAMETER “b”)

	AT	BE	BG	HR	CY	CZ	DK	EE	FI	FR	DE	EL	HU	IE	IT	LT	LV
C11	22.36	22.36	0.130	0.634	22.36	22.36	22.36	0.022	- .000	2.595	0.170	0.078	0.023	0.023	2,159,799	- 0.999	0.805
C12	193.6	193.6	2.605	0.022	193.6	2.61	0.380	11.08	24.53	2.608	9.582	23.75	23.75	23.75	10,818,304	23.75	23.75
C21	0.447	0.293	1.419	2.615	0.485	1.480	0.411	2.605	0.726	0.227	0.050	0.961	0.941	0.941	10,895,905	10.12	0.312
C22	35.53	35.53	0.024	1.586	35.53	0.129	0.039	0.036	1.047	1.047	0.578	0.026	0.013	0.013	10,611,520	0.015	0.082
H11	2.614	2.614	7.321	2.574	1.396	2.590	2.590	2.580	0.017	0.017	0.027	- .000	- .000	- .000	5,270,529	- 4.184	182,614
H12	0.467	10.21	0.178	6.515	1.092	0.015	0.004	2.566	0.015	0.016	0.014	0.012	- .000	- .000	2,386,708	- 0.003	0.000
H13	1.385	1.249	9.728	8.020	0.426	2.605	10.34	2.600	0.032	0.038	0.014	- .000	- .000	- .000	583,946	0.008	0.023
H21	0.017	0.00	2.592	2.595	- .00	0.016	0.011	2.548	2.548	2.553	0.013	0.011	0.017	0.017	17,718	- 0.018	0.011
U11	0.231	0.21	0.394	2.616	0.057	0.028	0.013	2.604	0.074	0.083	0.011	0.011	0.003	0.003	7,643,207	0.007	0.002
U21	20.44	21.49	0.014	6.766	6.525	0.015	0.755	0.341	0.021	0.021	0.193	0.017	0.005	0.005	2,274,033	0.004	0.004
U22	0.370	0.404	2.601	8.418	0.015	0.024	1.104	0.057	0.404	0.404	2.573	0.222	9.749	9.749	3,879,735	9.155	24.22
U31	7.485	0.181	8.470	7.686	11.64	0.024	0.985	2.602	0.038	0.036	0.026	0.559	0.022	0.022	2,685,019	0.012	- 0.003
U32	0.269	0.175	2.606	2.543	10.66	0.050	0.012	2.606	0.026	0.024	0.025	0.013	0.016	0.016	2,655,442	0.022	6.545
I21	0.187	0.715	3.261	8.311	2.918	0.220	0.259	2.308	0.272	3.212	5.449	0.053	0.352	0.147	10	0.195	0.066
I22	0.028	0.034	2.515	1.995	4.106	0.530	1.368	0.542	0.635	0.635	0.560	0.878	1.176	1.176	1	1.001	1.978
P11	0.033	0.596	7.500	8.142	0.000	0.030	0.003	2.593	1.255	1.255	0.018	0.008	0.144	0.144	2,216,122	0.026	10.13

APPENDIX H.2 (Cont.): GOMPertz II (PARAMETER “b”)

