EXAMINING SIMILARITIES IN TIME ALLOCATION AMONGST EUROPEAN COUNTRIES

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ABSTRACT

The aim of the article is to analyse the similarities between the selected European countries in terms of time allocation. Time allocation has been defined as the daily distribution of time to various activities. Professional work time, domestic work time and leisure time are the most important for the economic approach. It has been proved that there are coherent groups of countries with similar structure of time allocation. The taxonomic methods used in order to verify the thesis included: cluster analysis, k-means method, generalised distance measure GDM and interval taxonomic method TMI. The analysis was performed on the basis of HETUS data.

Key words: time allocation, cluster analysis, k-means method, generalised distance measure GDM, interval taxonomic method TMI, HETUS survey.

1. Introduction

The previous study of the authors was dedicated to the classification of the Baltic Sea Region countries by the time spent on particular household production activities. It was shown that there was a similarity in the quantity and quality of time used on household work in the Scandinavian countries and Germany, and in the Baltic republics and Poland (Hozer-Koćmiel, Lis 2015). This article extends the research area from a single activity to all activities of the time budget, extends the research group including other European countries and uses not one but several taxonomic methods.

The issue of time allocation is not very popular, but there are economic theories that take it into account. The most important of these is the Becker's Theory of the Allocation of Time (1965), which introduced the concept of the total income significantly exceeding the monetary income. The difference is

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constituted by the foregone earnings directly related to the use of the time factor. Becker recommends the economists to devote more attention to time allocation and its efficiency.

The Commission on the Measurement of Economic Performance and Social Progress by A. Sen, J. Stiglitz and J.P. Fitoussi (2010) is another, broader approach to production, which takes into account non-market area. It has been noted that there is a need to introduce new methods of measurement for such categories as welfare, quality of life and sustainability of economic development. It is recommended to take greater account of the household perspective and extend the measurement of income to include the value of unpaid work of households.

Levy Economics Institute in the USA has proposed a two-dimensional approach to the study of poverty, taking into account its material and time aspect. They introduced an adjusted poverty threshold measure LIMTIP (the Levy Institute's Measure of Time and Income Poverty), which differs from the standard indicator by including the assessed deficit of time. Empirical studies show that the official poverty is significantly deeper than the one indicated by the standard measure, which does not take into account the aspect of time. One can distinguish the individuals and households that are not classified as poor, but their time allocation leads them to poverty (Antonopoulos et al. 2012).

The theory of the economics of happiness by Easterlin (2008) assumes that satisfaction in life is derived from three main areas, namely professional work, family life and health. It notes that happiness depends on the material situation, but it is not a linear relation. The increase in wealth does not result in the proportionate increase in happiness. For those who want to increase the level of happiness Easterlin recommends devoting more time to family life and health.

Other economic concepts regarding time allocation of the population include the theory of household satellite accounts (EC 2003), the theory of the triangle of the human economy by Pietila (1997), the theory of the economics of care (Folbre 1994) and the concept of the distribution of working time DCP by Hozer-Koćmiel (2008).

The aim of this study is to investigate the similarity of the selected European countries in terms of time allocation of the population. A thesis is formulated that there are groups of countries that show strong similarity in setting the time budget of the population.

2. Methodology and data

The taxonomic methods used for the classification of countries in terms of time allocation include cluster analysis methods such as the agglomerative procedure based on single linkage and Euclidean distances or the *k*-means method (Pociecha et al. 1988, Jajuga 1993), and other taxonomic methods such as interval taxonomic method TMI (Strahl, Walesiak 1997; Lis 2013), and generalised

distance measure GDM (Walesiak 2000, 2011). The normalization of variables for determining TMI was performed using zeroed unitarization.

The analysis included the working population by gender from 15 European countries: Belgium, Estonia, Finland, France, Spain, Lithuania, Latvia, Germany, Norway, Poland, Slovenia, Sweden, Hungary, United Kingdom and Italy. They were investigated in respect of the following variables of time allocation of the population in minutes per day: 1. Professional work 2. Domestic work 3. Leisure 4. Study, 5. Travel, 6. Sleep 7. Other physiological functions.

