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APPLICATION OF SELECTED SYNTHETIC MEASURES IN THE ASSESSMENT OF THE LEVEL OF SATISFIED HOUSING NEEDS IN POLAND

Summary: In the article the authors propose the application of synthetic measures to assess the level of satisfied housing needs. They have proven that the methods of multi-dimensional statistics, helpful in determining the synthetic measures, are particularly useful in the analysis of the spatial diversification of housing needs. Due to their structure, the synthetic measures make it possible to rank objects in terms of the level of a multi-attribute phenomenon. In this article, the authors propose to apply Hellwig's measure of growth, the synthetic measure by Strahl and the relevant measure of growth by Cieślak to assess the level of satisfied housing needs in Poland in 2012. The objects of interest were voivodships. The selected measures brought similar classification results, and the choice of particular method did not significantly affect the ranking order of the voivodships in terms of their level of satisfied housing needs.

Keywords: housing needs, synthetic measure, comparative analysis.

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1. Introduction

Everyone has the fundamental right to housing. This is why it is beyond any doubt that *'...in the hierarchy of human needs, housing plays one of the most important roles in individual consumption; it is also a social need, ...the satisfaction of which, as Krzeczkowski points out , (...) influences every human environment as hardly anything else does'* [Krzeczkowski 1939]. According to Bryx [2001, p.19] housing can gratify not only the basic, but also the higher level needs which are *'a feeling of deficiency combined with the wish to satisfy it (...) and that wish is not conditioned by a financial capability'*. According to the reference literature housing needs can have their subjective and objective, as well as their market form. The subjective needs are the individual predilections of household members which change over time as the family enters subsequent stages of life, career and material situation. The

objective needs are regarded as traditional norms that are generally accepted in a given community and which "...define what is a fair level of satisfying people's housing needs" [*Lokalne strategie mieszkaniowe...* p. 46] while the market character of needs is determined by the financial capability to satisfy them. Although the transformation period is long past, the housing needs in Poland have not been met yet. According to statistical data, at the end of 2012 the surplus of households over the number of flats was over 2 million. What makes the situation even worse is the fact that some flats have had to be eliminated from the market due to their poor technical condition. When we compare the housing situation in Poland and other European countries, the emerging picture is not optimistic. The large deficit of flats, the low supply of new ones and high construction costs result in a situation where housing needs, in terms of both their quantity and quality, are very hard to satisfy. The basic condition to achieve this goal is to adopt and successfully implement long-term housing policies as well as to establish a rational land use policy. The development of good housing policy and defining the areas of its efficient implementation by large administration units (voivodships) requires a thorough knowledge of local problems and local potential.

In this article we propose the application of selected synthetic measures in assessing the extent to which housing needs were met in Poland in 2012. We used three different (Hellwig's measure of growth, Strahl's synthetic measure and Cieślak's relative measure of growth) methods proposed in the literature for constructing synthetic measures by means of the same set of diagnostic variables. This enabled us to demonstrate how the choice of a method affects the obtained results, and which of the applied methods seem to be adequate to assess the level of satisfied housing needs.

2. Constructing the Synthetic Measures for this Study

To begin, it should be pointed out that there are no methods that are absolutely perfect. Finding the perfect method would allow our knowledge about the subjects of our studies to develop. Although each of the known methods has its advantages, all of them are imperfect in one way or another. Taxonomic methods, including the methods of taxonomic and synthetic measure are the basic methods to study socio-economic phenomena. The application of synthetic measures brings concrete, relatively objective results. The construction of these measures and their application in studies on socio-economic phenomena are frequent subjects of the related publications [e.g. Hellwig 1968, Cieślak 1974, Bartosiewicz 1976, Strahl 1978, Borys 1978, Zeliaś, Malina 1997]. There are two groups of ways to determine synthetic measures: standard and non-standard methods. In this paper the authors use a method which is typical and popular in empirical research – Hellwig's measure [1968] as well as the measures proposed by Cieślak [1974] and Strahl [1978]. The fundamental purpose of creating the synthetic measures is to order objects described

by means of one aggregate measure that replaces a multi-attribute description of objects. The differences that can be seen in the methodology of the synthetic measure construction concern [Strahl 1978, p. 205]:

- a) the way of including variables that stimulate the development of a given phenomenon (stimulants) or hampering it (destimulants),
- b) the way in which attributes are brought to the common comparative system,
- c) determining the value of the attributes of the standard object,
- d) constructing the measure,
- e) properties of the measure.

