The Sustainability Pension Sub-Index in the Context of the Indicators Weights

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Abstract

Pension systems are sensitive to economic and demographic challenges. The sustainability sub-index is essential for ensuring the stability and reliability of pension systems for both current and future pensioners. It assists policymakers and stakeholders in identifying areas where reforms may be necessary to enhance the sustainability of pension policies. This contribution focuses on determining the weights for individual indicators of the sustainability sub-index using several methods of weight determination in multi-criteria decision-making, specifically subjective methods. The weights are determined using four methods: Saaty's exact and approximate method, Thurstone's method of pair comparison, and Best-Worst method. It also provides sustainability sub-index values for selected European countries included in Mercer's score determination, as well as for Slovakia, which is not yet included in Mercer's evaluations. Thurstone's method of pair comparison appears to be the method most consistent with Mercer's methodology in determining the weights for indicators of the sustainability sub-index.

Keywords	***DOI***	***JEL code***
Sustainability, indicators, weights, Saaty's method, Best-Worst method, Thurstone's method of pair comparison	*https://doi.org/10.54694/stat.2024.40*	*H55, J26, C18*

INTRODUCTION

The Global Pension Index is an annual report that assesses the retirement income systems of different countries. It was started by the Mercer consulting firm in 2009 and, over time, gained participation from various stakeholders, including governments, financial, and academic institutions, Mercer (2009). In 2023, the Mercer CFA Institute Global Pension Index 2023 compares retirement income systems in 47 countries around the world Mercer (2023). The ranking includes countries with advanced economies and less developed countries. It is difficult to estimate based on which key the countries are selected; there are missing some economically advanced countries such as Luxembourg or politically influential countries,

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as well as Ukraine and Russia, are missing. The index ranks countries according to several factors to provide information on the effectiveness of their pension systems. It considers variables such as retirement income levels, coverage, and the regulatory framework. The aim is to highlight strengths and weaknesses in pension systems around the world. All data used come from the Pensions at a Glance 2021, OECD (2021), life expectancy 2024 and 2053, age dependency 2053, and total fertility rate 2021-2020 data were from the United Nations World Population Prospects 2022, United Nations (2022). Countries with higher scores are considered to have stronger pension systems. The index helps policy-makers and stakeholders identify areas for improvement in pension policies. It serves as a reference for comparing pension systems across countries. The Global Pension Index is widely recognized and used by governments, organizations, and researchers. Its findings contribute to discussions about retirement planning and policy reforms around the world.

The Global Pension Index evaluates three main factors: the adequacy, sustainability, and integrity of pension systems. Sub-index adequacy assesses the retirement income levels and the extent to which pension systems provide sufficient financial support to retirees. However, the sub-index of integrity evaluates the regulatory framework and governance of pension systems, focussing on transparency, accountability, and protection against fraud or mismanagement. Each index value represents a score between 0 and 100. Each question is scored for each system with a minimum score of 0 and a maximum score of 10, Mercer (2023).

The main reason we offer this paper is that the individual indicators in all three sub-indices are assigned weights based on their importance. Although the authors state that the weights of individual indicators were determined subjectively. We believe that a full description of the determination of weights is certainly beyond the scope of their publications. Therefore, from the position of examining the importance of individual indicators, we have decided to offer the determination of weights specifically for the sustainability sub-index. We decided to start with this sub-index because it has nine indicators. Experts in determining scales assume that 9 indicators represent a relatively high number when a person can recognize the importance of the mentioned indicators. Of course, in the future, we will also have to deal with a larger number of them.

The sustainability sub-index focusses on the future and uses various indicators that will affect the likelihood that the current system will be able to provide benefits in the future. The sub-index includes the economic importance of the private pension system, the level of its financing, the length of expected retirement now and in the future, the rate of participation of the elderly population in the labour market, the current level of public pension expenditure and government debt, and the level of real economic growth. The most important indicators that influence this sub-index are the coverage of private pension plans, demographic factors, and the level of pension assets as a share of GDP.

The paper is organized as follows. Section 1 – *Preliminaries* recalls 9 indicators that make up the sub-index of sustainability, Mercer (2023). They are used in the form of questions as presented by Mercer. In addition, they are supplemented with additional information so that their mutual importance and comparability are clearly evident to the reader. Section 2 – *Methods and Methodologies* introduces our own approach to determining the weights of individual indicators using the Saaty's exact and approximate method, the Thurstone's method of pair comparison, and finally the Best-Worst method. Section 3 – *Results* gives sustainability index scores for selected European countries that are included in Mercer's research and also for Slovakia, which is not yet included in the mentioned publication. Section 4 – *Discussion* selects the method for determining the weights of the individual indicators that most closely aligns with Mercer's methodology. Last section – *Conclusion* talks about our next plans and the possibility of a solution procedure in examining and determining the scores of individual indicators using new methods that use fuzzy numbers.

