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# Assessment of Sustainable Socioeconomic Development in European Union Countries

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**Abstract:** There are still debates in the scientific literature about the factors influencing countries' sustainable socioeconomic development. Therefore, the current article aims at determining the factors of sustainable socioeconomic development and assessing its level in the EU countries. The following methods were employed for the research: an evaluation based on distance from average solution (EDAS) and hierarchical cluster analysis (HCA). EDAS was used to reveal which countries have the highest level of sustainable socioeconomic development, and which have the lowest. The ranking was done based on the appraisal score, which is an outcome of EDAS. Hierarchical cluster analysis (HCA) was used for clustering the countries based on the appraisal scores in order to distinguish groups of countries having a similar level of sustainable socioeconomic development. The results revealed that the highest level of sustainable socioeconomic development is in Germany, and the lowest in Portugal. Based on HCA, the countries were divided into three groups. The first cluster's countries have the weakest sustainable socioeconomic development, and countries assigned to the third cluster have the best. In the current research, the third cluster consists of one country, Germany, which supports the results obtained with the EDAS method, i.e., Germany is the country with the highest level of sustainable socioeconomic development in the EU.

**Keywords:** sustainable development; socioeconomic development; multicriteria decision-making approach (MCDA); evaluation based on distance from average solution (EDAS); hierarchical cluster analysis (HCA)

## 1. Introduction

Sustainable development is being analysed by a large number of scientists. Many scholars study sustainable development in the context of the sustainable development goals (SDG) announced by the United Nations [1]. The 17 announced goals cover three sustainability pillars: environmental, social, and economical. However, many researchers state that the social and economic pillars should be analysed in relationship. Hence, we examine those two pillars together to explore sustainable socioeconomic development.

A wide range of scientists have researched sustainable social and economic development. Some scholars have investigated the link between social and economic development and water. For instance, Liu, Zhang, and Zhang (2019) [2] claim that there is a relationship between socioeconomic development and industrial and domestic water pollution, i.e., the availability of clean water is crucial [3]. There are also scholars analysing sustainable development from an organisational perspective [4,5].

However, there are few articles investigating socioeconomic development from the economic perspective. It is worth mentioning that in the Economics category in the Clarivate Analytics Database only 17 articles cover sustainable socioeconomic development, which means that the topic is vital for the overall development of a country, but there are only a few pieces of research examining that issue. Some articles are devoted to methodology development [6–8]; others analyse the role of business in socioeconomic development [7,9]. However, there is a lack of research investigating the factors of socioeconomic development. Hence, the research problem is how sustainable socioeconomic development can be assessed from an economic perspective. This study aims to determine the factors of socioeconomic development and assess the level of the development of EU countries in 2015–2017. After analysing and summarising previous research, the most critical factors of socioeconomic development are identified. Moreover, the indicators that can be used for the measurement of the distinguished factors are identified.

## 2. Literature Review

Before determining the factors of socioeconomic sustainable development assessment, it is necessary to define the concept of socioeconomic sustainability. The term "sustainability" could be described as the ability to maintain a decent standard of living without causing damage to the environment. Sustainability could thus be understood as the qualities of human well-being, social equity, and environmental integrity [10]. In other words, it could be viewed as the goal of human-ecosystem equilibrium. Socioeconomic sustainability includes two sustainability pillars—social and economical; hence, first of all, it is crucial to understand them. Social sustainability refers to the improvement of living conditions for both current and future generations [11]. Economic sustainability could be defined as the ability of the economy to support and maintain economic growth, but at the same time, it requires that natural resources be used efficiently [12]. Hence, socioeconomic sustainability could be understood as the ability to ensure economic growth without undermining humans' interests and to meet their needs without harming nature.

In order to evaluate sustainable socioeconomic development, scientists use different factors. For instance, Gonzalez-Garcia, Manteiga, Moreira, and Feijoo (2018) [13] used net disposable income, the number of operating companies, the number of inhabitants with higher education, house prices, and unemployment rates. Pietrzak and Balcerzak [14] distinguished five diagnostic variables proposed by Eurostat relating to socioeconomic sustainability. Diagnostic variables used for the assessment of socioeconomic sustainability are GDP per capita, which measures socioeconomic development, resource productivity, which measures sustainable production and consumption, people at risk of poverty or social exclusion, the unemployment rate of workers aged 55–65, and healthy life years and life expectancy [14]. Ssebunya et al. (2019) [15] distinguished three elements of socioeconomic sustainability: social wellbeing, economic resilience, and good governance. The economic resilience element consists of profitability, the stability of production, the stability of supply, the stability of the market, risk management, private investment, and value creation. According to the author, all these indexes could be used to assess the country's socioeconomic sustainability [15].

Rugani, Marvuglia, and Pulselli (2018) [16] used the Index of Sustainable Economic Welfare (ISEW) for socioeconomic sustainability research, which is a complementary macroeconomic measure to describe the performance of the country realistically. The Index of Sustainable Economic Welfare is a monetary measure of sustainability and economic welfare that aims to overcome some of the limitations of the Gross Domestic Product (GDP) [17]. They use 20 different variables in the research. From the point of view of socioeconomic sustainability, they use personal consumption expenditures and net capital growth. According to the scientists, personal consumption and expenditure directly affect the economic welfare in a country, while net capital growth estimates the amount of annual capital that must be maintained over time to ensure socioeconomic sustainability [16]. Gigliarano, Balducci, Ciommi, and Chelli (2014) [17] also analysed the Index of Sustainable Economic Welfare. They used the adjusted private consumption expenditures, net capital growth, and net balance payment. The authors adjusted private consumption expenditures to take into account income inequality and the poverty rate. They calculated the net balance of payment by subtracting imports from exports [17].

Moreover, Menegaki and Tugcu (2018) [18], as well as previous scientists, analysed the Index of Sustainable Economic Welfare. The authors used eight variables. From a socioeconomic perspective, the authors used the adjusted personal consumption of durables, education expenditures, and net capital growth. They also adjusted personal consumption of durables by multiplying by the Gini coefficient and poverty index. Education expenditures include wages and salaries and exclude capital investment in buildings and equipment, while net capital growth represents the fixed capital accumulation [18].

Song et al. (2018) [19] pinpointed both qualitative and quantitative factors influencing sustainability. From the socioeconomic sustainability perspective, they identified five leading indicators: land ownership, living conditions, food insecurity, personal wealth, and subjective change in wealth. According to scientists, direct economic benefits include land value increase, and indirect economic benefits include employment and local business vitality [19]. All these factors have an impact on socioeconomic sustainability [19]. Economic issues such as poverty and land scarcity are the primary factors that influence socioeconomic sustainability [20]. Chelan et al. (2018) [21] extracted eight sustainability components as follows: activity and employment, utilisation, productivity, economic welfare, efficiency, economic justice, and governmental services. They state that business and work, productivity and economic well-being are the most essential and significant components for economic sustainability compared with the eight elements listed above [21]. Cadil, Mirosnik, Petkovova, and Mirvald (2018) [22] evaluated the effect of public R&D on private companies in the context of socioeconomic sustainability. Performance indicators, such as value-added, sales, or productivity, reflect the competitiveness of companies and their socioeconomic sustainability. For this reason, they used the following indicators in the research: value-added, patents, and value-added per labour cost. According to scholars, one of the main engines of economic growth is R&D, and a higher amount of R&D means more innovations, which leads to higher competitiveness and sustainable economic growth [22]. However, according to the calculations, scientists conclude that the public R&D support for private companies is probably ineffective from an economic sustainability point of view. These results might arise due to the limitations on research and the data availability of selected indicators [22].