	LU	MT	NL	PL	PT	RO	SK	SI	ES	SE	UK	IS	NO	CH
C11	32,132	32,132	0.060	22.36	22.36	0.025	0.109	22.36	22.36	0.310	0.087	0.028	0.527	0.527
C12	115,923	115,923	23.75	193.6	193.6	0.093	9.852	193.6	193.6	2.606	11.53	0.033	0.016	0.016
C21	110,972	110,972	0.030	0.474	2.923	0.370	0.945	0.070	1.060	0.049	0.086	0.177	0.088	0.088
C22	98,658	98,658	7.368	35.53	35.535	0.796	0.842	35.53	35.53	0.479	0.016	0.033	2.587	2.587
H11	95,514	95,514	182,614	10.45	35.05	0.016	2.599	35.055	35.05	2.616	0.842	0.694	2.599	2.599
H12	55,746	55,746	0.006	9.42	24.97	1.209	1.706	24.972	24.97	0.018	0.005	1.934	2.120	2.120
H13	13,732	13,732	0.005	1.385	1.385	0.752	3.246	0.016	- .000	11.48	1.514	0.041	0.085	0.085
H21	401	401.3	0.015	0.009	0.001	10.23	2.605	- .000	0.005	0.018	- .000	2.506	2.556	2.556
U11	112,679	112,679	0.008	0.670	0.208	0.023	1.746	0.315	0.070	0.327	1.208	0.021	0.673	0.673
U21	45,044	45,044	0.026	84.89	84.89	0.033	11.53	84.89	84.89	1.042	1.318	0.112	0.040	0.040
U22	60,656	60,656	24.22	0.230	0.201	0.018	0.691	0.024	0.418	2.522	1.104	0.061	0.439	0.439
U31	62,321	62,321	0.020	0.828	0.015	0.023	1.134	0.009	0.013	1.336	0.097	0.395	0.108	0.108
U32	70,100	70,100	22.91	0.436	0.017	2.560	1.323	0.020	0.029	1.100	0.718	12.44	0.061	0.061
I21	35.47	30.73	0.485	0.057	0.042	11.51	0.436	0.066	0.095	1.253	1.225	0.148	0.436	0.061
I22	5.60	4.107	3.238	0.039	0.038	1.575	0.255	0.674	0.587	0.317	0.630	1.247	0.328	0.328
P11	65,339	65,339	53.76	0.031	0.000	0.016	2.596	0.013	0.019	0.687	0.016	0.027	0.025	0.025

APPENDIX H.2 (Cont.): GOMPERTZ II (PARAMETER “b”)

	RS	AU	BR	CA	CL	CN	IL	JP	KR	MX	NZ	RU	TR	US
C11	0.768	0.026	0.303	0.063	0.698	1.492	0.050	0.724	0.070	0.299	0.414	0.023	0.407	0.027
C12	11.44	10.16	2.682	2.627	2.611	0.631	2.602	2.583	8.028	2.588	2.576	2.618	2.553	8
C21	0.854	0.776	0.312	0.806	0.323	1.187	1.729	2.625	0.938	0.031	0.035	0.195	0.028	0.08
C22	0.015	0.092	1.346	0.326	0.520	1.392	2.557	0.122	0.153	0.361	2.595	0.039	0.845	0.307
H11	13.05	29.65	12.10	10.93	12.959	- .000	2.575	2.539	2.560	2.600	2.547	2.590	1.011	9.870
H12	8.664	42.94	10.21	11.43	10.831	1.761	2.510	2.558	2.550	0.326	0.025	0.952	11.93	8.307
H13	2.424	3.427	2.586	0.019	11.170	- .000	2.501	2.585	0.013	0.345	1.845	11.972	3.198	12.78
H21	0.067	0.007	2.909	2.600	12.398	5,037,377,590	0.061	0.636	0.014	2.608	2.568	0.883	0.202	0.27
U11	0.028	7.246	0.279	0.081	2.609	1.961	0.017	2.588	0.452	0.091	3.383	0.030	0.053	0.29
U21	0.012	0.006	0.187	3.215	2.737	18.47	0.017	0.658	4.250	0.293	0.022	0.018	0.151	0.027
U22	2.571	2.571	0.081	10.05	9.798	- .000	1.958	0.028	0.900	0.211	2.604	8.86	0.172	0.017
U31	2.436	1.376	0.206	2.420	2.613	7.676	0.016	0.579	0.405	0.019	2.526	10.42	0.038	0.018
U32	0.014	2.594	0.049	1.605	2.607	12.16	0.016	2.613	0.258	0.130	2.547	2.61	0.024	0.018
I21	7.603	0.392	0.204	1.605	20.763	0.287	1.988	10.315	0.340	- .000	35.010	2.608	2.402	0.092
I22	2.535	0.392	1.462	1.126	2.813	3.699	0.690	0.091	0.158	0.811	0.601	0.912	0.935	0.070
P11	2.427	2.547	0.039	0.025	1.662	10.48	0.016	2.484	0.015	0.085	2.593	11.467	0.546	0.016

APPENDIX H.3: GOMPertz II (PARAMETER “S”)