1 PRELIMINARIES

The sustainability sub-index assesses the long-term viability of pension systems. It takes into account factors such as demographic trends, financial stability, and the ability to meet future pension obligations. Sustainability evaluates whether pension systems can adapt to changes in the demographic composition of the population, such as ageing populations and declining birth rates. It also examines the balance between contributions and expenditures to ensure the sustainable operation of pension systems.

1.1 Indicators of the sustainability pension sub-index

In Mercer's original text Mercer (2023), individual indicators are written in the form of questions. We quote them as follows.

Question S1: What proportion of the working age population are members of retirement savings plans? Question S1 assesses the proportion of the working population that is a member of a retirement savings plan. This measures the degree of participation of the working population in retirement savings schemes, which may indicate the level of preparedness of the population for future pension needs.

Question S2: What is the level of pension assets, expressed as a percentage of GDP, held in private pension arrangements, public pension reserve funds, protected book reserves, and pension insurance contracts? Question S2 assesses the level of pension assets, expressed as a percentage of GDP, that are held in private pension schemes, public reserve funds, protected book reserves, and pension insurance contracts. In this way, the total value of pension assets is measured compared to the economic performance of the country. A higher proportion may indicate a stronger and more stable pension system with sufficient funds for future pensions.

Question S3:
a. What is the life expectancy at the current state pension age?
b. What is the projected life expectancy at the expected state pension age in 2053 (that is, in 30 years' time)? This calculation allows for an improvement in mortality.
c. What is the projected old-age dependency ratio in 2053?
d. What is the estimated total fertility rate (TFR) for 2021–2025?

To a. The first question aims to determine how long people live on average when they start receiving state pension benefits. This helps to understand the duration for which pensions might need to be paid out.

To b. By projecting life expectancy in 2053, the question seeks to estimate how long people will live in the future, allowing policymakers to anticipate the financial needs and sustainability of pension systems.

To c. The projected old-age dependency ratio in 2053 is intended to assess the balance between the working-age population and retirees, helping to gauge the strain on pension systems and the economy.

To d. The question about TFR for 2021–2025 aims to understand the current trend in childbirth rates, which influences the future size of the workforce and, consequently, the financial stability of pension systems. The previous four sub-questions were grouped into one question to comprehensively assess various aspects of the pension system's sustainability and demographics. By covering life expectancy, dependency ratio, and fertility rate in a single question, policy-makers can understand the interconnected factors influencing the future of pension systems. This consolidated approach provides a holistic view of the challenges and opportunities facing pension schemes, allowing for more informed decision-making.

Question S4: What is the level of mandatory contributions that are set aside for future retirement benefits (that is, funded), expressed as a percentage of the annual wage for a full-time median income earner?

This may include mandatory employer and/or employee contributions paid into funded public benefits (that is, social security) and/or retirement benefits from the private sector. Question S4 assesses the level of mandatory contributions for future pensions (i.e., funded), expressed as a percentage of the annual salary for a full-time worker with a middle income. This may include mandatory employer and/or employee contributions paid into funded public pension benefits (i.e., social security) and/or private sector pension benefits.

Question S5: What is the labour force participation rate for people 55 to 64 years of age? What is the labour force participation rate for people 65 years or older?

Question S5 determines the labour force participation rate for a person aged 55 to 64 years and also for people 65 years and older. This assesses the proportion of people in specific age groups that are still active on the labour market. Higher labour force participation rates may indicate higher work participation of older individuals, which may have an impact on a country's economy and social stability. This assessment helps gauge the extent to which older people contribute to the economy. Higher participation rates among older age groups may suggest increased economic productivity and social stability, highlighting the potential impact on a country's labour market dynamics and overall well-being. The older generation (65+) can contribute to improving the economy by continuing to work, volunteering, mentoring, investing wisely, and participating in community activities. Here, two scenarios can occur. If the older generation continues to work, this can potentially increase the rate of participation in the labour force, leading to higher economic productivity and GDP growth. It can also ease pressure on pension schemes by delaying the payment of pension benefits. However, it can also limit employment opportunities for younger generations, which can lead to intergenerational competition in the labour market. However, if the older generation cares for their grandchildren, this can allow parents to work or take advantage of educational opportunities, potentially increasing labour force participation and economic performance. It can also strengthen family bonds and reduce parental childcare costs. However, it may limit the direct economic contribution of the older generation and potentially increase the financial burden on the pension and healthcare systems if they retire earlier. Ultimately, the optimal scenario depends on balancing the economic benefits of increased participation in the labour force with the social benefits of intergenerational support and family bonds.

Question S6: What is the level of adjusted government debt (being the gross public debt reduced by the size of any sovereign wealth funds that are not set aside for future pension liabilities), expressed as a percentage of GDP? What is the level of public expenditure on pensions expressed as a percentage of GDP, averaged over the latest available figure and the projected figure for 2050?