Madudova, Čorejova, and Valica (2018) [23] analysed socioeconomic sustainability in a broader context based on the method of the Composite Sustainable Development Index. They used the Location Index (LI), the Hoover Coefficient of Concentration (CC), and the Sustainability subindex. The Location Index (LI) consists of two variables: national and regional employment, and national and regional population. The Hoover Coefficient of Concentration (CC) consists of six indicators: sectoral employment, national and regional employment, value-added costs, production value, and gross operating surplus. The sustainability subindex includes total profit, value-added factors cost, gross operating surplus, production value and sales revenue, an average monthly wage, average monthly employees, and R&D. According to scientists, it is impossible to assess sector sustainability only by the evaluation of economic data related to economic sustainability [23].

To sum up, the assessment of socioeconomic development relies on both social and economic factors. Based on the analysis of the scientific literature that aimed to assess the factors of sustainable socioeconomic development and the availability of statistical data of indicators (factor measurement), 11 factors measured by 12 indicators were used in the current research (see Table 1).

**Table 1.** Factors and indicators assessed in the research.

| Factors | Indicators (Factor Measurement) | Authors |
|---|---|---|
| Education | Total general government expenditures on education (% of GDP) | Gonzalez-Garcia et al. (2018) [13]; Kolukisa & Uğurlu (2016) [24]; Menegaki and Tugcu (2018) [18]; United Nations (2015) [1] |
| | Population with tertiary education, 25–34 years old (% in the same age group) | Gonzalez-Garcia et al. (2018) [13] |
| Innovation and technology | Patent application to the European Patent Office (EPO) (thousand) | Cadil et al. (2018) [19]; Knoerzer (2016) [25] |
| Economic performance and living standards | GDP per capita (thousand EUR) | Pietrzak and Balcerzak (2016) [14] |
| Unemployment | Unemployment rate (% of active population) | Gonzalez-Garcia et al. (2018) [13]; Madudova et al. (2018) [23]; Mofidi Chelan et al. (2018) [21]; Pietrzak and Balcerzak (2016) [14] |
| Disposable income | Adjusted gross disposable income of households per capita (thousand EUR) | Gonzalez-Garcia et al. (2018) [13] |
| Research and Development (R&D) | Intramural R&D expenditure (GERD) by sectors of performance and fields of science (EUR per inhabitant) | Cadil et al. (2018) [22] |
| General government gross debt | General government gross debt (% of GDP) | Madudova et al. (2018) [23] |
| Cost of labour force | Average wage per hour (EUR) | Madudova et al. (2018) [23] |
| Government services | Corruption Perception Index | Mofidi Chelan et al. (2018) [21] |
| Consumption | Final consumption expenditure (% of GDP) | Gigliarano et al. (2014) [17]; Menegaki and Tugcu (2018); Pietrzak and Balcerzak (2016) [14]; Rugani et al. (2018) [16] |
| Value added | Manufacturing gross value added (% of GDP) | Cadil et al. (2018) [22]; Madudova et al. (2018) [23]; Ssebunya et al. (2019) [15] |
| House price index | House price index (%) | Gonzalez-Garcia et al. (2018) [13] |
| Poverty rate | People at risk of poverty or social exclusion (%) | Pietrzak and Balcerzak (2016) [14] |

Source: developed by authors based on the literature review.

The indicators summarised in Table 1 were used to assess the socioeconomic development of European Union countries.

## 3. Methodology

The methodology aggregates the joint performance of the country by ranking, assuming that a country with better sustainable socioeconomic development should be close to the top rank and far from the worst. Conversely, a country with the lowest sustainable socioeconomic development should be close to the lowest position and distant from the highest one. For a comprehensive assessment, MCDA and HCA were used in the research.

Due to the research limitation (a lack of statistical information), not all European Union countries are included in the research. Countries involved in the study are Belgium, the Czech Republic, Denmark, Germany, Estonia, Spain, Italy, Latvia, Lithuania, Luxembourg, Hungary, the Netherlands, Austria, Poland, Portugal, Slovenia, the Slovak Republic, Finland, Sweden, and the United Kingdom.

The present study uses data that cover 2015–2017. The data were collected from the World Bank, Eurostat, OECD, and Transparency International Organization databases.

*Multicriteria Decision-Making Approach.* MCDA refers to choosing the best alternative from among a finite set of decision alternatives [26]. The MCDA method is characterised by the ability to handle multiple and conflicting data, as well as the ability to integrate values and perceptions, identify risks, and process vast amounts of information. MCDA can involve both quantitative and qualitative factors [27]. This method is based on the assumption that a country that has a better sustainable economic development is closer to the best scores on indexes and far from the worst ratings and vice versa. The MCDA approach is based on the distance to two reference points—one is desirable and the other undesirable [28].

MCDA consists of three application stages: decision context and structuring, analysis, and decision. In the first stage, it is necessary to determine goals, identify criteria and alternatives, and select the MCDA technique. The main objective of the use of MCDA is to rank European Union countries in the context of sustainable socioeconomic development.

For the countries assessment, the Evaluation Based on Distance from Average Solution (EDAS) method was chosen. The EDAS method is based on the average solution for appraising the alternatives. Because of that, EDAS is very useful when there are some different criteria [29]. The method is relatively new compared with other multicriteria decision-making methods. It was developed by Keshavarz Ghorabaee, Zavadskas, Olfat, and Turskis (2015) [30] and is based on searching for the best solutions by finding the distance from the average one. This is the main difference to the TOPSIS method, which seeks to find the best solution by calculating the distance from the ideal solutions (both positive and negative) [31]. The motivation for selecting the EDAS method as a tool for the current research is that the obtained results are based on the average solution that represents normalised data that significantly limit the chances of deviation from the best solution; this allows this technique to generate more accurate solutions in solving real-life problems [32]. The methodology of the EDAS is provided below [30].

First, the decision-making matrix is constructed:

$$X = \left[X_{ij}\right]_{m \times n} = \begin{bmatrix} X_{11} & \cdots & X_{1m} \\ \vdots & \ddots & \vdots \\ X_{n1} & \cdots & X_{nm} \end{bmatrix}, \tag{1}$$

where:

$X_{ij}$—value of $i$-th alternative on $j$-th criterion
$n$—number of alternatives
$m$—number of criteria

Second, the average solution is determined:

$$AV_j = \frac{\sum_{i=1}^{n} X_{ij}}{n}, \tag{2}$$

where $AV_j$ is the average solution

Third, the positive distance from average (PDA) and the negative distance from average (NDA) matrixes according to the type of criteria (benefit and cost) are calculated:

if $j$-th criterion is beneficial:

$$PDA_{ij} = \frac{\max\left(0, \left(X_{ij} - AV_j\right)\right)}{AV_j} \tag{3}$$

$$NDA_{ij} = \frac{\max\left(0, \left(AV_j - X_{ij}\right)\right)}{AV_j}; \tag{4}$$

if $j$-th criterion is cost:

$$PDA_{ij} = \frac{\max\left(0, \left(AV_j - X_{ij}\right)\right)}{AV_j} \tag{5}$$

$$NDA_{ij} = \frac{\max\left(0, \left(X_{ij} - AV_j\right)\right)}{AV_j}, \tag{6}$$

where:

$PDA_{ij}$—positive distance from average
$NDA_{ij}$—negative distance from average.