2.1. The Choice of Diagnostic Variables

Every construction of a synthetic measure starts with defining the set of diagnostic variables which characterise a given phenomenon. The selection of variables determine the outcome, therefore the set of the diagnostic variables should be specified in such a manner so that the crucial aspects of the analysed phenomenon can be properly characterised [Podolec, Zając 1978, p. 20]. Hence, the preliminary list of attributes made by the researcher is scrutinised in regard to variation coefficients, correlation coefficients and the standard deviation. The short-listed set of variables should comprise the attributes that are not highly correlated (they should not convey the same information about the objects) and are strongly spatially diversified (generally, the adopted variation coefficient is >0.1).

The assessment of housing needs in Poland in 2012 was founded on variables available in public statistics and those whose construction was based on data from publications by the Central Statistical Office (GUS) [*Gospodarka mieszkaniowa w 2012*; *Obrót nieruchomościami w 2012*; the GUS data published at www.stat.gov.pl]. Each voivodship was described with six variables characterising the local housing resource, five variables defining economic conditions for the housing market and five variables describing the demographic situation. Eventually, for the construction of the synthetic measure of satisfied housing needs the authors selected two variables characterising the local housing resources, four variables describing the economic situation and one variable depicting the demographic situation.

- z_1 number of flats per 1000 people,
- z_6 housing deficit expressed with the ratio of the number of flats to the number of households,
- e_1 average price of 1m² of floor space,
- e_2 income availability measured with the ratio of the gross average monthly salary in the enterprise sector and the average price of 1m² of floor space on the primary market,
- e_3 number of flats completed per 1000 of marriages,
- e_4 number of transactions per 100 flats completed,
- d_3 population dynamics rate counted as the ratio of live births in a given period of time to the number of deaths in the same period.

The voivodships under investigation comprised the 16-element set Ω of the so called operational taxonomic units described by seven diagnostic variables.

2.2. Hellwig's Measure of Growth

One of the three synthetic measures that is used in this paper to assess the level of satisfied housing needs is the method proposed by Hellwig [1968, pp. 307-327]. *The method is founded on the concept of the distance of objects from the 'standard', i.e. the abstract object that has all the highest values of attributes (stimulants) and the lowest of the attributes observed in the analysed set (destimulants)* [Cieślak 1974, p. 30]. Hellwig [1968, p. 342] gave the name of stimulants (S) to those variables which stimulated economic growth, while destimulants (D) were the variables hampering that growth. The attributes of the standard adopt the values:

$$y_{0j} = \max_i y_{ij} \text{ when: } y_j \in S \text{ (set of stimulant attributes)} \quad (1)$$

$$y_{0j} = \min_i y_{ij} \text{ when: } y_j \in D \text{ (set of destimulant attributes)}$$

The synthetic measure was built by means of standardised variables:

$$y'_{ij} = \frac{y_{ij} - \bar{y}_j}{s_j} \quad (2)$$

where: y_{it} is the value of the j -th attribute ($j = 2, \dots, m$) in the i -th object ($i = 1, 2, \dots, k$), \bar{y}_j – the mean value of the j -th attribute, and s_j – the standard deviation of the j -th attribute

Therefore, for each of the voivodships represented by the point of coordinates $(z_{i1}, z_{i6}, e_{i1}, e_{i2}, \dots, d_{i1})$ ($i = 1, \dots, 16$), according to the Euclid formula, taxonomic distances (c_{i0}) were determined to the standard P_0 whose coordinates adopt the highest values respectively for each variable. The taxonomic, synthetic measure of satisfied housing needs was calculated with the formula:

$$d_i = 1 - \frac{c_{i0}}{c_0} \quad (3)$$

$$\text{where: } c_{i0} = \left[\sum_{j=1}^m (y'_{ij} - y_{0j})^2 \right]^{\frac{1}{2}} \quad (4)$$

$$c_0 = \bar{c}_0 + 2s_0 \quad (5)$$

$$\bar{c}_0 = \frac{1}{k} \sum_{i=0}^k c_{i0} \quad (6)$$

$$s_0 = \left[\frac{1}{k} \sum_{i=0}^k (c_{i0} - \bar{c}_{i0})^2 \right]^{\frac{1}{2}} \quad (7)$$

\bar{c}_0 – mean value of the determined distances c_{i0} ; s_0 – standard deviation of the distance c_{i0} .

The indicator values usually fall into the interval $[0, 1]$. The measure d_i can exceed 1, but the likelihood of such a case is very low. The closer the values of d_i approach 0, the lower the level of satisfied housing needs in a given voivodship is. And vice versa, the closer the d_i approach 1, the more the housing needs in a given voivodship are satisfied. The obtained values of the measure d_i , for the analysed voivodships in 2012 is presented in Table 1.