Question S7: In respect of private pension arrangements, are older employees able to access part of their retirement savings or pension and continue working (for example, part time)? If so, can employees continue to contribute and accrue benefits at an appropriate rate?

Question S8: What is the real economic growth rate averaged over seven years (namely, the last four years and projected for the next three years)?

Question S9: Is it a requirement for the pension plan's trustees/fiduciaries to consider environmental, social and governance (ESG) issues in developing their investment policies or strategies? If not a requirement, is it encouraged by the relevant pension regulator?

2 METHODS AND METHODOLOGIES

Although the company Mercer mentions the weights of individual indicators in its annual reports, it does not mention where or by what methods these weights were determined.

We have decided to look at the importance of individual indicators from the perspective of several methods for determining weights in multi-criteria decision-making, which belong to the group of so-called subjective methods. In our research, we used the Saaty's exact and approximate method, or the Thurstone's method of pair comparison, and the so-called Best-Worst method. Saaty emphasizes that the human mind is capable of meaningfully comparing approximately 7 ± 2 indicators, Saaty (1977). That is why we also chose the sustainability sub-index, which includes 9 indicators.

Table 1 Share of positive answers to job search questions and item-response probabilities

Scale	Numerical evaluation alternative *i* from *j*	Reciprocal alternative *i* from *j*
Extremely preferred	9	1/9
Between very strong and extremely	8	1/8
Very strongly preferred	7	1/7
Between strong and very strong	6	1/6
Very strongly preferred	5	1/5
Between moderate and strong	4	1/4
Moderately preferred	3	1/3
Between equal and moderate	2	1/2
Equal importance	1	1

Source: Authors' work based on Saaty (2005)

The first step is to create a square table that has as many rows and columns as we have indicators. We write the values from 1 to 9 in the table so that we express the relative importance of the row indicator compared to the column one. To make the data consistent, it is obvious that we express the relative "unimportance" as the inverse value. To verify the validity of Table 1, it is necessary to calculate the so-called consistency index first using the formula:

$$CI = \frac{\lambda_{max} - n}{n - 1}, \tag{1}$$

where: λ_{max} is the largest positive eigenvalue of the matrix, n is the number of the indicators.

We can calculate the Consistency ratio CR as follows:

$$CR = \frac{CI}{RI}, \tag{2}$$

where: RI is the random index, which can be found e.g. in Mu et al. (2017).

For the table to be valid, with respect to Mu et al. (2017) the value CR must not exceed 0.10. The individual weights in Table 2 can be calculated using the solver function in MS Office Excel, where the Saaty optimization criterion (3) is minimized:

$$\min \sum_{i=1}^{n}\sum_{j=1}^{n}\left(s_{i,j}-\frac{v_i}{v_j}\right)^2, \tag{3}$$

with conditions:

$$v_1, v_2, \ldots, v_n > 0 \wedge \sum_{i=1}^{n} v_i = 1, \tag{4}$$

where $s_{i,j}$ are individual matrix elements.

In this part, we introduce specific data on the basis of which we determined the weights of individual indicators. Since none of the methods for determining the weights is a priori superior and none can be preferred, it will finally use the weights of the indicators as the average value of the weights determined by the selected methods.

2.1 Exact Saaty's method

To determine the relative importance of each indicator with maximum precision, we began by ranking them based on our subjective yet professional and thorough research. We consider indicator S1 to be the most important, as it reflects the level of participation of the working population in private pension schemes. In our view, private savings will play a critical role in providing greater financial security during retirement. This is closely linked to indicator S2, which represents a form of national wealth. In third place, we ranked indicator S8, which reflects economic growth over a given period and forecasts future growth. Next in importance is indicator S6, which pertains to government debt and public expenditures, as well as their projected future trends. Following this, we placed indicator S4 in fifth position, as it highlights the amount of mandatory contributions set aside for retirement. While life expectancy S3 is undoubtedly significant in determining pension payments, we anticipate that its rate of increase will not be as extreme moving forward. Hence, we placed S3 in sixth place. In our opinion, it is closely related to indicator S5, which measures the labour force participation of older individuals. Finally, we ranked indicator S9 last, as we believe that while ESG issues may currently be a popular topic of discussion, they do not yet have a tangible impact on the sustainability of pension systems.

The importance of each indicator is ranked as shown in Table 2. To determine the weights with the greatest accuracy, we utilized the full range of values from 1 to 9. Since the indicators are listed from most to least important, we can easily apply Saaty's relative importance scale, as presented in Table 1.