Fourth, the weighted sums of $PDA_{ij}$ and $NDA_{ij}$ for all alternatives are determined:

$$SP_i = \sum_{j=1}^{m} w_j PDA_{ij} \tag{7}$$

$$SN_i = \sum_{j=1}^{m} w_j NDA_{ij}, \tag{8}$$

where:

$SP_i$—weighted sum of $PDA_{ij}$
$SN_i$—weighted sum of $NDA_{ij}$.

Fifth, the values of $SP_i$ and $NP_i$ for all alternative are normalised:

$$NSP_i = \frac{SP_i}{max_i(SP_i)} \tag{9}$$

$$NSN_i = 1 - \frac{SN_i}{\max_i(SN_i)}, \tag{10}$$

where:

$NSP_i$—normalised value of $SP_i$
$NSN_i$—normalised value of $SN_i$.

Sixth, the appraisal score ($AS_i$) for all alternatives is calculated:

$$AS_i = \frac{1}{2}(NSP_i + NSN_i), \tag{11}$$

where $AS_i$ is the appraisal score (AS) for all alternatives, $0 \leq AS_i \leq 1$.

Lastly, the alternatives are ranked according to the decreasing values of $AS_i$, i.e., the alternative with the highest AS is the best choice among the candidate alternatives.

*Hierarchical Cluster Analysis*. HCA is a technique used to classify data by similar factors into groups, called clusters. HCA is a way of grouping sets of available data based on the measurement of similarities or distance. The results of HCA are usually presented in a dendrogram. The horizontal axis of the dendrogram represents the objects and clusters (in this case, European Union countries), while the vertical axis of the dendrogram represents the distance or dissimilarity between clusters. Hierarchical Cluster Analysis is based on the range that combines the most similar objects (in the current study, countries) into one group/cluster. Each cluster has well-defined centroids, meaning the average across all the points in the cluster. Therefore, each cluster is represented by the centroids. According to the centroids' values, countries are assigned to a cluster [33].

The HCA method is applied via the following steps [33,34]:

Step 1. Let the distance between clusters $i$ and $j$ be represented as $d_{ij}$ and let cluster $i$ contain $n_i$ objects. Let $D$ denote the set of all remaining $d_{ij}$. Suppose there are $N$ objects to the cluster.

Step 2. Find the smallest element $d_{ij}$ remaining in $D$.

Step 3. Merge cluster $i$ and $j$ into a single new cluster, $k$.

Step 4. Calculate a new set of distances $d_{km}$ using the following formula:

$$d_{km} = \alpha_i d_{im} + \alpha_j d_{jm} + \beta d_{ij} + \gamma \left| d_{im} - d_{jm} \right|, \tag{12}$$

where $m$ represents any cluster different from $k$.

These new distances replace $d_{im,}$ and $d_{jm}$ in $D$. Also, let $n_k = n_i + n_j$. The coefficients of the distance equation are:

$$\alpha_i = \frac{n_i}{n_k},\ \alpha_j = \frac{n_j}{n_k},\ \beta = -\alpha_i \alpha_j,\ \gamma = 0. \tag{13}$$

Step 5. Repeat steps 1–3 until $D$ contains a single group made up of all objects.

Based on the steps above, the method of HCA will be used for grouping the researched countries.

## 4. Results

The first step of the research aimed at prioritising the EU countries, where the criteria were the socioeconomic development factors, measured by indicators (see Table 1). The EDAS method was used to rank the countries. The prioritising procedure was completed for 2015–2017 in order to see the changes between the years (initial data is presented in Appendix A). After the prioritising was done, the hierarchical cluster analysis was employed using the appraisal score. The cluster analysis was used in order to group the countries with similar levels of socioeconomic development. The cluster analysis covered 2015–2017. This was done not only in order to divide EU countries into groups, but also to analyse how the groups have been changing.

Before obtaining the main results of the study, descriptive statistics were gathered (see Appendix B). The mean values of the unemployment rate varied from 6.90 to 8.61 (with a standard deviation varying from 3.164 to 3.924). It is worth mentioning that the lowest values were in 2017. The mean values of Intramural R&D expenditure (GERD) by sectors of performance and fields of science varied from 56.1 to 1615 (with standard deviation varying from 492.4 to 526.84). Based on that, it could be stated that these expenditures were very different in different countries in different years. That is supported by a high value of standard deviation as well. The mean of patent applications to the EPO was almost the same all three years and varied from 2.226 to 2.350 (with a standard deviation varying from 4.219 to 4.688). The mean value of the total general government expenditures on education varied from 5.085 to 5.275 percentage of GDP (with a standard deviation varying from 0.733 to 0.799, percentage of GDP). It could be stated that government expenditure on education was quite stable.

The mean value of GDP per capita, in thousands of euros, varied from 29.990 to 31.435 (with a standard deviation varying from 19.207 to 19.278, thousands of euros). The mean of the house price index varied from 99.998 to 111.823, in percentage (standard deviation differs from 0.006 to 5.414, %). Corruption perception index, i.e., its mean value, varied from 68.250 to 69.300 (with standard deviation varying from 13.661 to 14.833). Based on these figures, it could be concluded that the index was stable and sufficiently predictable. The situation is different from the average wage per hour. The mean values (in euros) varied from 22.715 to 23.430; on the other hand, the standard deviation was high, i.e., from 12.488 to 12.639. The mean values of people at risk of poverty or social exclusion changed from 20.960 to 22.120 and the standard deviations were not high, i.e., from 4.879 to 5.095. A very similar situation is seen with adjusted gross disposable income of households per capita. The mean values vary from (in thousands of euros) 20.881 to 21.145 (the standard deviation is from 5.165 to 5.517).

Final consumption expenditure, as a percentage of GDP, could be treated as stable and predictable as the mean values varied from 73.267 to 73.798 with a standard deviation varying from 7.946 to 8.009. The mean values of general government gross debt, as a percentage of GDP, varied from 63.850 to 66.810. The standard deviation was adequately high (varying from 32.744 to 33.392), which shows that it could not be treated as a standard for the EU average. The mean values of manufacturing gross value-added percentage of GDP varied from 14.937 to 15.035, with a standard deviation from 4.627 to 4.670. The last variable analysed was the population with tertiary education and 25–34 years old, a percentage in the same age group. Its mean value changed from 40.519 to 41.655, with the standard deviation varying from 7.700 to 7.986.

The main findings are presented in the following subsections.

### *4.1. Sustainable Economic Development Assessment Using the EDAS Technique*

The first stage of the current study is to rank the countries by applying a multicriteria decision-making approach, EDAS. The results are presented in Table 2.