The data are derived from a survey on the population time budget HETUS - Harmonised European Time Use Survey 2004 (see Table 1).

Table 1. The average duration of particular activities in minutes per day in the selected European countries in 2004

	Belgium	Estonia	Finland	France	Germany	Hungary	Italy	Latvia	Lithuania	Norway	Poland	Slovenia	Spain	Sweden	UK
WOMEN															
Professional work	228	248	247	273	213	275	275	337	349	208	277	250	285	235	234
Study	5	5	13	2	19	8	4	9	6	18	9	13	12	10	12
Domestic work	232	244	201	212	191	234	231	188	204	206	238	264	209	212	208
Leisure	231	240	278	190	289	223	197	193	185	322	223	231	214	267	261
Travel	90	75	76	66	87	62	88	86	67	77	70	69	82	88	93
Sleep	496	503	502	521	491	498	480	501	493	487	488	492	491	485	505
Other physiological functions	156	126	122	176	151	141	164	126	136	122	134	122	148	143	127
MEN															
Professional work	298	295	324	339	294	320	370	396	388	286	362	311	363	310	333
Study	5	5	8	3	11	5	3	5	3	10	8	9	8	7	9
Domestic work	135	140	119	110	112	129	70	86	99	132	113	144	80	143	114
Leisure	263	287	306	234	311	277	246	238	242	337	269	292	260	291	281
Travel	103	80	77	72	91	70	100	91	77	83	75	74	83	92	96
Sleep	481	502	492	506	480	488	478	496	488	473	479	486	495	472	491
Other physiological functions	155	131	115	176	141	150	172	128	143	118	134	127	151	125	115

Source: own study based on the data from HETUS survey.

3. The results of grouping the European countries by time allocation of the population

3.1. Tree diagrams

For the active part of the day, most of the time is spent on professional work, domestic work and leisure. The study was conducted for the employed people, therefore the duration of professional work was relatively long. If the analysis had been performed for all people, both employed and unemployed, most of the daily time would have been spent on domestic work, then professional work and leisure.

Some significant differences in time allocation for men and women were visible. Women spent less time than men on professional work and more time on domestic work on average. They had less free time and studied more than men.

On the basis of the tree diagram it can be stated that the countries that are most similar to each other in terms of time allocation for women were Poland and Hungary. The linkage based on the Euclidean distance was the shortest in this case. The next countries that joined the group were Spain, Italy, Slovenia and Estonia. For this group, professional work time and domestic work time was clearly longer than in other countries, whereas leisure time was reduced. These are the countries with relatively traditional division of responsibilities in the household compared to other European countries.

A strong similarity of the time use structure for women was also observed in Sweden, Finland, United Kingdom and Germany. For Germany, the distance of the linkage was significantly longer, and therefore the similarity of time allocation in relation to the Scandinavian countries was smaller. The group, unlike the previously described one, was characterized by relatively short professional work time and domestic work time, and considerable leisure time. The second group was comprised of more economically developed countries, the so-called 'old EU', including countries that were the world leaders in terms of equality between women and men (Scandinavia).

The countries that showed a clear distinction in relation to all other countries included Lithuania and Latvia. They represent a separate small group with exceptionally long professional work time, short domestic work time and short leisure time. They are less economically developed compared to the aforementioned representatives of the 'old EU'. A few decades ago they underwent the economic transformation. The situation on their labour market is more difficult than in western countries, which is probably the reason why the average working time for women is so long there.

In order to observe similarities of time allocation in selected EU countries and the process of agglomeration, the agglomerative procedure (joining) based on the single linkage and Euclidean distances was used and presented as a tree diagram below.