In our case, Saaty's optimization function (3) acquires the value 37.3645. The maximum positive eigenvalue of the matrix is λmax = 9.4015042, Brunner (2008), and the consistency index according to (1) is CI = 0.050188, and the consistency ratio (2) with the random index 1.45 is on the level of CR = 0.0346. This means that we can consider our data to be consistent and the respective weights to be relevant.

Table 2 Exact Saaty's method

i, j	S_1	S_2	S_8	S_6	S_4	S_3	S_5	S_7	S_9	v_i
S_1	1	2	3	4	5	6	7	8	9	0.25
S_2	$\frac{1}{2}$	1	2	3	4	5	6	7	8	0.22
S_8	$\frac{1}{3}$	$\frac{1}{2}$	1	2	3	4	5	6	7	0.18
S_6	$\frac{1}{4}$	$\frac{1}{3}$	$\frac{1}{2}$	1	2	3	4	5	6	0.13
S_4	$\frac{1}{5}$	$\frac{1}{4}$	$\frac{1}{3}$	$\frac{1}{2}$	1	2	3	4	5	0.08
S_3	$\frac{1}{6}$	$\frac{1}{5}$	$\frac{1}{4}$	$\frac{1}{3}$	$\frac{1}{2}$	1	2	3	4	0.05
S_5	$\frac{1}{7}$	$\frac{1}{6}$	$\frac{1}{5}$	$\frac{1}{4}$	$\frac{1}{3}$	$\frac{1}{2}$	1	2	3	0.04
S_7	$\frac{1}{8}$	$\frac{1}{7}$	$\frac{1}{6}$	$\frac{1}{5}$	$\frac{1}{4}$	$\frac{1}{3}$	$\frac{1}{2}$	1	2	0.03
S_9	$\frac{1}{9}$	$\frac{1}{8}$	$\frac{1}{7}$	$\frac{1}{6}$	$\frac{1}{5}$	$\frac{1}{4}$	$\frac{1}{3}$	$\frac{1}{2}$	1	0.02
v_i	0.25	0.22	0.18	0.13	0.08	0.05	0.04	0.03	0.02	1.00

Source: Authors' work

2.2 Approximate Saaty's method

If we do not have the solver function available, we can also use the proximate Saaty's method. An approximate determination of the weights was derived from the logarithmic least-squares method, and the resulting values are not very different from the weights obtained from more precise procedures Boďa et al. (2021). In the approximate Saaty's procedure, the average multiple importance is determined for each criterion using the geometric mean.

Table 3 Approximate Saaty's method

i, j	S_1	S_2	S_8	S_6	S_4	S_3	S_5	S_7	S_9	p_i	v_i
S_1	1	2	3	4	5	6	7	8	9	4.1472	0.31
S_2	$\frac{1}{2}$	1	2	3	4	5	6	7	8	3.0008	0.22
S_8	$\frac{1}{3}$	$\frac{1}{2}$	1	2	3	4	5	6	7	2.1131	0.16
S_6	$\frac{1}{4}$	$\frac{1}{3}$	$\frac{1}{2}$	1	2	3	4	5	6	1.4592	0.11
S_4	$\frac{1}{5}$	$\frac{1}{4}$	$\frac{1}{3}$	$\frac{1}{2}$	1	2	3	4	5	1.0000	0.07
S_3	$\frac{1}{6}$	$\frac{1}{5}$	$\frac{1}{4}$	$\frac{1}{3}$	$\frac{1}{2}$	1	2	3	4	0.6853	0.05
S_5	$\frac{1}{7}$	$\frac{1}{6}$	$\frac{1}{5}$	$\frac{1}{4}$	$\frac{1}{3}$	$\frac{1}{2}$	1	2	3	0.4732	0.04
S_7	$\frac{1}{8}$	$\frac{1}{7}$	$\frac{1}{6}$	$\frac{1}{5}$	$\frac{1}{4}$	$\frac{1}{3}$	$\frac{1}{2}$	1	2	0.3324	0.02
S_9	$\frac{1}{9}$	$\frac{1}{8}$	$\frac{1}{7}$	$\frac{1}{6}$	$\frac{1}{5}$	$\frac{1}{4}$	$\frac{1}{3}$	$\frac{1}{2}$	1	0.2411	0.02
Sum										13.4596	1.00

Source: Authors' work

Values of p_i are determined by formula:

$$p_i = \sqrt[n]{\prod_{j=1}^{n} s_{i,j}}\ . \tag{5}$$

From the pi values, the normalized weights are usually determined by the formula:

$$v_i = \frac{p_i}{\sum_{i=1}^{n} p_i}\ . \tag{6}$$

2.3 Thurstone's method of pair comparison

The Thurstone's method of pair comparison or pairwise comparison method was first introduced by Thurstone (1927). In the method, it is assumed that it is possible to evaluate the mutual significance of indicators in pairs. The decision-maker always compares pairs of indicators and decides which is more significant. He then writes his choice of couple preferences into the table using the following three options:

1. assigns the value $s_{i,j} = 1$ if the *i*-th is more significant, i.e., the line indicator.
2. assigns the value $s_{i,j} = 0$ if the *j*-th is more significant, that is, the column indicator.
3. assigns the value $s_{i,j} = 0.5$ if the indicator of rows and columns is equally significant Boďa et al. (2021).