**Table 2.** Countries' ranking procedure results obtained using the EDAS technique.

| Country | 2015 | | 2016 | | 2017 | |
|---|---|---|---|---|---|---|
| | $AS_i$ | Rank | $AS_i$ | Rank | $AS_i$ | Rank |
| Belgium | 0.464 | 9 | 0.489 | 9 | 0.487 | 9 |
| Czech Republic | 0.291 | 10 | 0.260 | 11 | 0.282 | 10 |
| Denmark | 0.603 | 3 | 0.662 | 3 | 0.657 | 3 |
| Germany | 0.926 | 1 | 0.948 | 1 | 0.952 | 1 |
| Estonia | 0.235 | 13 | 0.226 | 12 | 0.230 | 12 |
| Spain | 0.089 | 18 | 0.077 | 18 | 0.064 | 18 |
| Italy | 0.262 | 12 | 0.200 | 13 | 0.173 | 14 |
| Latvia | 0.066 | 19 | 0.037 | 19 | 0.024 | 19 |
| Lithuania | 0.156 | 15 | 0.131 | 15 | 0.120 | 15 |
| Luxembourg | 0.561 | 6 | 0.587 | 6 | 0.577 | 5 |
| Hungary | 0.126 | 17 | 0.081 | 17 | 0.076 | 17 |
| Netherlands | 0.563 | 5 | 0.599 | 4 | 0.605 | 4 |
| Austria | 0.572 | 4 | 0.589 | 5 | 0.577 | 6 |
| Poland | 0.196 | 14 | 0.193 | 14 | 0.196 | 13 |
| Portugal | 0.004 | 20 | 0.000 | 20 | 0.010 | 20 |
| Slovenia | 0.275 | 11 | 0.269 | 10 | 0.275 | 11 |
| Slovak Republic | 0.147 | 16 | 0.114 | 16 | 0.115 | 16 |
| Finland | 0.506 | 8 | 0.546 | 7 | 0.529 | 7 |
| Sweden | 0.652 | 2 | 0.695 | 2 | 0.692 | 2 |
| United Kingdom | 0.516 | 7 | 0.526 | 8 | 0.499 | 8 |

Source: authors' calculations.

Table 2 displays the $AS_i$ (appraisal score) values according to which the countries are ranked. Germany had the highest appraisal score, while Portugal had the lowest in 2015–2017. This means that Germany had the most significant sustainable socioeconomic development, while Portugal had the worst in comparison with the 20 European Union countries. A similar situation was seen in Sweden and Latvia, which took second and nineteenth place in all three research years, respectively. This means that Germany and Sweden could be treated as a benchmark of sustainable socioeconomic development. It is worth mentioning that environmental development was not the objective of the current study; hence, the results of the environmental sustainability level could differ from the current research outcomes.

What is more, all the countries analysed reached more significant sustainable socioeconomic development in 2017, while in some countries, we noticed a decrease in sustainable socioeconomic development in 2016. This might arise due to the slight reduction in total general government expenditures on education, corruption perception index, adjusted gross disposable income of households per capita, patent applications to the EPO, manufacturing gross value added, Intramural R&D expenditure (GERD) by sectors of performance and fields of science compared to 2015.

In order to see the whole picture more thoroughly, the results are depicted in Figure 1.

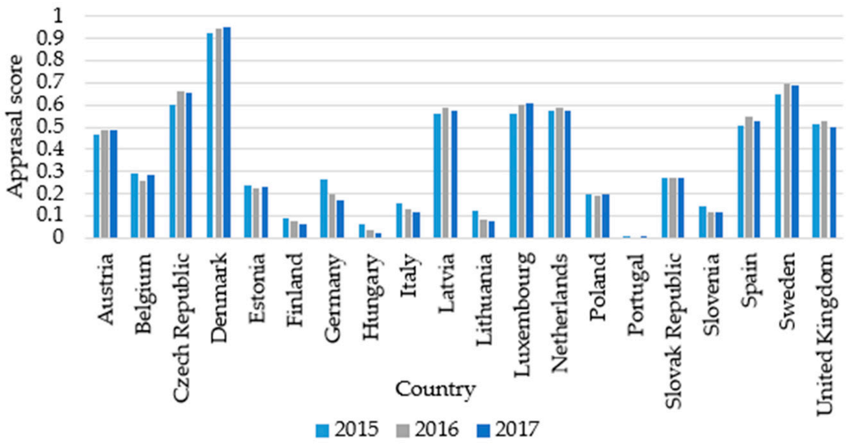


**Figure 1.** Appraisal scores obtained using EDAS in 2015-2017. Source: created by authors.

Figure 1 summarises the appraisal scores of sustainable socioeconomic development during 2015-2017. There are no significant differences within this period. However, it is worth mentioning that sustainable socioeconomic development increased in the following countries in 2017, compared to 2015: Austria, the Czech Republic, Denmark, Latvia, Luxembourg, Spain, and Sweden. However, there are only a few countries in which the level of socioeconomic development increased in 2017 compared to 2016: Belgium, Estonia, Luxembourg, and the Slovak Republic.

The results revealed that the countries that gained the lowest rank had the highest unemployment rates, while Germany had one of the lowest. This means that the unemployment rate is crucial for ensuring sustainable socioeconomic development. The highest number of patent applications and R&D expenditures were in the leading countries as well. This means that the government should invest in education, research activities, and innovation support (start-ups) to reach the highest level of socioeconomic development. In order to ensure these activities, people should receive a decent salary in order to be motivated to conduct research and develop a new product. The research results support this as well, as the wage is the variable that could encourage sustainable socioeconomic development.

### 4.2. Hierarchical Cluster Analysis

Hierarchical Cluster Analysis (HCA) was carried out to group the European Union countries into separate clusters according to similar criteria in 2015, 2016, and 2017 to show the tendencies in sustainable economic development.

Information about clusters distinguished by HCA is presented in Table 3.

**Table 3.** Cluster analysis results.

| Cluster | Countries, 2015–2017 |
| --- | --- |
| 1 | Czech Republic, Estonia, Spain, Italy, Latvia, Lithuania, Hungary, Poland, Portugal, Slovenia, Slovak Republic |
| 2 | Belgium, Denmark, Luxembourg, Netherlands, Austria, Finland, Sweden United Kingdom |
| 3 | Germany |

Source: authors' calculation.

As can be seen from Table 3, the clusters are the same for the whole period. The first cluster consists of the Czech Republic, Estonia, Spain, Italy, Latvia, Lithuania, Hungary, Poland, Portugal, Slovenia, and the Slovak Republic; the second cluster consists of Belgium, Denmark, Luxembourg, the Netherlands, Austria, Finland, Sweden, and the United Kingdom; and the third cluster consists of Germany. In this case, Germany is interpreted as the best country in terms of sustainable socioeconomic development, because it has a zero value as the minimum distance to the centroid, average distance to the centroid, and maximum distance to the centroid. Countries that are assigned to the first cluster have the weakest sustainable economic development compared to the other European Union countries as they have the highest values for the minimum distance to the centroid, the average distance to the centroid, and the maximum distance to the centroid. The results of the EDAS method confirm that countries assigned to the first cluster have the weakest sustainable socioeconomic development, while Germany, assigned to the third cluster, has the most sustainable socioeconomic development.