Table 1. Ranking of voivodships according to the Hellwig measure of growth (d_i)

Voivodship	Growth measure d_i	Rank	Voivodship	Growth measure d_i	Rank
Dolnośląskie	0.49	1	Podkarpackie	0.16	12
Kujawsko-pomorskie	0.21	8	Podlaskie	0.09	14
Lubelskie	0.14	13	Pomorskie	0.43	7
Lubuskie	0.30	5	Śląskie	0.35	2
Łódzkie	0.31	4	Świętokrzyskie	0.09	16
Małopolskie	0.09	15	Warmińsko-mazurskie	0.26	3
Mazowieckie	0.16	11	Wielkopolskie	0.20	9
Opolskie	0.18	10	Zachodniopomorskie	0.26	6

Source: own calculations.

Having determined the standard attribute values, we could objectively assign each voivodship to its rank in the hierarchy of all the voivodships in respect of the level of satisfied housing needs.

2.3. The Relative Measure of Growth by Cieślak

As the second measure of satisfied housing needs we used the synthetic measure proposed by Cieślak – the relative measure of growth [Cieślak 1974, pp. 29-39] which is based on the alternative construction rule which takes into consideration the standard of growth. ‘this standard can be a particular object included in the study, for instance, the best developed or abstract object...’ [Cieślak 1974, p. 33]. Then the standard attributes adopt the values:

$$y_{0j} = \min_i y_{ij} \quad \text{because: } y_j \in S$$

or

$$y_{0j} = y_{ij} \quad \text{where: } y_{ij} \in P_i \quad (8)$$

P_i – the object of study ($i = 1, 2, \dots, k$).

Cieślak assumes that all the variables have the character of stimulants. Therefore the starting point of constructing the measure is to bring all the variables to the form of stimulants. In the case of destimulants this is achieved by calculating their inverse forms. In the discussed version of the taxonomic method, the normalisation of variables was applied instead of its standardisation, which is written as:

$$y'_{ij} = \frac{y_{ij}}{s_j} \quad (9)$$

The relative measure of growth is counted just as in the case of Hellwig's measure, but the calculations are performed for each period (t), i.e. by means of the formula:

$$d_i = 1 - \frac{c_{i0t}}{c_{0t}} \quad (10)$$

where:

$$c_{0t} = \bar{c}_{0t} + 2s_{0t} \quad (11)$$

The values of the relative measure of growth d_{ic} obtained for the analysed voivodships in 2012 are presented in Table 2.

Table 2. Ranking of voivodships according to the relative measure of growth by (d_{ic})

Voivodship	Relative measure of growth d_{ic}	Rank	Voivodship	Relative measure of growth d_{ic}	Rank
Dolnośląskie	0.48	1	Podkarpackie	0.16	16
Kujawsko-pomorskie	0.20	10	Podlaskie	0.10	15
Lubelskie	0.13	13	Pomorskie	0.45	2
Lubuskie	0.44	3	Śląskie	0.37	4
Łódzkie	0.33	5	Świętokrzyskie	0.10	12
Małopolskie	0.11	14	Warmińsko-mazurskie	0.32	9
Mazowieckie	0.25	6	Wielkopolskie	0.19	11
Opolskie	0.28	8	Zachodniopomorskie	0.31	7

Source: own calculations.

Cieślak [1974, p. 33] points out that her '*...version of the taxonomic method can be used to determine single, but aggregate processes (...), and can be particularly useful (...) when examining processes remaining in interrelations.*'. Maintaining a higher value of the measure means that the object is better developed and enables us to set 'the goal of growth'.

2.4. Constructing the Synthetic Measure by Strahl

The third synthetic measure of the level of satisfied housing needs is the one proposed by Strahl [1978, pp. 205 – 215]. Strahl [1978, p. 209] allows the attributes of stimulants Y_j^S and of destimulants Y_j^D . Bringing the attribute values to the common comparative system is based on the concept of the standard. Assuming that the standard attributes take values as in Hellwig's method and that bringing the attribute values to the common comparative system follows the formula:

$$y'_{ij}{}^S = \frac{y_{ij}}{\min_i y_{ij}} \quad \text{when } y_j \in S$$

$$y'_{ij}{}^D = \frac{\max_i y_{ij}}{y_{ij}} \quad \text{when } y_j \in D$$
(12)

then the normalised values of each attribute fall into the interval $[0, 1]$, which means that *"the closer the attribute value is to one, the closer a given object is to the standard in relation to a given stimulant or destimulant (...)"*. The value of the normalised attribute can be interpreted as its *"...share in the value of the standard's attribute"*, while *"...normalised attributes of the destimulant inform about the share of the standard's attribute in the attribute value of the objects P_i ($i=1, 2, \dots, k$)"*. Such an approach allows to rank the objects (the voivodships) according to the level of the j -th attribute ($j= 1, 2, \dots, m$) and to rank the attribute within one object. Information obtained in this manner is of principal importance in the process of programming the directions of policies aiming at satisfying housing needs in the analysed voivodships.