Table 4 Thurstone's method of pair comparison

i, j	S_1	S_2	S_8	S_6	S_4	S_3	S_5	S_7	S_9	w_i	w_i^*	v_i
S_1		1	1	1	1	1	1	1	1	8	9	0.20
S_2	0		1	1	1	1	1	1	1	7	8	0.18
S_8	0	0		1	1	1	1	1	1	6	7	0.16
S_6	0	0	0		1	1	1	1	1	5	6	0.13
S_4	0	0	0	0		1	1	1	1	4	5	0.11
S_3	0	0	0	0	0		1	1	1	3	4	0.09
S_5	0	0	0	0	0	0		1	1	2	3	0.07
S_7	0	0	0	0	0	0	0		1	1	2	0.04
S_9	0	0	0	0	0	0	0	0		0	1	0.02
Sum											45.00	1.00

Source: Authors' work

After obtaining the comparison matrix, the number of pairs preferences assigned is added by individual lines, and thus the number of preferences $w_i = \sum_i s_{i,j}$ is obtained for the indicator *i-th*. Subsequently, we will determine the weight of the *i*-th indicator using the formula:

$$v_i = \frac{w_i}{\sum_{i=1}^{n} w_i}. \tag{7}$$

If some value of w_i is equal to 0, as in our case, we can add, e.g. to each value of w_i value 1. Then we can calculate the nonzero normalized weights of individual indicators replacing w_i by w_i^*

2.4 Best-Worst method

The Best-Worst method is, similarly to the previous methods, based on the gradual comparison of pairs of indicators. It was developed by Rezaei (2016a) and is believed to be capable of providing reliable scales in less time. In addition, it turns out that within a few years this method has be- come, thanks to its properties, very popular in multi-criteria decision-making, Brunelli et al. (2019), Mi et al. (2019).

The method is implemented in several steps:

1. Determine a set of decision criteria. In our case we have 9 indicators of the sustainability sub-index.
2. Determine the best and worst criteria. If more than one criterion is considered to be the best or the worst, one can be arbitrarily chosen, Rezaei (2015). Among 9 indicators, the most significant – Best and the least significant – Worst are identified. The best is $S_{1,}$ and the worst is S_9.
3. The preference for the best indicator will be gradually expressed in comparison with other indicators using the cardinal scale, which was also used in the previous methods. Again, a value of 1 represents agreement in importance. In this way, we get the vector $A_B = (s_{B1}, \ldots s_{Bn})$ of the most significant indicator to the others. In our case, the vector $A_B = (1, 2, 3, 4, 5, 6, 7, 8, 9)$, see Table 5.
4. The preference of the worst indicator will gradually be expressed in comparison with other indicators. This is how we get the vector $A_W = (s_{1W}, \ldots s_{nW})$ of the least significant indicator for the others. This vector is $A_W = (9, 8, 7, 6, 5, 4, 3, 2, 1)$, and you can see it written in Table 5.

Table 5 Best-Worst method

Names of criteria	**S_1**	**S_2**	**S_8**	**S_6**	**S_4**	**S_3**	**S_5**	**S_7**	**S_9**
Select the best	S_1								
Select the worst	S_9								
Best to others A_B	1	2	3	4	5	6	7	8	9
Others to the worst	A_W								
S_1	9								
S_2	8								
S_8	7								
S_6	6								
S_4	5								
S_3	4								
S_5	3								
S_7	2								
S_9	1								
Optimal weights v_i^*	0.31	0.19	0.06	0.08	0.05	0.10	0.05	0.13	0.03

Source: Authors' work

5. Find the optimal weights $\left(v_1^*, v_2^*, \ldots, v_n^*\right)$.

The optimal weights are determined using an optimization mini-max model:

$$\min\max\left\{\left|\frac{v_B}{v_i}-s_{Bi}\right|,\left|\frac{v_i}{v_W}-s_{iW}\right|\right\}, \tag{8}$$

with conditions $\sum_{i=1}^{n} v_i = 1$ and $v_1, v_2, \ldots, v_n > 0.$.

This model is converted to the following model:

$$\min \xi, \tag{9}$$

under conditions:

$$\left|\frac{v_B}{v_i}-s_{Bi}\right| \le \xi, \tag{10}$$

$$\left|\frac{v_i}{v_W}-s_{iW}\right| \le \xi, \tag{11}$$

and $\sum_{i=1}^{n} v_i = 1$ and $v_1, v_2, \ldots, v_n > 0$. Solving this model, the optimal weights $\left(v_1^*, v_2^*, \ldots, v_n^*\right)$ are obtained.