## 5. Discussion

The study aimed at assessing the sustainable socioeconomic development of the EU countries. For that purpose, socioeconomic development was defined as the ability to ensure economic growth without undermining humans' interests and to meet their needs without harming nature. To evaluate the level of socioeconomic development, the following factors were distinguished from the scientific literature: education, innovation and technology, economic performance and living standards, unemployment, disposable income, R&D, cost of the labour force, government services, consumption, value-added, changes in prices, and poverty rate.

Two indicators measured education: total general government expenditures on education, and the population with tertiary education 25–34 years old. The research results revealed that in almost all the analysed countries, the higher the government's expenditures on education, the higher the number of young people who graduated from higher education institutions. This could be explained by the fact that expenditure on education increases the affordability of higher education. In turn, tertiary education could have a positive impact on a country's economy [35]. Governments should take this into account while planning the budget.

Innovation and technology were measured by patent applications to the EPO. The results revealed that this variable is one of the most powerful forces of sustainable socioeconomic development. The highest value was found for Germany, which has the highest level of socioeconomic development according to the results obtained by the EDAS technique. In fact, many studies support this outcome [36–39]. It is worth noting that innovation is one of the sustainable development goals [40].

Traditional indicators such as GDP per capita and the unemployment rate were also employed for the evaluation of sustainable socioeconomic development. The results were entirely predictable, i.e., the GDP of countries with a higher level of sustainable socioeconomic development is higher. As for the unemployment rate, it is different in every country and it is challenging to find a general tendency.

Disposable income, the cost of the labour force, and consumption could be analysed together. It is worth mentioning that the countries that are more socioeconomically developed have higher levels of disposable income and a higher cost of the labour force, which seems logical. In other words, those variables are directly proportional quantities. Regarding consumption, it is noted that the figures are almost the same in all the countries (Luxembourg is an exception); hence, it can be said that expenditure on final consumption is not a variable that has a relationship with the final results. However, it is worth noting that in other countries, final consumption could play a significant role in the rankings.

The countries that are more socioeconomically developed have higher R&D expenditure. The difference between the lowest and the highest value is more than 15,000 euros per inhabitant. Based on those results, it is highly recommended that local/regional governments encourage scientists to conduct high-quality research in order to develop their research skills and capabilities, which, in turn, will promote the sustainable socioeconomic development of a country/region.

Government service is the variable that could not be treated as having a close link with the level of a country's sustainable socioeconomic development in the analysed countries, i.e., it cannot be claimed that the level of sustainable socioeconomic development and government debt move in the same direction. The same situation is seen with manufacturing gross value added (% of GDP), which is used for measuring a country's value-added.

The house price index and poverty rate are similar in the investigated countries; hence, these variables could be treated as significant when assessing the level of socioeconomic development in other countries or regions.

## 6. Conclusions and Future Research Directions

In the current paper, sustainable socioeconomic development was examined. The aim of the study was to determine the factors and evaluate the level of sustainable socioeconomic development of the EU countries from 2015 to 2017. The identified factors were assigned indicators that were used for the quantitative representation. The results obtained by the EDAS method revealed that the most sustainably socioeconomically developed country is Germany, with the least being Portugal.

Moreover, the results highlighted that the countries that were assigned to the lowest sustainable socioeconomic development level had the highest level of unemployment. Hence, unemployment is the social area that should be given the most government attention. The significance of that factor was supported by the outcome that Germany, which has the highest level of sustainable socioeconomic development, had one of the lowest unemployment rates. What is more, the findings emphasised that Germany had the highest R&D expenditure, which significantly contributed to its sustainable socioeconomic development. This means that the German government paid great attention to such areas as education, scientific development, and innovation. In fact, R&D could speed up the development of other areas, such as technology, which, in turn, could create new job opportunities. In other words, there is a connection between all the sustainable socioeconomic development factors. Hence, future studies should focus on establishing the relationships between the factors and determining their strength.

Additionally, a cluster analysis was performed. According to the HCA results, clusters and clusters' structure in 2015–2017 were the same. It is noteworthy that the third cluster contained only one country—Germany, which means that it has the most sustainable socioeconomic development, while the countries assigned to the second cluster were the weakest in terms of sustainable socioeconomic development. The clusters will be used in further research to create models for each cluster to speed up the process of reaching a higher level of sustainable socioeconomic development.

What is more, it is crucial to note that there were several limitations of the research. Firstly, not all countries were investigated due to limited statistical data. Secondly, the latest data were from 2017, i.e., not all the necessary statistics had been announced for 2018 and 2019. Consequently, in future research, it is vital to investigate the situation from 2018 and 2019.

**Author Contributions:** V.S. and G.V. developed the research idea. G.V. and D.J. were responsible for the scientific literature review, visualisation, research results interpretation, and conclusions preparation. V.S. and G.V. were responsible for the research design, methodology, data collection and analysis, and validation of the research results. All authors have read and agreed to the published version of the manuscript.