Tree Diagram for 15 Cases
Single Linkage
Euclidean distances
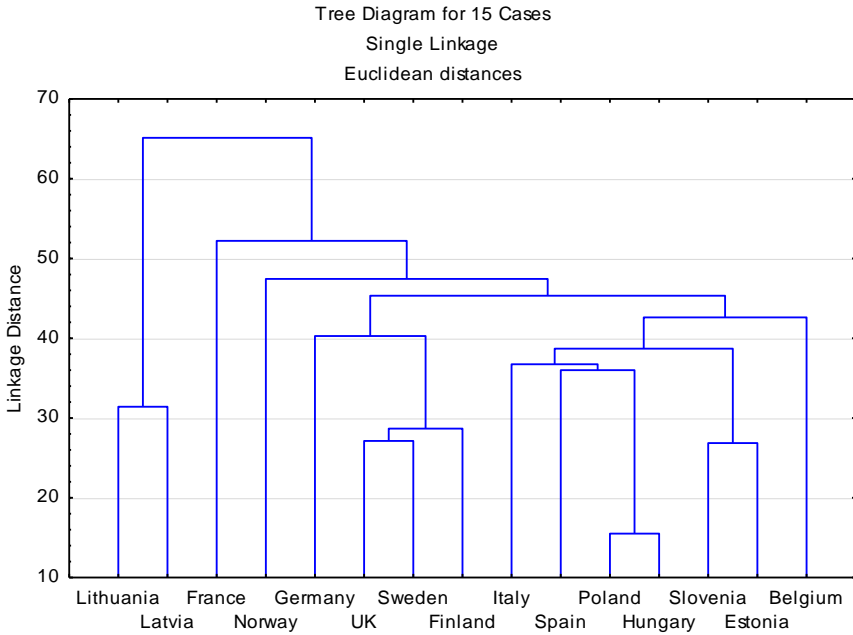
Figure. 1. Tree diagram of time allocation for women in the selected EU countries
Source: own study based on the data from HETUS survey.

Tree Diagram for 15 Cases
Single Linkage
Euclidean distances
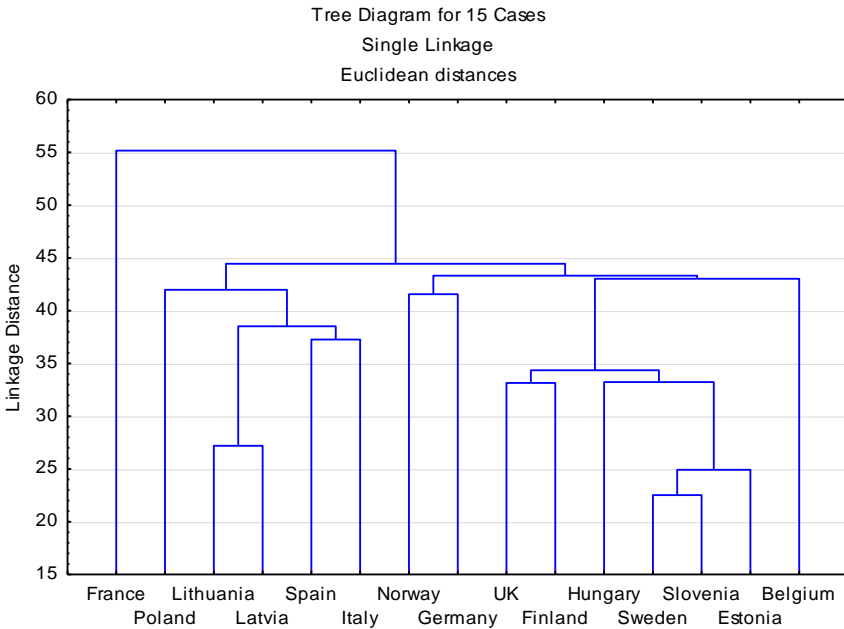
Figure 2. Tree diagram of time allocation for men in the selected EU countries
Source: own study based on the data from HETUS survey.

For men, Sweden, Slovenia and Estonia were the most similar in terms of time allocation were Sweden, Slovenia and Estonia, followed by the United Kingdom, Finland and Hungary. They were characterized by a relatively short professional work time, long domestic work time and long leisure time. In the previous work (Hozer-Koćmiel, Lis 2015) it was observed that men in the Scandinavian countries, which are part of this group, spend significantly more time on household activities, particularly on childcare.

Lithuania and Latvia, followed by Spain, Italy and Poland, also formed a distinct group for men. These are the countries that have undergone a transformation towards market economy (Lithuania, Latvia, Poland) and countries firmly embedded in the Mediterranean culture (Spain and Italy). The common denominator for them is the popularity of traditional roles in the household. As a consequence, men in this group worked a long time, had relatively long leisure time, but did not engage considerably in housework.