6. The last step is to calculate the level of consistency using a robust index called consistency ratio *CR* which is given by:

$$CR = \frac{\xi^*}{CI}, \tag{12}$$

where: *CI* is consistency index which is for $n = 9$ indicators on the level of 5.23, Rezaei (2015).

Using solver Rezaei (2016b) we obtained optimal value $\xi^* = 0.06839945$, hence $CR = 0.0131$. The consistency ratio is a number from the interval [0, 1], and the smaller it is, the more reliable the results.

Let us compare the consistency ratio determined using the Saaty's method and the Best-Worst method. Based on Saaty's method, $CR = 0.0346$, and using the Best-Worst method, this value is $CR = 0.0131$. Also, based on our calculations, the statement Rezaei (2015) that the Best-Worst method leads to a more consistent comparison that gives more reliable results is confirmed.

Based on our personal experience, we characterize individual methods as indicated in Table 6.

Table 6 Features, advantages and disadvantages of selected methods

	Exact Saaty's method	Approximate Saaty's method	Thurstone's method of pair comparison	Best-Worst method
Complexity	✓	✓	✓	✓
Time consumption	–	✓	✓	–
Subjectivity	✓	✓	✓	✓
Interpretation problems	–	–	–	–
Coherence	–	–	✓	✓

Source: Authors' work

3 RESULTS

We would like to emphasize that the weights of individual indicators were determined based on our professional expertise in the area of pension system sustainability. Additionally, since Slovakia was not included in the list of countries for which Mercer calculates the total pension index, we independently determined Slovakia's individual score. We utilized the available sources and methodologies from Mercer (2023) in our calculations. The remaining scores were sourced directly from Mercer (2023). Our objective was to derive the weights of sustainability indicators using selected methodologies and to compare them with the Mercer approach. We can confirm that our assessment of the importance of sustainability indicators closely aligns with Mercer's findings.

Table 7 presents the European countries for which Mercer annually publishes a sustainability sub-index, now supplemented by Slovakia's sub-index, which has not yet been included among the monitored countries. The countries are ranked in descending order according to their sustainability sub-index values. For better clarity, Figure 1 provides a graphical representation of the individual sub-index values.

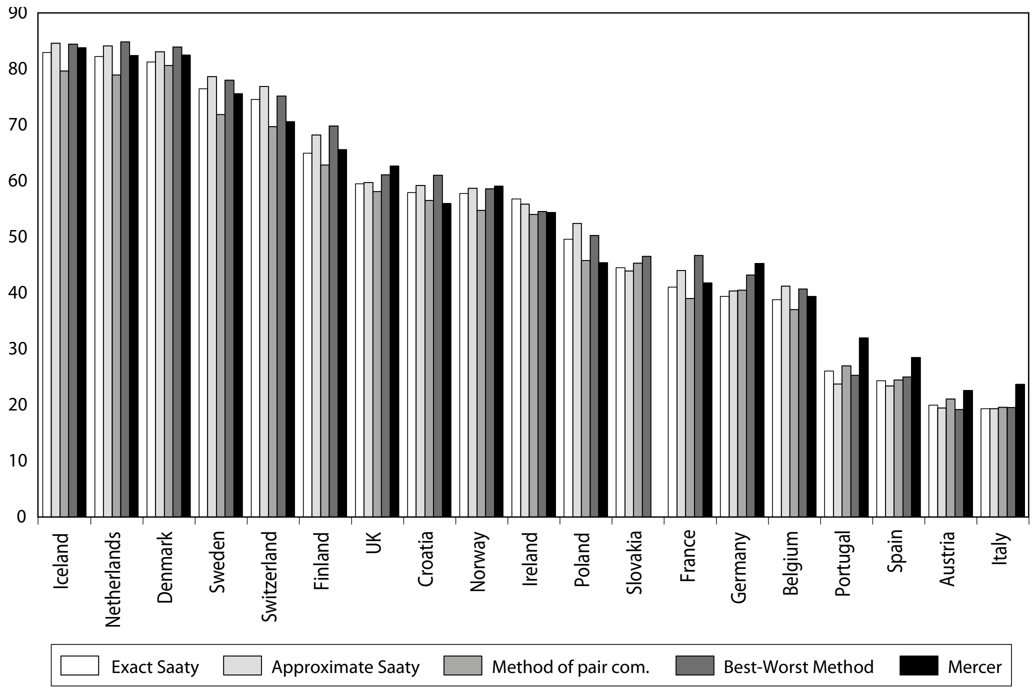
According to our assessment, Slovakia ranks 11th out of the 19 monitored countries. Notably, some developed Western European countries, such as France, Germany, and Belgium, ranked behind Slovakia. Among the V4 countries, Poland's placement in 10th position was also a surprising result.