**Conflicts of Interest:** The authors declare no conflict of interest.

## Appendix A. Initial Research Data

**Table A1.** The 2015 data.

| Country | Austria | Belgium | Czech Republic | Denmark | Estonia | Finland | Germany | Hungary | Italy | Latvia | Lithuania | Luxembourg | Netherlands | Poland | Portugal | Slovak Republic | Slovenia | Spain | Sweden | United Kingdom |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Unemployment rate (% of active population) | 5.70 | 8.50 | 5.10 | 6.20 | 6.20 | 9.40 | 4.60 | 6.80 | 11.90 | 9.90 | 9.10 | 6.50 | 6.90 | 7.50 | 12.60 | 11.50 | 9.00 | 22.10 | 7.40 | 5.30 |
| Intramural R&D expenditure (GERD) by sectors of performance and fields of science (EUR per inhabitant) | 959.5 | 280.8 | 1 534.2 | 1 121.7 | 205.4 | 285.5 | 382 | 56.1 | 113.4 | 1 198.1 | 139.5 | 833 | 1 279.9 | 108.3 | 231 | 393.4 | 118.1 | 1 080 | 1 537 | 618.3 |
| Patent applications to the EPO (thousands) | 2.00 | 1.57 | 0.30 | 1.36 | 0.04 | 1.38 | 21.03 | 0.21 | 4.37 | 0.03 | 0.02 | 0.07 | 3.50 | 0.58 | 0.14 | 0.04 | 0.12 | 1.63 | 2.93 | 5.69 |
| Total general government expenditures on education (% of GDP) | 4.90 | 6.40 | 4.90 | 7.00 | 6.00 | 6.20 | 4.20 | 5.10 | 3.90 | 5.90 | 5.40 | 4.70 | 5.20 | 5.30 | 5.10 | 4.20 | 5.50 | 4.10 | 6.50 | 5.00 |
| GDP per capita (thousand EUR) | 39.90 | 36.60 | 16.00 | 48.00 | 15.70 | 38.30 | 37.30 | 11.30 | 27.20 | 12.30 | 12.90 | 90.60 | 40.70 | 11.20 | 17.40 | 14.60 | 18.80 | 23.30 | 45.80 | 40.10 |
| House price index (%) | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 99.98 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| Corruption perception index | 76.00 | 77.00 | 56.00 | 91.00 | 70.00 | 90.00 | 81.00 | 51.00 | 44.00 | 56.00 | 59.00 | 85.00 | 84.00 | 63.00 | 64.00 | 51.00 | 60.00 | 58.00 | 89.00 | 81.00 |
| Average wage per hour (EUR) | 32.50 | 39.10 | 9.80 | 41.20 | 10.40 | 33.00 | 32.30 | 7.90 | 28.10 | 7.10 | 6.80 | 36.30 | 33.70 | 8.60 | 13.40 | 10.00 | 15.80 | 21.20 | 37.40 | 29.70 |
| People at risk of poverty or social exclusion (%) | 18.30 | 21.10 | 14.00 | 17.70 | 24.20 | 16.80 | 20.00 | 28.20 | 28.70 | 30.90 | 29.30 | 18.50 | 16.40 | 23.40 | 26.60 | 18.40 | 19.20 | 28.60 | 18.60 | 23.50 |
| Adjusted gross disposable income of households per capita (thousand EUR) | 26.97 | 25.06 | 17.16 | 23.76 | 15.19 | 24.33 | 28.08 | 13.87 | 21.40 | 13.06 | 16.60 | 33.08 | 24.96 | 15.13 | 17.22 | 16.39 | 16.97 | 19.31 | 24.75 | 24.33 |
| Final consumption expenditure (% of GDP) | 72.50 | 75.06 | 66.05 | 72.74 | 72.18 | 79.70 | 72.86 | 69.31 | 79.76 | 78.28 | 79.90 | 46.65 | 69.52 | 76.53 | 83.59 | 74.19 | 72.04 | 77.34 | 70.85 | 84.74 |
| General government gross debt (% of GDP) | 84.80 | 106.50 | 40.00 | 39.90 | 9.90 | 63.60 | 70.80 | 76.60 | 131.60 | 36.80 | 42.60 | 22.20 | 64.60 | 51.30 | 128.80 | 52.20 | 82.60 | 99.30 | 44.20 | 87.90 |
| Manufacturing gross value added (% of GDP) | 16.56 | 12.83 | 24.13 | 12.41 | 13.83 | 14.80 | 20.76 | 20.52 | 14.39 | 10.52 | 17.36 | 4.86 | 10.70 | 17.64 | 12.16 | 19.75 | 19.96 | 12.90 | 13.69 | 8.97 |
| Population with tertiary education, 25–34 years old (% in same age group) | 48.47 | 43.14 | 31.01 | 44.48 | 40.51 | 40.52 | 29.59 | 32.13 | 25.15 | 39.87 | 54.77 | 49.95 | 45.09 | 43.19 | 33.14 | 31.31 | 40.76 | 40.96 | 46.41 | 49.94 |

**Table A2.** The 2016 data.

| Country | Austria | Belgium | Czech Republic | Denmark | Estonia | Finland | Germany | Hungary | Italy | Latvia | Lithuania | Luxembourg | Netherlands | Poland | Portugal | Slovak Republic | Slovenia | Spain | Sweden | United Kingdom |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Unemployment rate (% of active population) | 6.00 | 7.80 | 4.00 | 6.20 | 6.80 | 8.80 | 4.10 | 5.10 | 11.70 | 9.60 | 7.90 | 6.30 | 6.00 | 6.20 | 11.20 | 9.70 | 8.00 | 19.60 | 6.90 | 4.80 |
| Intramural R&D expenditure (GERD) by sectors of performance and fields of science (EUR per inhabitant) | 959.5 | 280.8 | 1 534.2 | 1 121.7 | 205.4 | 285.5 | 382 | 56.1 | 113.4 | 1 198.1 | 139.5 | 833 | 1 279.9 | 108.3 | 231 | 393.4 | 118.1 | 1 080 | 1 537 | 618.3 |
| Patent applications to the EPO (thousands) | 2.03 | 1.59 | 0.32 | 1.37 | 0.03 | 1.31 | 20.14 | 0.20 | 4.24 | 0.02 | 0.02 | 0.06 | 3.45 | 0.63 | 0.14 | 0.05 | 0.11 | 1.64 | 2.90 | 5.54 |
| Total general government expenditures on education (% of GDP) | 4.90 | 6.30 | 4.50 | 6.80 | 5.80 | 6.10 | 4.10 | 4.90 | 3.80 | 5.50 | 5.10 | 4.60 | 5.20 | 5.00 | 4.80 | 3.80 | 5.50 | 4.00 | 6.70 | 4.80 |
| GDP per capita (thousand EUR) | 40.80 | 37.60 | 16.70 | 49.20 | 16.50 | 39.30 | 38.40 | 11.60 | 27.90 | 12.80 | 13.50 | 91.30 | 41.60 | 11.10 | 18.10 | 15.00 | 19.50 | 24.10 | 46.70 | 36.60 |
| House price index (%) | 114.26 | 106.37 | 119.70 | 110.00 | 110.51 | 102.01 | 110.78 | 120.13 | 99.18 | 118.01 | 114.80 | 111.96 | 112.93 | 105.78 | 117.02 | 112.99 | 111.56 | 111.10 | 115.58 | 111.81 |
| Corruption perception index | 75.00 | 77.00 | 55.00 | 90.00 | 70.00 | 89.00 | 81.00 | 48.00 | 47.00 | 57.00 | 59.00 | 81.00 | 83.00 | 62.00 | 62.00 | 51.00 | 61.00 | 58.00 | 88.00 | 81.00 |
| Average wage per hour (EUR) | 33.20 | 39.20 | 10.10 | 41.60 | 10.90 | 33.20 | 33.20 | 8.30 | 28.00 | 7.50 | 7.30 | 36.70 | 34.00 | 8.60 | 13.70 | 10.40 | 16.20 | 21.10 | 38.20 | 26.80 |
| People at risk of poverty or social exclusion (%) | 18.00 | 20.70 | 13.30 | 16.80 | 24.40 | 16.60 | 19.70 | 26.30 | 30.00 | 28.50 | 30.10 | 19.80 | 16.70 | 21.90 | 25.10 | 18.10 | 18.40 | 27.90 | 18.30 | 22.20 |
| Adjusted gross disposable income of households per capita (thousand EUR) | 26.70 | 24.73 | 17.30 | 23.68 | 15.40 | 24.09 | 28.00 | 14.03 | 21.58 | 13.49 | 16.96 | 31.67 | 24.39 | 15.34 | 17.32 | 16.28 | 17.04 | 19.21 | 24.26 | 23.90 |
| Final consumption expenditure (% of GDP) | 72.71 | 74.72 | 66.18 | 72.83 | 73.48 | 79.14 | 72.83 | 70.14 | 79.65 | 79.52 | 81.46 | 46.95 | 68.94 | 76.38 | 83.40 | 73.93 | 72.14 | 76.49 | 70.41 | 84.65 |
| General government gross debt (% of GDP) | 83.00 | 106.10 | 36.80 | 37.90 | 9.20 | 63.00 | 67.90 | 75.90 | 131.40 | 40.30 | 39.90 | 20.70 | 61.90 | 54.20 | 129.20 | 51.80 | 78.70 | 99.00 | 42.40 | 87.90 |
| Manufacturing gross value added (% of GDP) | 16.21 | 12.74 | 24.35 | 13.27 | 13.52 | 14.54 | 20.64 | 19.90 | 14.65 | 10.67 | 16.99 | 5.06 | 10.91 | 18.05 | 12.15 | 20.45 | 20.13 | 12.88 | 13.51 | 9.02 |
| Population with tertiary education, 25–34 years old (% in same age group) | 49.31 | 44.31 | 32.56 | 45.88 | 41.05 | 41.13 | 30.53 | 30.40 | 25.58 | 42.10 | 54.93 | 51.43 | 45.22 | 43.48 | 34.96 | 33.37 | 42.98 | 40.98 | 47.22 | 51.78 |