	AT	BE	BG	HR	CY	CZ	DK	EE	FI	FR
C11	1,768,194	3,523,681	2,554,914	805,085	225,315	2,261,082	2,115,820	5,772,098	4,087,134	1,296,495
C12	8,480,044	11,319,568	6,485,542	6,431,226	853,591	10,146,187	5,742,521	1,015,833	5,110,393	5,110,393
C21	8,728,783	11,509,542	7,167,956	4,085,331	1,022,486	10,598,756	5,825,777	1,306,519	5,510,949	5,556,657
C22	7,233,035	7,884,793	126,859,725	3,289,390	808,860	13,556,227	32,787,305	24,775,949	8,651,119	8,651,177
H11	5,387,464	6,286,957	2,821,379	1,870,896	405,165	5,596,769	3,847,780	737,390	7,305,241	7,390,535
H12	2,791,417	2,425,649	4,836,084	1,045,050	256,355	438,293,519,583	399,711,817,640	383,085	26,989,459	23,950,490
H13	543,070	582,528	277,816	149,557	82,168	353,786	786,723	86,866	81,175,875	36,977,351
H21	4,330,518,919,228	4,385,968,440,465	24,599	9,047	4,167,379,647,556	1,949,076,668	1,909,120,886	3,944	20,208	20,208
U11	8,419,244	10,746,106	4,824,476	2,942,123	1,984,098	19,918,198	13,232,404	1,162,167	5,578,351	5,485,282
U21	2,332,055	3,305,800	5,713,242,841	843,259	551,048	1,102,591,430	2,999,002	454,886	3,480,856,733	2,871,178,145
U22	3,921,329	6,467,557	2,159,580	1,542,129	35,529,776	260,398,316	3,398,437	1,065,472	2,961,654	2,961,699
U31	3,812,183	6,831,022	2,226,947	1,294,775	432,267	161,425,255	3,902,929	780,655	5,063,719	5,143,417
U32	4,388,564	6,090,439	1,754,082	1,138,979	474,950	25,805,894	19,683,528	574,725	4,050,144	4,138,703
I21	1,535	2,137	2,797	758	152	5,468	2,520.88	482.52	2,858.45	4,180.80
I22	1,845,429,557	18,959,242	0	0	0	1	0.47	1.02	0.58	0.58
P11	21,785,696	4,863,079	2,630,009	1,555,126	8,583,507	1,063,068,050	812,619,665	771,360	3,421,578	3,421,577

APPENDIX H.3 (Cont.): GOMPERTZ II (PARAMETER “S”)

	DE	EL	HU	IE	IT	LT	LV	LU	MT	NL	PL
C11	34,126,382	8,071,866	34,754,069	34,754,069	11,119,830	609,442	371,850	165,404	155,033	9,122,759	3,903,542
C12	79,574,462	10,206,451	8,879,282	8,879,282	59,405,913	2,302,361	1,744,948	582,970	456,526	17,035,609	22,479,739
C21	104,073,838	10,773,445	9,700,715	9,700,715	58,508,909	2,791,482	2,000,813	559,715	456,526	21,480,890	37,980,619
C22	69,599,090	6,845,623,471	6,410,652,861	6,410,652,861	52,992,393	6,479,081,123	29,553,413	508,093	379,288	14,776,513	48,194,117
H11	72,026,577	6,221,189	5,905,624	5,905,624	26,645,452	1,332,079	895,024	476,818	217,391	12,600,059	14,865,709
H12	619,298,413,414	607,497,606,024	523,904,957,658	523,904,957,658	10,992,356	545,043,894,653	494,384,967,599	281,867	145,296	816,360,522,486	4,746,389
H13	9,443,543,793	8,600,204,142	8,487,954,149	8,487,954,149	2,821,652	9,282,734,910	138,661,558,695	69,741	14,178	30,317,605,331	862,756
H21	2,804,044	2,666,731	7,123,508	7,123,508	98,759	5,201,528	3,697,334	1,865	1,556	5,956,477	4,240,437,430,870
U11	248,700,197	70,960,541	71,171,550	71,171,550	38,937,090	76,554,834	63,760,343	566,902	361,500	153,551,653	30,035,041
U21	92,712,097	8,696,410,551	7,675,520,166	7,675,520,166	12,388,531	7,321,333,654	7,405,819,378	227,865	108,909	17,982,456,423	9,004,878
U22	32,758,028	4,964,518	4,934,708	4,934,708	19,731,220	1,156,380	864,119	301,902	146,445	8,154,176	17,778,407
U31	226,713,496	2,538,475	45,654,343	45,654,343	13,850,318	37,583,829	26,201,570	316,861	223,592	34,796,189	13,083,594
U32	92,282,710	52,807,194	29,136,808	29,136,808	14,018,985	45,499,289	652,691	348,128	206,813	9,779,399	15,416,216
I21	11,994.38	12,929.01	1,659.68	1,587.14	13,057.06	794.40	5682.558	69.51	22.18	4,714	153,213
I22	1.14	0.06	0.22	0.22	0.14	0.23	0.15	0.43	0.14	0.73	1,385,589,688
P11	95,698,266	21,497,305	5,500,093	5,500,093	11,030,414	3,532,423	986,180	321,747	248,495	10,027,047	145,010,833