Table 7 The sustainability pension sub-index of the selected methods, maximal score 100

Country	w.r.to Exact Saaty's method	w.r.to Approximate Saaty's method	w.r.to Thurstone`s method of pair comparison	w.r.to Best-Worst method	w.r.to Mercer (2023) weights	Average
Iceland	82.97	84.63	79.67	84.46	83.80	82.93
Netherlands	82.25	84.13	78.95	84.85	82.40	82.55
Denmark	81.26	83.1	80.62	83.94	82.50	82.23
Sweden	76.49	78.66	71.86	77.99	75.60	76.25
Switzerland	74.59	76.90	69.72	75.16	70.60	74.09
Finland	64.98	68.23	62.87	69.82	65.60	66.48
UK	59.51	59.74	58.10	61.14	62.70	59.62
Croatia	57.96	59.20	56.53	61.04	56.00	58.68
Norway	57.78	58.69	54.78	58.62	59.10	57.47
Ireland	56.82	55.86	54.03	54.58	54.40	55.32
Poland	49.62	52.46	45.79	50.30	45.40	49.54
Slovakia	44.52	43.93	45.32	46.55	–	45.08
France	41.07	44.03	39.04	46.73	41.80	42.72
Germany	39.40	40.36	40.51	43.22	45.30	40.87
Belgium	38.83	41.21	37.03	40.73	39.40	39.45
Portugal	26.07	23.73	26.99	25.32	32.00	25.53
Spain	24.32	23.42	24.46	25.00	28.50	24.30
Austria	19.96	19.48	21.07	19.21	22.60	19.93
Italy	19.33	19.34	19.61	19.54	23.70	19.46

Source: Authors' work using basic score data from Mercer (2023)

Figure 1 The sustainability pension sub-index in selected European countries



Source: Authors' work

4 DISCUSSION

Using the four selected methods, we obtained sustainability sub-index values that were very similar to those determined by Mercer, as shown in Table 7. Our next step is to select the method for determining the weights of the individual indicators that most closely aligns with Mercer's methodology. To do this, we will apply two criteria: the relative or absolute differences and the ranking of the sustainability sub-index values determined by the selected methods compared to those determined by Mercer.

For the first criterion, we calculated the absolute differences between the sustainability sub-index values using the data in Table 7. As illustrated in Table 8, based on the sum of both absolute and relative differences, the Exact Saaty's method produced the smallest sum of differences. According to this criterion of relative differences, the Exact Saaty's method aligns most closely with Mercer's methodology, followed by Thurstone's pairwise comparison method, the Best-Worst method, and the Approximate Saaty's method.

Applying the second criterion, we first established the rankings of the countries across all methods, as presented in Table 9. Table 10 then shows the differences in rankings compared to those determined by Mercer. This table also highlights the number of countries whose rankings differ in each method, revealing that Thurstone's pairwise comparison method has the fewest discrepancies. Based on this criterion of ranking differences, Thurstone's method of pairwise comparison aligns most closely with Mercer's methodology, followed by the Best-Worst method, the Exact Saaty's method, and the Approximate Saaty's method.

Using Thurstone's method, only a third of the 18 monitored countries experienced changes in their rankings – 3 countries improved their positions (Denmark, Croatia, Austria), while 3 others (Iceland, Norway, Italy) saw their rankings decline.

Table 8 Difference between the sustainability pension sub-index (method – Mercer)

Country	Exact Saaty's method – Mercer	Approximate Saaty's method – Mercer	Thurstone`s method – Mercer	Best-Worst method – Mercer	Average – Mercer
Iceland	0.83	0.83	4.13	0.66	0.87
Denmark	1.24	0.60	1.88	1.44	0.27
Netherlands	0.15	1.73	3.45	2.45	0.15
Sweden	0.89	3.06	3.74	2.39	0.65
Switzerland	3.99	6.30	0.88	4.56	3.49
Finland	0.62	2.63	2.73	4.22	0.88
UK	3.19	2.96	4.60	1.56	3.08
Norway	1.32	0.41	4.32	0.48	1.63
Croatia	1.96	3.20	0.53	5.04	2.68
Ireland	2.42	1.46	0.37	0.18	0.92
Poland	4.22	7.06	0.39	4.90	4.14
Germany	5.90	4.94	4.79	2.08	4.43
France	0.73	2.23	2.76	4.93	0.92
Belgium	0.57	1.81	2.37	1.33	0.05
Portugal	5.93	8.27	5.01	6.68	6.47
Spain	4.18	5.08	4.04	3.50	4.20
Italy	4.37	4.36	4.09	4.16	4.24
Austria	2.64	3.12	1.53	3.39	2.67
Sum of absolute differences	45.15	60.05	51.61	53.95	41.74
Sum of relative differences	0.74	0.98	0.84	0.88	0.68