**Table A3.** The 2017 data.

| Country | Austria | Belgium | Czech Republic | Denmark | Estonia | Finland | Germany | Hungary | Italy | Latvia | Lithuania | Luxembourg | Netherlands | Poland | Portugal | Slovak Republic | Slovenia | Spain | Sweden | United Kingdom |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Unemployment rate (% of active population) | 5.50 | 7.10 | 2.90 | 5.70 | 5.80 | 8.60 | 3.80 | 4.20 | 11.20 | 8.70 | 7.10 | 5.60 | 4.90 | 4.90 | 9.00 | 8.10 | 6.60 | 17.20 | 6.70 | 4.40 |
| Intramural R&D expenditure (GERD) by sectors of performance and fields of science (EUR per inhabitant) | 1 045.5 | 324.5 | 1 551.4 | 1 206.4 | 231.3 | 302.2 | 392.7 | 70.7 | 133 | 1 220.1 | 170.8 | 857 | 1 286.9 | 127.3 | 250.7 | 388.4 | 137.8 | 1 121.7 | 1 615 | 590.8 |
| Patent applications to the EPO (thousands) | 2.03 | 1.66 | 0.36 | 1.42 | 0.04 | 1.30 | 18.88 | 0.20 | 4.15 | 0.02 | 0.02 | 0.06 | 3.48 | 0.69 | 0.14 | 0.06 | 0.11 | 1.65 | 2.83 | 5.44 |
| Total general government expenditures on education (% of GDP) | 4.80 | 6.30 | 4.60 | 6.50 | 5.80 | 5.70 | 4.10 | 5.10 | 3.80 | 5.80 | 4.90 | 4.70 | 5.10 | 4.90 | 5.00 | 3.80 | 5.40 | 4.00 | 6.80 | 4.60 |
| GDP per capita (thousand EUR) | 42.10 | 38.70 | 18.10 | 50.80 | 18.00 | 40.60 | 39.60 | 12.70 | 28.50 | 13.90 | 14.90 | 92.60 | 43.00 | 12.20 | 18.90 | 15.60 | 20.80 | 25.10 | 47.20 | 35.40 |
| House price index (%) | 114.26 | 106.37 | 119.70 | 110.00 | 110.51 | 102.01 | 110.78 | 120.13 | 99.18 | 118.01 | 114.80 | 111.96 | 112.93 | 105.78 | 117.02 | 112.99 | 111.56 | 111.10 | 115.58 | 111.81 |
| Corruption perception index | 75.00 | 75.00 | 57.00 | 88.00 | 71.00 | 85.00 | 81.00 | 45.00 | 50.00 | 58.00 | 59.00 | 82.00 | 82.00 | 60.00 | 63.00 | 50.00 | 61.00 | 57.00 | 84.00 | 82.00 |
| Average wage per hour (EUR) | 34.10 | 39.60 | 11.30 | 42.50 | 11.70 | 32.70 | 34.10 | 9.10 | 28.20 | 8.10 | 8.00 | 37.60 | 34.80 | 9.40 | 14.10 | 11.10 | 17.00 | 21.20 | 38.30 | 25.70 |
| People at risk of poverty or social exclusion (%) | 18.10 | 20.30 | 12.20 | 17.20 | 23.40 | 15.70 | 19.00 | 25.60 | 28.90 | 28.20 | 29.60 | 21.50 | 17.00 | 19.50 | 23.30 | 16.30 | 17.10 | 26.60 | 17.70 | 22.00 |
| Adjusted gross disposable income of households per capita (thousand EUR) | 26.73 | 24.96 | 17.97 | 24.40 | 15.96 | 24.17 | 28.47 | 14.41 | 21.80 | 14.04 | 17.56 | 32.68 | 24.70 | 15.68 | 17.73 | 16.65 | 17.50 | 19.34 | 24.54 | 23.60 |
| Final consumption expenditure (% of GDP) | 71.63 | 74.67 | 66.45 | 71.94 | 71.58 | 77.64 | 72.64 | 69.64 | 79.67 | 79.86 | 80.53 | 46.65 | 68.16 | 76.27 | 82.65 | 73.86 | 71.06 | 76.19 | 70.11 | 84.15 |
| General government gross debt (% of GDP) | 78.30 | 103.40 | 34.70 | 36.10 | 8.70 | 61.30 | 63.90 | 73.30 | 131.20 | 40.00 | 39.40 | 23.00 | 57.00 | 50.60 | 124.80 | 50.90 | 74.10 | 98.10 | 40.80 | 87.40 |
| Manufacturing gross value added (% of GDP) | 16.51 | 12.54 | 24.28 | 12.81 | 13.28 | 14.93 | 20.66 | 19.87 | 14.69 | 11.05 | 17.56 | 5.15 | 10.75 | 17.59 | 12.37 | 20.10 | 20.70 | 13.06 | 13.60 | 9.20 |
| Population with tertiary education. 25–34 years old (% in same age group) | 40.32 | 45.73 | 33.82 | 46.57 | 43.04 | 41.25 | 31.31 | 30.16 | 26.82 | 41.61 | 55.63 | 51.40 | 46.59 | 43.53 | 34.03 | 35.07 | 44.57 | 42.64 | 47.39 | 51.62 |