3.2. Cluster analysis

In the next stage of the research, the *k*-mean method, as a method of cluster analysis, was used. As in the previous section of the paper, Euclidean distances between clusters were calculated. Three clusters were proposed a priori to distinguish between women and men.

The results of grouping of the EU countries in terms of time allocation for employed men and women are presented in Table 2.

Table 2. Cluster analysis of the EU countries in terms of time allocation for women and men in 2004

WOMEN		
Cluster 1	Cluster 2	Cluster 3
Latvia Lithuania	Finland Sweden Norway Germany UK	Estonia Hungary Poland Slovenia Spain Italy France Belgium
Prof.work = 343.2	Prof.work = 227.3	Prof.work = 264.0
Study = 7.7	Study = 14.4	Study = 7.2
Dom.work = 195.8	Dom.work = 203.6	Dom.work = 233.0
Sleep = 497.1	Sleep = 494.0	Sleep = 496.2
Leisure = 189.0	Leisure = 283.5	Leisure = 218.6
Other physio. = 131.0	Other physio.= 132.8	Other physio. = 145.9
Travel = 76.3	Travel = 84.1	Travel = 75.3

Table 2. Cluster analysis of the EU countries in terms of time allocation for women and men in 2004 (cont.)

MEN		
Cluster 1	Cluster 2	Cluster 3
Finland Sweden UK Belgium Estonia Hungary Slovenia	Germany Norway	Latvia Lithuania Poland Spain Italy France
Prof.work = 312.9	Prof.work = 290.1	Prof.work = 369.6
Study = 6.9	Study = 10.5	Study = 5.0
Dom.work = 132.1	Dom.work = 122.2	Dom.work = 93.0
Sleep = 487.6	Sleep = 476.5	Sleep = 490.3
Leisure = 285.3	Leisure = 324.1	Leisure = 248.1
Other physio. =131.0	Other physio. = 129.3	Other physio = 150.7
Travel = 84.5	Travel = 86.8	Travel = 83.0

Source: own study based on the data from HETUS survey.

The grouping of the countries was carried out differently for men and women due to the fact that the division of daily time differs significantly by gender. The countries which were similar to each other were grouped together, not only according to time allocation, but also economically and culturally. For women, the first cluster consisted of Lithuania and Latvia, two of the three Baltic republics seized after World War II by the Soviet Union. The difficult economic situation, including the labour market, caused that on average employed women from this group worked longer than in other countries. This is also related to the fact that less people worked part-time there. Long professional work time contributed to the reduction of leisure time devoted to cultural life, sport, social activities or hobbies. Women living in Lithuania and Latvia devoted relatively small amount of time for domestic work.

The second cluster included the Scandinavian countries and two more developed countries of the 'old EU': Germany and the United Kingdom. As for the main features of time allocation, this group was characterized by short professional work time, average domestic work time and relatively long leisure time. The countries of the second cluster show high economic activity of women, but the average work time is shorter here than in other parts of Europe. This results from the availability of part-time and flexible forms employment, among others. It is also worth noting that the study time for women was on average twice as long as in the other two groups.

The third cluster for women gathered less wealthy countries after economic transformation and the countries of the south-west Europe. The latter are the countries of Roman culture, characterized by the Latin-based language and, in the case of Spain and Italy, more traditional division of work in the family, among others. The duration of particular daily activities turned out average there: time spent on professional work, domestic work and leisure.

For men, the clusters of the European countries were formed differently and it was harder to find a common denominator for their components. The first cluster included the Scandinavian countries, the more economically developed United Kingdom and Belgium, and three less developed eastern countries: Estonia, Hungary and Slovenia. Basic variables of the time budget for men were at the average level (professional work time and leisure time), whereas domestic work time was relatively long. The latter regularity is associated with the presence of the Scandinavian countries in the cluster in which the equality policy is the most advanced in the world.