Source: Authors' work using basic score data from Mercer (2023)

Table 9 Ranking of countries according to the sustainability pension sub-index values

Country	Exact Saaty's method	Approximate Saaty's method	Thurstone`s method	Best-Worst method	Mercer	Average
Iceland	1	1	2	2	1	1
Denmark	3	3	1	3	2	3
Netherlands	2	2	3	1	3	2
Sweden	4	4	4	4	4	4
Switzerland	5	5	5	5	5	5
Finland	6	6	6	6	6	6
UK	7	7	7	7	7	7
Norway	9	9	9	9	8	9
Croatia	8	8	8	8	9	8
Ireland	10	10	10	10	10	10
Poland	11	11	11	11	11	11
Germany	13	14	12	13	12	13
France	12	12	13	12	13	12
Belgium	14	13	14	14	14	14
Portugal	15	15	15	15	15	15
Spain	16	16	16	16	16	16
Italy	18	18	18	17	17	18
Austria	17	17	17	18	18	17

Source: Authors' work

Under the criterion of ranking changes, approximately half of the countries saw an improvement in their rankings. For all methods, each country's ranking shifted by only one position relative to Mercer's ranking, with two exceptions: the Netherlands improved by two places in the Best-Worst method, and Germany's ranking deteriorated by two places in the Approximate Saaty's method.

Table 10 Difference between places in the ranking (Method – Mercer)

Country	Exact Saaty's method – Mercer	Approximate Saaty's method – Mercer	Thurstone`s method – Mercer	Best-Worst method – Mercer	Average – Mercer
Iceland	0	0	1	1	0
Denmark	1	1	1	1	1
Netherlands	1	1	0	2	1
Sweden	0	0	0	0	0
Switzerland	0	0	0	0	0
Finland	0	0	0	0	0
UK	0	0	0	0	0
Norway	1	1	1	1	1
Croatia	1	1	1	1	1
Ireland	0	0	0	0	0
Poland	0	0	0	0	0
Germany	1	2	0	1	1
France	1	1	0	1	1
Belgium	0	1	0	0	0
Portugal	0	0	0	0	0
Spain	0	0	0	0	0
Italy	1	1	1	0	1
Austria	1	1	1	0	1
Number of countries with different positions	8	9	6	7	8

Source: Authors' work

Table 11 summarizes the evaluation of the most suitable method when both criteria are applied simultaneously. In the table, the following designations are used for the individual methods: a rating of 1 indicates the most similar method, while a rating of 4 signifies the least similar.

The method that aligns most closely with Mercer's methodology is Thurstone's pairwise comparison method, followed by the Exact Saaty's method, the Best-Worst method, and lastly, the Approximate Saaty's method. According to both Thurstone's and the Exact Saaty's methods, Slovakia ranks 12th among the selected European countries, while the Best-Worst and Approximate Saaty's methods place Slovakia in 13th position.

Table 11 Summary of method evaluation

Criterion	Exact Saaty's method	Approximate Saaty's method	Thurstone`s method	Best-Worst method
Number of countries with different positions in the compared rankings	3	4	1	2
Sum of relative differences	1	4	2	3
Sum	4	8	3	5
Ranking	2	4	1	3

Source: Authors' work

CONCLUSION

In our contribution, we provided both psychological and economic perspectives on the sustainability of pension systems. Our work was motivated by Mercer, which does not include our home country, Slovakia, among the evaluated countries. Consequently, we decided to establish the sustainability sub-index value for Slovakia as well. Additionally, we presented our calculations for the weights of individual sustainability indicators using four different methods.

It is important to note that we should not view these individual weights as precisely determined figures; rather, they invite discussion and potential adjustments. We can confirm that our weight determinations are relatively consistent with those established by Mercer.

To select the method that aligns most closely with Mercer's methodology, we applied two criteria: the comparison of relative or absolute differences and the ranking of sustainability sub-index values derived from our chosen methods against those determined by Mercer. When using both criteria simultaneously, the method most similar to Mercer's approach is Thurstone's pairwise comparison, followed by the Exact Saaty's method, the Best-Worst method, and lastly, the Approximate Saaty's method.

According to both Thurstone's method and the Exact Saaty's method, Slovakia ranks 12th among the 19 selected European countries. In contrast, the Best-Worst and Approximate Saaty's methods place Slovakia in 13th position.

Looking ahead, we plan to establish weights not only for the sustainability sub-index but also for the remaining two sub-indices – Adequacy and Integrity. Our next challenge will be to determine these weights using new procedures, specifically the Fuzzy Best-Worst Multi-Criteria Decision-Making Method as described by Guo et al. (2021), and Dong (2021), along with the insights from Rezaei (2020). Our overarching ambition is to collaborate with Mercer.

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