## Appendix B. Descriptive Statistics

**Table A4.** Descriptive statistics of 2015 data.

| Statistic | Minimum | Maximum | 1st Quartile | Median | 3rd Quartile | Mean | Variance (n-1) | Standard deviation (n-1) |
|---|---|---|---|---|---|---|---|---|
| Unemployment rate (% of active population) | 4.600 | 22.10 | 6.200 | 7.45 | 9.525 | 8.610 | 15.4 | 3.924 |
| Intramural R&D expenditure (GERD) by sectors of performance and fields of science (EUR per inhabitant) | 76.6 | 1504 | 204.3 | 389 | 1097.4 | 621.3 | 242474 | 492.4 |
| Patent applications to the EPO (thousand) | 0.025 | 21.03 | 0.106 | 0.97 | 2.233 | 2.350 | 21.98 | 4.688 |
| Total general government expenditures on education (% of GDP) | 3.900 | 7.000 | 4.850 | 5.15 | 5.925 | 5.275 | 0.733 | 0.856 |
| GDP per capita (thousand EUR) | 11.20 | 90.60 | 15.43 | 25.3 | 39.9 | 29.90 | 368.9 | 19.21 |
| House price index (%) | 99.98 | 100.0 | 99.99 | 100 | 100.0 | 99.99 | 0.000 | 0.006 |
| Corruption perception index | 44.00 | 91.00 | 57.50 | 67.0 | 81.75 | 69.30 | 220.0 | 14.83 |
| Average wage per hour (EUR) | 6.800 | 41.20 | 9.950 | 24 | 33.18 | 22.72 | 159.7 | 12.64 |
| People at risk of poverty or social exclusion (%) | 14.00 | 30.90 | 18.38 | 20.6 | 27.00 | 22.12 | 25.96 | 5.095 |
| Adjusted gross disposable income of households per capita (thousand EUR) | 13.06 | 33.08 | 16.55 | 20.4 | 24.80 | 20.88 | 30.44 | 5.517 |
| Final consumption expenditure (% of GDP) | 46.65 | 84.7 | 71.74 | 73.5 | 78.63 | 73.69 | 64.15 | 8.009 |
| General government gross debt (% of GDP) | 9.900 | 131.6 | 41.95 | 64.1 | 85.58 | 66.81 | 1102 | 33.2 |
| Manufacturing gross value added (% of GDP) | 4.855 | 24.13 | 12.35 | 14.1 | 18.17 | 14.94 | 21.81 | 4.670 |
| Population with tertiary education, 25–34 years old (% in same age group) | 25.15 | 54.77 | 32.89 | 40.6 | 45.42 | 40.52 | 62.40 | 7.899 |

**Table A5.** Descriptive statistics of 2016 data.

| Statistic | Minimum | Maximum | 1st Quartile | Median | 3rd Quartile | Mean | Variance (n-1) | Standard deviation (n-1) |
|---|---|---|---|---|---|---|---|---|
| Unemployment rate (% of active population) | 4.00 | 19.60 | 6.00 | 6.85 | 9.00 | 7.84 | 12.31 | 4.00 |
| Intramural R&D expenditure (GERD) by sectors of performance and fields of science (EUR per inhabitant) | 56.1 | 1537 | 188.9 | 387.7 | 1090.4 | 623.8 | 265651 | 515.4 |
| Patent applications to the EPO (thousand) | 0.02 | 20.14 | 0.10 | 0.97 | 2.24 | 2.29 | 20.17 | 0.02 |
| Total general government expenditures on education (% of GDP) | 3.80 | 6.80 | 4.58 | 4.95 | 5.58 | 5.11 | 0.80 | 3.80 |
| GDP per capita (thousand EUR) | 11.10 | 91.30 | 16.13 | 26.0 | 39.68 | 30.42 | 371.1 | 11.10 |
| House price index (%) | 99.18 | 120.1 | 110.4 | 112 | 115 | 111.8 | 29.32 | 99.18 |
| Corruption perception index | 47.00 | 90.00 | 57.75 | 66.0 | 81.00 | 68.75 | 205.4 | 47.00 |
| Average wage per hour (EUR) | 7.30 | 41.60 | 10.33 | 24 | 33.40 | 22.91 | 158.8 | 7.30 |
| People at risk of poverty or social exclusion (%) | 13.30 | 30.10 | 18.08 | 20.3 | 25.40 | 21.64 | 24.61 | 13.30 |
| Adjusted gross disposable income of households per capita (thousand EUR) | 13.49 | 31.67 | 16.79 | 20.4 | 24.29 | 20.77 | 26.78 | 13.49 |
| Final consumption expenditure (% of GDP) | 46.95 | 84.65 | 71.71 | 73.7 | 79.24 | 73.80 | 63.82 | 46.95 |
| General government gross debt (% of GDP) | 9.20 | 131.4 | 40.20 | 62 | 84.23 | 65.86 | 1115 | 9.20 |
| Manufacturing gross value added (% of GDP) | 5.06 | 24.35 | 12.60 | 14.0 | 18.52 | 14.98 | 21.55 | 5.06 |
| Population with tertiary education, 25–34 years old (% in same age group) | 25.58 | 54.93 | 34.57 | 42.5 | 46.22 | 41.46 | 63.77 | 25.58 |

**Table A6.** Descriptive statistics of 2017 data.

| Statistic | Minimum | Maximum | 1st Quartile | Median | 3rd Quartile | Mean | Variance (n-1) | Standard deviation (n-1) |
|---|---|---|---|---|---|---|---|---|
| Unemployment rate (% of active population) | 2.90 | 17.20 | 4.90 | 6.20 | 8.23 | 6.90 | 10.01 | 2.90 |
| Intramural R&D expenditure (GERD) by sectors of performance and fields of science (EUR per inhabitant) | 70.7 | 1615 | 216.17 | 390.6 | 1142.9 | 651.21 | 277558 | 526.84 |
| Patent applications to the EPO (thousand) | 0.02 | 18.88 | 0.10 | 0.99 | 2.23 | 2.23 | 17.80 | 0.02 |
| Total general government expenditures on education (% of GDP) | 3.80 | 6.80 | 4.60 | 4.95 | 5.73 | 5.09 | 0.74 | 3.80 |
| GDP per capita (thousand EUR) | 12.20 | 92.60 | 17.40 | 26.8 | 40.98 | 31.44 | 371.7 | 12.20 |
| House price index (%) | 99.18 | 120.1 | 110.4 | 112 | 115 | 111.8 | 29.32 | 99.18 |
| Corruption perception index | 45.00 | 88.00 | 57.75 | 67.0 | 82.00 | 68.25 | 186.6 | 45.00 |
| Average wage per hour (EUR) | 8.00 | 42.50 | 11.25 | 23.5 | 34.28 | 23.43 | 156 | 8.00 |
| People at risk of poverty or social exclusion (%) | 12.20 | 29.60 | 17.18 | 19.9 | 23.95 | 20.96 | 23.81 | 12.20 |

**Table A6.** *Cont.*

| Statistic | Minimum | Maximum | 1st Quartile | Median | 3rd Quartile | Mean | Variance (n-1) | Standard deviation (n-1) |
|---|---|---|---|---|---|---|---|---|
| Adjusted gross disposable income of households per capita (thousand EUR) | 14.04 | 32.68 | 17.29 | 20.6 | 24.58 | 21.15 | 26.67 | 14.04 |
| Final consumption expenditure (% of GDP) | 46.65 | 84.15 | 70.82 | 73.3 | 78.15 | 73.27 | 63.13 | 46.65 |
| General government gross debt (% of GDP) | 8.70 | 131.2 | 39.85 | 59.2 | 80.58 | 63.85 | 1072 | 8.70 |
| Manufacturing gross value added (% of GDP) | 5.15 | 24.28 | 12.50 | 14.2 | 18.16 | 15.04 | 21.41 | 5.15 |
| Population with tertiary education, 25–34 years old (% in same age group) | 26.82 | 55.63 | 34.81 | 42.8 | 46.58 | 41.65 | 59.29 | 26.82 |

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