The second small group consisted of Germany and Norway. Professional work time for men was short there, domestic work time was average (affected by the situation in Germany), whereas the leisure time was significantly longer in comparison with other countries. This structure of time allocation is optimal according to Bergmann (2014), who recommends shorter professional work time, more domestic work and work for the local community, and engaging only in activities that bring satisfaction.

The third cluster for men covered Latvia, Lithuania and Poland – Eastern Europe, and Spain, Italy, France – countries of Latin roots. This group was characterized by long professional work time, short domestic work time and short leisure time. This is related to the traditional division of roles in the household, where men focus on market activities and women on household work.

3.3. Interval taxonomic method TMI

The next part of the analysis was the classification of the countries by the interval taxonomic method TMI.

The first stage of TMI calculation is splitting the set of variables into three possible sets: stimulants, destimulants and nominants. Then, a specific measure d_{ij} for each variable from the subsets has to be calculated. The measure represents the distance to the pattern. An object that is defined as the pattern has got the best possible values for each j-th variable, which denotes the maximal value observed in the economy for stimulants (x_{max}), the minimal value for destimulants (x_{min}) and finally a specific value that is needed for nominants (x_N).

Next, distances to the best possible values are calculated according to formulae as follows:

1. Stimulants:

$$d_{ij} = \frac{x_{max\,j} - x_{ij}}{x_{max\,j} - x_{min\,j}};$$

(1)

2. Destimulants:

$$d_{ij} = \frac{x_{ij} - x_{min\,j}}{x_{max\,j} - x_{min\,j}};$$

(2)

3. Nominants:
   a) determined at the point x_{Nj}

$$d_{ij} = \begin{cases} 0 & \text{if } x_{ij} = x_{Nj}; \\[2mm] \dfrac{x_{Nj} - x_{ij}}{x_{Nj} - x_{min\,j}} & \text{if } x_{ij} < x_{Nj}; \\[2mm] \dfrac{x_{ij} - x_{Nj}}{x_{max\,j} - x_{Nj}} & \text{if } x_{ij} > x_{Nj}; \end{cases}$$

(3)

   b) determined in the interval $<x_{NLj,}\, x_{NUj}>$

$$d_{ij} = \begin{cases} 0 & \text{if } x_{ij} \in < x_{NLj}, x_{NUj} >; \\[2mm] \dfrac{x_{NLj} - x_{ij}}{x_{NLj} - x_{min\,j}} & \text{if } x_{ij} < x_{NLj}; \\[2mm] \dfrac{x_{ij} - x_{NUj}}{x_{max\,j} - x_{NUj}} & \text{if } x_{ij} > x_{NUj}. \end{cases}$$

(4)

Finally, TMI measure is calculated for each i-th object with the use of aggregation formula as follows:

$$TMI_i = d_i = \frac{\sum_{j=1}^{k} d_{ij}}{k}.$$

(5)

For each variable of time allocation, the following standards for a pattern were adopted:

- Professional work – the minimum value, 208 min. per day (W) and 286 min. per day (M)
- Study – the maximum value, 19 min. per day (W) and 11 min. per day (M),
- Domestic work – the average value, 218 min. per day (W) and 115 min. per day (M),

- Leisure – the maximum value: 322 min. per day (W) and 337 min. per day (M),
- Travel – the minimum value: 62 min. per day (W) and 70 min. per day (M),
- Sleep – the optimal level of sleep: 8 hours per day, 480 min. per day (W, M),
- Other physiological functions – the average value:140 min. per day (W) and 139 min. per day (M).

Table 3. The results of the classification of the countries based on TMI in 2004

Rank	Country	TMI women	Rank	Country	TMI men	Rank	Country	TMI total
1.	Norway	0.168	1.	Germany	0.146	1.	Norway	0.176
2.	Germany	0.274	2.	Norway	0.185	2.	Germany	0.210
3.	Sweden	0.312	3.	Slovenia	0.256	3.	Finland	0.322
4.	Finland	0.354	4.	Poland	0.281	4.	Slovenia	0.324
5.	Hungary	0.362	5.	Finland	0.290	5.	Poland	0.325
6.	Poland	0.369	6.	Hungary	0.315	6.	Hungary	0.339
7.	Slovenia	0.392	7.	Sweden	0.385	7.	Sweden	0.349
8.	Spain	0.418	8.	Estonia	0.392	8.	UK	0.411
9.	UK	0.428	9.	UK	0.395	9.	Estonia	0.430
10.	Estonia	0.468	10.	Belgium	0.443	10.	Spain	0.447
11.	Belgium	0.490	11.	Spain	0.477	11.	Belgium	0.467
12.	Lithuania	0.499	12.	Lithuania	0.513	12.	Lithuania	0.506
13.	Italy	0.533	13.	France	0.571	13.	France	0.594
14.	France	0.616	14.	Latvia	0.631	14.	Italy	0.608
15.	Latvia	0.621	15.	Italy	0.683	15.	Latvia	0.626