APPENDIX H.3 (Cont.): GOMPERTZ II (PARAMETER “S”)

	PT	RO	SK	SI	ES	SE	UK	IS	NO	CH
C11	2,724,268	398,151,652	2,468,556	418,799	10,595,704	3,641,301	33,769,663	758,951	1,876,262	1,876,262
C12	9,559,731	24,907,973	4,218,478	1,969,266	42,897,827	9,532,146	65,078,977	845,962	15,633,658	15,633,658
C21	10,215,471	21,745,451	5,189,608	2,505,574	45,948,472	12,890,589	75,733,468	399,802	5,994,346	5,994,346
C22	6,685,699	17,416,100	4,753,354	1,330,930	42,399,482	12,619,827	1,102,494,341	10,423,894	5,457,766	5,457,766
H11	4,759,311	22,015,230,362	2,696,305	1,080,652	23,707,508	6,609,891	42,863,611	266,553	3,679,207	3,679,207
H12	2,954,947	4,919,337	1,055,526	655,419	10,449,842	857,047,292,029	810,550,888,724	138,199	1,570,541	1,570,541
H13	650,590	5,621,662	173,984	133,694,021	114,201,975	1,042,378	6,312,468	5,410,093	1,695,718	1,695,718
H21	4,037,289,113,638	77,434	10,031	3,788,995,501,965	3,862,307,253,389	5,156,555,644,894	4,938,853,855,986	1,285	12,279	12,279
U11	8,471,584	304,094,285	4,412,851	1,754,661	61,852,138	9,856,901	62,823,990	928,460	5,115,960	5,115,960
U21	2,336,693	957,515,701,318	1,886,015	534,059	9,741,433	4,066,522	24,570,918	205,266	18,966,663	18,966,663
U22	5,853,835	11,162,506,000,951	2,601,864	33,385,403	21,711,889	5,156,384	35,009,698	1,921,327	3,512,689	3,512,689
U31	2,585,378,650	4,533,925,328	2,197,070	2,394,735,145	2,717,518,519	6,222,156	75,896,650	266,922	4,371,573	4,371,573
U32	69,913,209	5,244,504	2,539,019	66,415,699	282,297,904	5,808,785	41,103,629	200,165	4,380,446	4,380,446
I21	2,604	4,112	797	3,012	39,355,250	3,081	12,647	857	1,557	15,501,686
I22	1,170,763	0	1	1	0	1	0	1	1	1
P11	113,639,229	15,691,281,436	2,119,302	96,696,556	206,684,871	6,294,991	922,804,668	684,051	15,146,677	15,146,677

APPENDIX H.3 (Cont.): GOMPERTZ II (PARAMETER “S”)

