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Measuring the multidimensional adequacy of pension systems in European countries

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Abstract

The paper presents a multidimensional approach to the adequacy of the pension system, recognising it as the most relevant in comparative analyses of pension systems, as well as more authoritative than a one-dimensional approach based exclusively on pensioners' income calculated on the basis of the replacement rate. Adequacy of the pension system can be also understood to mean the effectiveness of pension system when assessing its ability to realize income objectives. Starting from the micro- and macro functions of the pension system, OMC and World Bank objectives in terms of pension adequacy, and taking into account the indicators used by the European Commission to monitor the attainment of OMC objectives, the paper presents the overall concept of multidimensional adequacy of a pension system. Three dimensions of adequacy are defined: income, poverty, and differentiation of pensioners' material situation by gender. Next, sub-indicators measuring the individual dimensions of adequacy are proposed, along with an aggregation procedure based on the tools of multidimensional statistical analysis. First the sub-indicators are aggregated into synthetic indicators for individual dimensions, and finally the synthetic indicators for individual dimensions are aggregated into a single synthetic indicator of the adequacy of the pension system (APS). Based on the proposed procedure, the adequacy of the pensions systems of 26 European countries is measured, and the quality of this measurement is assessed.

Key words: pensions, adequacy of pensions, effectiveness of pension system, pensioners' income, multidimensional statistical analysis, synthetic indicator

1. Introduction

No matter how we define a pension system and its goals or functions, it is beyond doubt that its main goal is to provide adequate income during retirement. Research into the degree of attainment of this goal is usually limited to studying the level of pensions disbursed from the public or entire pension system, thus presenting a one-dimensional approach to the issue of pension system adequacy. The presented paper represents another approach to the topic, a multidimensional one, based on the microfunction of the pension system, namely the allocation of income over the lifecycle. The proposed concept of a theoretical approach to pension system adequacy and the proposal for its measurement was developed on the basis of the first group of objectives of the Open Method of Coordination (OMC) with regard to pension security, i.e. pension adequacy, and constitutes a slightly modified expansion thereof.

The aim of this paper is to present and support the overall concept of multidimensional adequacy of the pension system, and to propose a method for its measurement using a synthetic measure. Adequacy of the pension system in the paper can be understood to mean the effectiveness of pension system when assessing its ability to realize income objectives. A presentation is made of the approach to pension system adequacy as found in the literature, followed by that proposed by the author, as well as theoretical and practical support for this approach, selection and description of measures of pension system adequacy, methodology for the construction of the adequacy measure based on multidimensional statistical analysis, and the measurement of this adequacy on the example of selected European countries. The paper ends with a summary featuring synthetic conclusions drawn from the analyses performed.

2. Adequacy of the pension system as found in the literature

Authors considering the adequacy of the pension system usually refer to the adequacy of pension benefits. The World Bank specifies the goal of the pension system as the provision of adequate benefits. The objectives of the pension system linked to this kind of adequacy were defined by Holzmann and Hinz (2005). They indicate that the pension system should be one "that provides benefits to the full breadth of the population that are sufficient to prevent old-age poverty on a country-specific absolute level, in addition to providing a reliable means to smooth lifetime consumption for the vast majority of the population." Attainment of these goals thus consists primarily in the prevention of poverty among pensioners and development of tools within the system which enable the proper allocation of income over the lifecycle.

On the other hand, the Open Method of Coordination for the pension systems of EU countries defines the first group of goals as *Adequacy of pensions*, which includes the following specific objectives (European Commission, 2003):

- Preventing social exclusion, which means that "older people are not placed at risk of poverty and can enjoy a decent standard of living; that they share in the economic wellbeing of their country and can accordingly participate in public, social and cultural life."
- Enabling people to maintain living standards, which means to "provide access all individuals to appropriate pension arrangements, public and/or private, which allow them to earn pension entitlements enabling them to maintain, to a reasonable degree, their living standard after retirement."
- Promoting solidarity within and between generations.

The approaches of the World Bank and the European Commission to the issue of pension system adequacy are very similar and basically cover the same goals, with the difference that the Commission also includes among the goals that of inter- and intragenerational solidarity, which in fact is not a goal but an instrument necessary for achieving another goal, i.e. the prevention of social exclusion of the elderly. It is worth noting that the goals of pension systems defined by both institutions display a multidimensional approach to pension system adequacy. Although it is true that they focus primarily on the level of pension benefits – which should ensure an adequate standard of living, at least above the poverty level – they also stress the necessity of providing instruments for the allocation of income over the lifecycle, as well as the necessary solidarity, not just within generations, but also between

them. The latter type of solidarity implies that the standards of living of the working and retired generations should be comparable.