Source: own study based on the data from HETUS survey.

    Germany and Norway bore the closet similarity with the adopted standard. For men, they were followed by: Slovenia, Poland, Finland, Hungary and Sweden. For women, the countries were exactly the same but in different order: Sweden, Finland, Hungary, Poland and Slovenia. France, Italy and Latvia showed the lowest similarity to the pattern.

TMI was also used to compare the similarity in time allocation for the selected countries in relation to each other. Time allocation for women in Poland was the most similar to that of Hungary, Slovenia, Estonia and Spain. For those countries, TMI values were the lowest, i.e. lower than 0.2. Time allocation structure for men in Poland showed the closest similarity to Slovenia, Spain, Finland and Hungary.

3.4. Generalized distance measure (GDM)

The last step of the analysis involved the generalized distance measure. GDM combines different variables in one synthetic indicator. Such an approach makes it possible to classify the selected countries by the similarity of time allocation. Unfortunately, the variables used in the analysis had different ranges. In order to make variables comparable, transformations that make them similar are performed. Such procedures are called variable normalizations. One of them, used in this study, is known as standardization.

After the process of standardization the vector of distances from the specific object (a virtual, artificial country) that is characterized by the best possible values of each variable has to be calculated. GDM is based on the idea of the generalized correlation coefficient. The generalized distance measure is calculated by the following equation (Walesiak 2000):

$$GDM = d_{ik} = \frac{1 - s_{ik}}{2} = \frac{1}{2} - \frac{\sum\limits_{j=1}^{m} a_{ikj}b_{kij} + \sum\limits_{j=1}^{m}\sum\limits_{l=1}^{n} a_{ilj}b_{klj}}{\sqrt{\sum\limits_{j=1}^{m}\sum\limits_{l=1}^{n} a_{ilj}^2 \cdot \sum\limits_{j=1}^{m}\sum\limits_{l=1}^{n} b_{klj}^2}}$$
[6]

where:

d_{ik} (s_{ik}) – distance (similarity) measure;
$i, k, l = 1, 2, …, n$ – the number of objects;
$j = 1, 2, …, m$ – the number of variables.

If variables are measured on ratio or interval scale, a_{ipj}, b_{krj} are defined as:

$$a_{ipj} = x_{ij} - x_{pj} \quad \text{for } p = k, l$$
[7]

$$b_{krj} = x_{kj} - x_{rj} \quad \text{for } r = i, l$$
[8]

If variables are measured on ordinal scale, then a_{ipj}, b_{krj} are defined as follows:

$$a_{ipj}\left(b_{krj}\right) = \begin{cases} 1 & \text{when } x_{ij} > x_{pj} \ \left(x_{kj} > x_{rj}\right) \\ 0 & \text{when } x_{ij} = x_{pj} \ \left(x_{kj} = x_{rj}\right) \\ -1 & \text{when } x_{ij} < x_{pj} \ \left(x_{kj} < x_{rj}\right) \end{cases} , \quad \text{for } p = k, l; r = i, l$$
[9]

where:

x_{ij} (x_{pj}, x_{rj}) - the ith (p^{th}, r^{th}) observation of the jth variable.

Similarly, as in TMI procedure, the selected countries were finally ranked for women, men and total population using the presented method. The results are listed in the table below.