	RS	AU	BR	CA	CL	CN	IL	JP
C11	574,220	225,197,877	22,112,964	22,811,777	1,513,112	371,129,683	4,373,661	31,642,320
C12	6,655,830	20,608,041	179,513,415	32,125,789	16,872,379	1,290,536,935	7,042,982	111,344,007
C21	7,180,718	24,755,059	198,845,702	36,709,726	18,052,333	1,391,512,750	6,204,375	125,167,975
C22	109,060,792	49,732,861	187,781,866	32,737,368	19,359,292	2,293,375,635	7,807,824	681,206,524
H11	3,517,457	15,113,221	70,845,082	24,518,453	9,512,986	555,156,541	4,226,129	54,339,170
H12	1,480,903	8,061,120	42,776,670	8,725,242	4,760,405	1,033,744,180	1,670,701	46,013,859
H13	139,913	1,844,875	6,861,608	2,544,243,706	1,968,019	90,964,297	678,834	17,042,783
H21	1,205,544	258,819,480,456	655,165	50,054	44,799	6,205,228	107,136,429,148,994	337,372
U11	16,557,644	20,747,846	167,570,885	40,530,825	13,614,817	743,142,785	393,193,260	115,809,791
U21	49,868,676,883	47,783,888,817	194,164,442	14,739,213	4,990,391	15,416,199,968,094,100	89,602,703,098,583	62,514,290
U22	3,451,679	11,143,154	284,864,418	21,878,687	8,091,626	576,105,891	4,121,574	411,075,116
U31	2,131,681	12,643,962	56,324,407	22,007,220	2,901,704	193,232,558,203	70,198,368,025	18,371,012
U32	89,670,048,995	12,409,817	106,690,208	21,380,640	3,391,783	13,163,603,638,861	10,266,565,699,485	48,933,707
I21	2,205,831	12,736,312	51297283	21380612	2241.967	1,966,481	2,668	63,017
I22	0	0.847	0	0	0	0	0	215
P11	2,766,853	11,821,559	484,606,420	254,218,744	4,158,151	4,451,927,916,988	13,310,176,638,556	24,262,136

APPENDIX H.3 (Cont.): GOMPERTZ II (PARAMETER “S”)

	KR	MX	NZ	RU	TR	US
C11	29,072,407	14,069,398	1,428,068	1,747,905,018	9,109,755	883,105,558
C12	49,945,486	118,500,559	4,033,425	113,017,042	53,539,427	319,465,000
C21	51,203,368	4,440,223,113	14,781,707	148,936,389	650,639,720	352,716,992
C22	65,630,016	107,122,397	5,044,662	844,102,634	61,854,934	531,161,461
H11	24,089,707	50,618,350	2,801,308	52,509,560	27,416,598	185,798,380
H12	10,764,306	31,856,404	69,885,655	31,495,909	10,668,501	132,660,628
H13	3,175,443,499	25,058,355	361,369	4,229,692	2,036,590	34,194,986
H21	165,341,049	188,568	13,836	348,993	565,931	2,421,397
U11	50,447,306	153,898,381	4,136,130	511,958,748	374,165,954	371,382,547
U21	18,543,049	97,786,560	1,938,155,049	338,570,687,816	190,021,554	131,629,028,288
U22	27,918,659	72,222,910	2,123,547	63,781,054	66,139,650	126,440,114,865
U31	29,778,236	15,973,373,999	2,499,993	51,172,387	5,699,350,877	604,063,141,862
U32	30,883,368	97,250,282	2,288,450	54,654,572	32,384,137,088	58,516,668,724
I21	1,661,680	81,774,026	1,392	45,399	2,647	3,111,785
I22	0	0	0	0.068	0	35,661
P11	739,096,512	224,380,061	2,428,256	63,231,743	30,768,387	1,116,927,023,237

RESUME

Name Surname: Mohamed Noufal ZERHOUNI

▷ OBJECTIVE

Highly qualified Financial Profile with more than 15 years working in various institutions (family-owned to transnational ones), including the European Bank for Reconstruction and Development (EBRD). Mastery in the implementation of various analyzes, Management Reports, controls and tools. Polyglot, excellent communicator with high ethics and dynamic personality seeking a senior manager position and/or Board of Directors membership.

▷ SKILL HIGHLIGHTS

Languages: English (TOEFL: 92/120), French (Bilingual), Arabic (native-speaker), Spanish (intermediate), Turkish (elementary)

Computer Skills: Word, Excel (expert), PowerPoint (expert), Outlook, Mendeley, ERPs: QAD, SAP, J.D. Edwards, Appian

Email marketing, Wordpress, Social Media Marketing

▷ EXPERIENCE

Confidential (Manufacturing) | July 2022 – to Date, Controlling Manager

Zerhouni Research International | Sep 2018 – Jun 2022, Managing Partner

- Management training and consulting

European Bank for Reconstruction and Development EBRD | Jun 2016 – Jun 2018, Analyst, ASB (Advice for Small Businesses)

- Project lead for Local Consultancy Program
- Business diagnostic and identification of Local Consultancy needs
- Lead Project management cycle (conception, team staffing, management, monitoring) and evaluation
- Lead the market development activities
- Responsible for reporting ASB local team KPIs on a weekly basis.