According to Strahl [1978, p. 212] the synthetic measure is defined as:

$$s_i \sum_{j=1}^m y'_{ij} = \sum_j y'_{ij}{}^S + \sum_j y'_{ij}{}^D$$
(13)

whereas in the normalised version as:

$$s_i = \frac{1}{m} \sum_{j=1}^m y'_{ij} \quad \text{or} \quad s_i = \sum_j^{m-m_{0i}} y'_{ij} / (m - m_{0i}) \quad y_j \in S \cup D$$
(14)

where: m is the number of attributes (stimulants and destimulants); m_{0i} is the number of attributes for which $y_{ij} = 0$; m

When normalising of the attributes is conducted according to formula 12, the measure S_i is growing in the interval $(0, m)$, while the values of the measure s_i fall into the interval $(0, 1)$, when y'_{ij} is counted using formula 12. The values of the synthetic measure s_i for the voivodships in 2012 are presented in Table 3.

Table 3. Ranking of the voivodships according to the Strahl synthetic measure (d_{ic})

Voivodship	Synthetic measure s_i	Rank	Voivodship	Synthetic measure s_i	Rank
Dolnośląskie	0.79	2	Podkarpackie	0.61	14
Kujawsko-pomorskie	0.65	11	Podlaskie	0.69	12
Lubelskie	0.62	13	Pomorskie	0.79	3
Lubuskie	0.73	1	Śląskie	0.75	4
Łódzkie	0.77	8	Świętokrzyskie	0.61	16
Małopolskie	0.61	15	Warmińsko-mazurskie	0.71	5
Mazowieckie	0.62	9	Wielkopolskie	0.65	10
Opolskie	0.71	6	Zachodniopomorskie	0.69	7

Source: own calculations.

The obtained values of the measure that approach zero denote the voivodships at a lower level of satisfied housing needs. The closer the value is to one, the more satisfied the housing needs are.

3. Comparison of Methods Used in the Study

For the purpose of constructing the synthetic variable of satisfied housing needs, the authors used standard methods where they took as a standard an abstract object whose coordinates adopted values that were the highest for each individual variable. The consequence of such a calculation of the synthetic measure was finding the taxonomic distance between the voivodships and the standard of growth. With the view to comparing the level of satisfied housing needs in the voivodships, the authors ranked the examined objects according to the values of the determined measures. The measures made it possible to rank objectively a given voivodship in the hierarchy of all the analysed voivodships. When positioning the voivodships, the authors found that four of them had taken the same position no matter which measure had been used. They were the two top voivodships (dolnośląskie and pomorskie taking the first and second position respectively), thus confirming that the housing needs in these voivodships were met at the highest level in regard to the variables selected for this study. Furthermore, the same (last) position in all the rankings was occupied by the świętokrzyskie voivodship where the level of satisfied housing needs was the lowest. The last voivodship that kept the same thirteenth place in the rankings was the lubelskie voivodship. The positions of the remaining voivodships were changing depending on the adopted method. In the majority of cases the shifts were minor, by two or three positions at the most. The positions of the voivodships according to the methods of constructing the synthetic variable used in this study are presented in Figure 1.