Table 4. Classification of the selected countries by GDM

Rank	Country	GDM women	Rank	Country	GDM men	Rank	Country	GDM total
1.	Norway	0.015	1.	Norway	0.029	1.	Norway	0.022
2.	Germany	0.058	2.	Germany	0.032	2.	Germany	0.045
3.	Sweden	0.097	3.	Finland	0.113	3.	Finland	0.108
4.	Finland	0.102	4.	Slovenia	0.148	4.	Sweden	0.129
5.	UK	0.152	5.	Estonia	0.154	5.	Estonia	0.212
6.	Estonia	0.270	6.	Sweden	0.161	6.	UK	0.225
7.	Belgium	0.289	7.	Hungary	0.227	7.	Slovenia	0.244
8.	Slovenia	0.341	8.	UK	0.299	8.	Belgium	0.295
9.	Hungary	0.439	9.	Belgium	0.301	9.	Hungary	0.333
10.	Poland	0.450	10.	Poland	0.460	10.	Poland	0.455
11.	Spain	0.545	11.	Spain	0.521	11.	Spain	0.533
12.	France	0.598	12.	France	0.561	12.	France	0.580
13.	Italy	0.606	13.	Lithuania	0.660	13.	Italy	0.646
14.	Latvia	0.712	14.	Italy	0.687	14.	Lithuania	0.696
15.	Lithuania	0.732	15.	Latvia	0.693	15.	Latvia	0.702

Source: own calculations.

Norway and Germany ranked first and second in the classification both for women and men. It means that these countries were the most similar to the invented artificial object (country) that had the best possible structure of time allocation. Poland was ranked 10th. The last two countries were Latvia and Lithuania for women, and Italy and Latvia for men.

TMI and GDM classifications were compared using the product-moment coefficient of correlation. It is worth noting that the achieved results were coherent. The coefficient of correlation between TMI and GDM for women was equal to 0.79 and for men to 0.87, which indicates a positive and relatively strong association between the two rankings. The scatter plots of the two classifications for women and men are presented in Fig. 3.
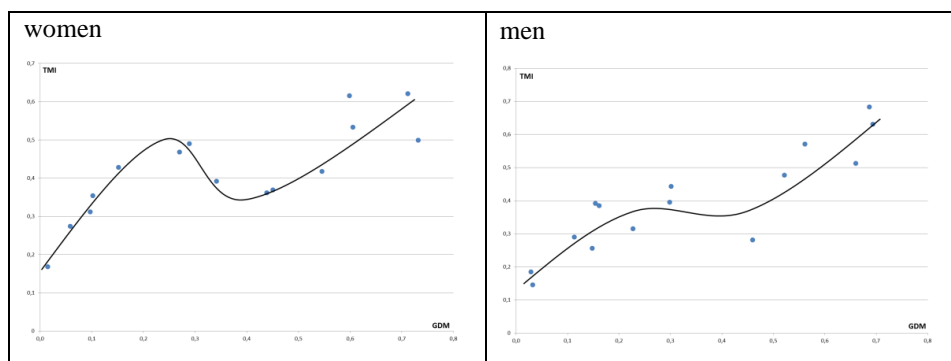
Figure 3. Relation between TMI and GDM results

Source: own work.

Interestingly, the method of calculating TMI and GDM makes those measures associated in a non-linear way. Scatter plots show that there are slight differences between TMI and GDM classification for objects (countries) in the middle of the ranking table. Summing up, despite the nonlinearity of the correlation between the results of the two aforementioned methods, they were still highly coherent.

4. Summary and directions for further research

The inclusion of the issue of time allocation in economic analyses is recommended by J. E. Stiglitz, A. Sen, J. P. Fitoussi and G. Becker. The implementation of the quantitative approach is possible based on the data from the study of time budgets of the population.

The analysis of the similarities between the selected European countries in terms of time allocation led to the conclusion that there are groups of countries that show strong similarity in setting the time budget of the population. The first group includes the 'new' European countries that has undergone economic transformation. They were characterized by a distinctly longer professional work time and shorter leisure time. The second coherent group consists of the Scandinavian countries and the more developed countries of Western Europe. In these regions, the basic variables of time allocation were opposite: relatively short professional work time and long leisure time.

The next step in the research will be to design the LIMTIP indicator for Poland, i.e. the measure which takes into account the material and time aspect of poverty.

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