Zerhouni Research International | May 2015 – May 2016, Managing Partner

- Management training, Consulting & Coaching

LEAR CORPORATION (Fortune 500) | Sep 2011 – Apr 2015, Project Controller

- Working as an integral part of the Plant Finance and Management team providing support and control to the Rabat plant.

- Assist the Plant Controller/Finance Manager in all aspects of corporate and internal reporting to ensure adherence to timetables, financial integrity and completeness.
- Management of KPIs including Sales, Production, Scrap, Inventory, Efficiency.
- Full responsibility for CAPEX and Customer tools monitoring and reporting.
- Pursuing Continuous Improvements to financial controls and other operational processes within the business.
- Inventory Obsolescence monitoring and reporting.
- Transportation costs calculation and provision.
- Management and completion of month-end processes including variance analysis.
- Reporting plant performance (actual, budgets, forecasts, variance walks) to the Local Management.
- Working closely with external auditors for year end and interim audit work.
- Reviewing, maintaining and implementation of internal controls including quarterly SOX testing.

COMAXYS Holding | Feb 2010 – Jul 2011, Management Controller

- Monitoring & Reporting of Sales, Opex and Capex, accounting records control.
- Design & Implementation of Management Reports for Three companies
- Performing of Costing and Ad Hoc Business Plans
- Design of Procedures Manual for the Holding's companies operations.

Fire Defense SARL | Jan 2009 – Jan 2010, Management Consultant

- Training of corporate staff in budgeting and management control

Aluminium Du Maroc | Sep 2007 – Dec 2008, Management Controller

- Monitoring & Reporting of Sales, Opex and Capex and accounting records
- Design and Implementation of Management Reports
- Costing and Ad-hoc financial & Operations analysis.

LAFARGE CEMENTS (FORTUNE 500) | Mar 2005 – Jul 2007, Management Analyst (Controller)

- Monitoring & Reporting to HQ of Sales, Opex and Capex, costing, budgeting, forecasting and SOX self-testing.

DELPHI PACKARD (FORTUNE 500) | Oct 2004 – Feb 2005, Material Controller

- Monitoring of +300 components, their procurement and delivery from dozen suppliers in Europe

▷ PUBLICATIONS

Zerhouni, M. N., & Özari, Ç. , 2022. Assessment of International Digital Economy and Society index using entropy based Topsis Methods. *International Journal of Recent Research in Commerce Economics and Management (IJRRCEM)*. <https://doi.org/10.5281/zenodo.6579884>

▷ EDUCATION

Master of Business Administration (MBA Candidate), GPA: 4.0/4

2019 – 2022 | Istanbul, Turkiye

Istanbul Aydin University

Certificate in Microeconomics

2017 – 2017| Online

Massachusetts Institute of Technology MIT & J-PAL

Certificate Project Management for Development Professionals

2017 – 2017| Online

InterAmerican Development Bank

Certificate in Challenges of Global Poverty

2017 – 2017| Online

Massachusetts Institute of Technology MIT & J-PAL, Taught by **Nobel Prize Economics 2019** Dr. E.Duflo & A.Banerjee

Licensed Master Practitioner of Neuro-linguistic Programming (NLP)

2014 – 2014| London, United Kingdom

The Society of NLP, United States. Trained by the co-creator of NLP Dr. Richard Bandler

Licensed Practitioner of Neuro-linguistic Programming (NLP)

2014 – 2014| London, United Kingdom.

The Society of NLP, United States. Trained by the co-creator of NLP Dr. Richard Bandler

National Diploma of Management (Bsc with honors)

2000 – 2004 | Tangier, Morocco

National School of Management (ENCG), Abdelmalek Essaadi University

High School Certificate in Economics, (First Rank)

1995 – 1999 | Tetouan, Morocco, Jabir Ibn Hayane High School