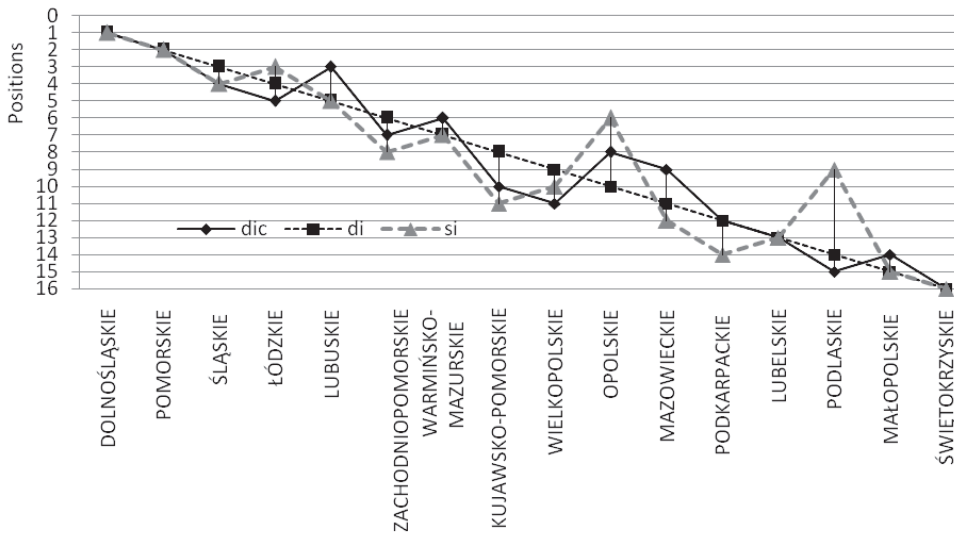


Figure 1. Positions taken by the voivodships according to the values of the synthetic measures of satisfied housing needs

Source: own calculations

The greatest discrepancies in the voivodship rankings were in the case of podlaskie and opolskie. The range of those discrepancies was as follows: from 9th position by s_i to 15th by d_{ic} (podlaskie) and from 6th position according to s_i to 10th according to d_i (opolskie).

In order to determine the similarity of the obtained results of voivodship ranking according to the selected synthetic variables of satisfied housing needs (d_p , d_{ic} , s_i), the authors used the Spearman rank correlation coefficient. The coefficient was counted according to the formula:

$$r_s = 1 - \frac{6 \sum d_i^2}{n(n^2 - 1)} \quad \text{where: } d_i = R_y - R_x \quad (15)$$

and: d_i – is a difference between the position of the i -th voivodship in the ranking according to the selected synthetic measures, n – the number of voivodships

The obtained values of the Spearman rank coefficient indicate the high conformity of the voivodship rankings according to the measures d_p , d_{ic} , s_i . The coefficient values are presented in Table 4.

Table 4. The values of the Spearman rank coefficient r_s

Synthetic measure	d_{ic}	d_i	s_i
d_{ic}	-	0.96	0.90
d_i		-	0.91
s_i			-

Source: own calculations.

The marked correlation coefficients are relevant for $p < 0,05$.

Based on the Spearman rank coefficient, the highest conformity of voivodship ranking was observed in cases of the measures d_i i d_{ic} ($r_s = 0.96$). Significant conformity was observed in cases of the measures s_i and d_{ic} ($r_s = 0.90$) and d_i and s_i ($r_s = 0.91$).

4. Conclusions

The study has led to the following conclusions:

1. The authors used the standard methods to construct synthetic measures which seem to be adequate when assessing the level of satisfied housing needs because they allow to define the maximum needs through determining the values of individual attributes. The best voivodships can be treated as the standard of growth for the remaining ones in terms of the diagnostic variables selected for this study.

2. Based on the Spearman rank coefficient, the authors observed that the application of the selected measures brought similar classification results. The choice of method does not have a significant impact on the order in the ranking of voivodships regarding their level of satisfied housing needs, according to the variables adopted in this study.

3. Regarding the values of the synthetic measure of the level of satisfied housing needs, the authors ascertained that in the hierarchy of the whole analysed set the voivodships that enjoyed the best satisfied housing needs in 2012 were dolnośląskie and pomorskie, whereas the lowest level of the satisfied housing needs was observed in the świętokrzyskie voivodship. This classification was confirmed by all the synthetic measures.

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WYKORZYSTANIE WYBRANYCH MIAR SYNTETYCZNYCH DO OCENY ZASPOKOJENIA POTRZEB MIESZKANIOWYCH W POLSCE

Streszczenie: W artykule przedstawiono propozycję wykorzystania miar syntetycznych do oceny zaspokojenia potrzeb mieszkaniowych. Wykazano, że metody statystyki wielowymiarowej, pozwalające na wyznaczenie miar syntetycznych, są szczególnie przydatne w analizie przestrzennego zróżnicowania potrzeb mieszkaniowych. Miary syntetyczne, dzięki swej konstrukcji, pozwalają na porządkowanie obiektów ze względu na poziom wielocechowego zjawiska. W niniejszym artykule do oceny zaspokojenia potrzeb mieszkaniowych w Polsce w 2012 r. zaproponowano wykorzystanie miary rozwoju Hellwiga, miary syntetycznej Strahl oraz względnego miernika rozwoju Cieślak. Badanymi obiektami były województwa. Zastosowanie wybranych miar dało zbliżone wyniki klasyfikacji, a wybór metody nie wpłynął istotnie na kolejność porządkowania województw pod względem poziomu zaspokojenia potrzeb mieszkaniowych.

Słowa kluczowe: potrzeby mieszkaniowe, miara syntetyczna, analiza porównawcza.