Let us use the concept of adequacy as defined by the World Bank and the European Commission as a starting point for a revision of approaches to the measurement of adequacy of benefits, and subsequently for the adopted concept of theoretical adequacy of not just pension benefits, but the entire, broadly-defined pension system. Many studies which aim to measure adequacy are based on a one-dimensional measurement employing the replacement rate as an indicator. This rate may be construed in various ways, and may be based either exclusively on income in the form of pension benefits, or on all income at the disposal of pensioners, including earnings from work. An extensive review of the types of replacement rates used in studies was made by Borella and Fornero (2009), who themselves based their analysis on broadly-defined replacement rates, involving not only pension benefits, but also other income of pensioners. A similar approach to replacement rates is represented by Zaidi (2010), Mintz (2009), Holzmann and Ufuk (2009) in their analysis of pension adequacy. Guisso, Japelli and Padula (2009) go as far as to state that the replacement rate is "a synthetic indicator of pension wealth". A broader view of adequacy is proposed by Hurd and Rohwedder (2008). First of all, they assume that pension adequacy should be considered in terms of individual welfare, and that income expressed in absolute or relative values (e.g. replacement rate) is not a sufficient measure of this. They adopt wealth as the measure of this welfare. They define economic preparation for retirement based on an inventory of an individual's economic resources and expressed in wealth, and compare it with the optimum consumption path. This approach, though not based exclusively on income, still refers only to the resources held by an individual.

The above-mentioned approaches to the measurement of pension adequacy taken from the literature are incomplete relative to the positions of the World Bank and European Commission quoted above. Namely, they disregard several aspects of broadly-defined adequacy, including primarily the level of poverty among pensioners, variance of their income, and inter- and intragenerational solidarity. The approach to adequacy and its measurement presented in the above-quoted publications is generally one-dimensional, as it is based only on income or wealth in hand. In fact it seems that in the context of the goals of the pension system with reference to its adequacy, a multidimensional approach is more suitable, especially if the measurement is made for several countries and adequacy is evaluated comparatively. The replacement rate alone, particularly if it is based exclusively on pension benefits, may lead to false conclusions. This is because today's pensioners may obtain their income from very different sources, including work and capital investments, and this affects their total income and consequently their standard of living. Therefore the adequacy of pensions only is highly inconclusive. A country with a lower replacement rate may be characterised by a lower degree of attainment of pension system goals in terms of its adequacy. The question to be asked is: Is pension adequacy higher in a country with a higher replacement rate and higher poverty rate among pensioners, or in a country with a lower replacement rate and lower poverty rate? Similar questions may be formulated with reference to the differences between the material situations of retired women and men, variance of incomes among pensioners, and asymmetry of these incomes. This important information concerning pension system adequacy is certainly not provided by the replacement rate or any other simple social indicator. In order to obtain comprehensive information on adequacy, one must use at least a few indicators, meaning that the issue must be approached in a multidimensional manner.

Such a multidimensional approach to the measurement of pension adequacy – and thus to the measurement of the degree of attainment of this group of OMC objectives – was presented by the European Commission in the *Portfolio of Overarching Indicators and Streamlined Social Inclusion, Pensions, and Health Portfolios* (European Commission 2006), describing indicators monitoring the attainment of OMC objectives in particular European countries. There are several indicators employed with reference to the pension system, which can be divided into the following three groups (according to OMC goals concerning pensions): adequacy, financial stability, and modernisation of pension systems. The indicators used for pension adequacy take into account both pensioners' incomes (which includes the replacement rate), but also the variance of these incomes among the population of the elderly, and the risk of poverty among them. It thus represents a multidimensional approach, viewing adequacy from a broad perspective. The further part of this paper presents an approach to pension system adequacy largely based on the one proposed by the European Commission (both in terms of

definition and measurement), but significantly expanded by way of a proposal for a classification of indicators, their supplementation with new indicators, and aggregation into a synthetic indicator.

3. Conceptual framework of adequacy – proposed approach

The modern pension system is an instrument for the allocation of income over a lifecycle (Barr 1987; Barr, Diamond 2006; Blake 2006). The proportions of this allocation may vary widely. Individuals have restricted freedom in making this allocation, and thus in smoothing consumption in over a lifecycle, because certain measures are imposed on them by the public pension system. Outside the system, they are free to choose the path of consumption smoothing. One of the possible paths involves decisions about income allocation over a lifecycle, aimed at providing funds for consumption in old age entirely from the transfer of capital generated in the period of professional activity. On the other hand, individuals may assume that they would still be working in their old age, and thus the transfer of capital (and consumption) from the period of professional activity to the old-age period may be smaller. This means that the pension contribution does not have to be, and today certainly is not, the only instrument in the allocation of income over a lifecycle, and it is in this context that the adequacy of both pensions and the pension system needs to be considered. The presented approach differs from the one usually adopted in literature in that, by taking into account all of pensioners' income, it leads to an evaluation of the pension system not just in terms of whether it provides an adequate level of pension benefits, but whether it enables pensioners to obtain adequate incomes. In this way, by adopting a broad definition of the pension system, we can compare the adequacy of very different systems. This is because some of them may provide pensioners with a high level of public benefits but strongly restrict possibilities of obtaining income from other sources, including work. Other systems may provide low benefits but give a broad range of possibilities of obtaining funds from other sources, including work. With such different systems, adequacy cannot be assessed only through the replacement rate based on the ratio of pension benefits to salaries. Instead, a broad definition of pensioners' income should be adopted, going significantly beyond pension benefits. When account is taken not only of the benefits themselves but also the possibility of other income, there is more of a basis for determining the adequacy of the pension system rather than simply the adequacy of pensions.

As has already been remarked above, the paper presents a multidimensional approach to pension adequacy, and accordingly the following dimensions of this adequacy are identified, based largely on the goals of the pension system as defined by the World Bank and the European Commission:

- 1st dimension: pensioners' incomes,
- 2nd dimension: poverty among pensioners,
- 3rd dimension: gender-based variance of income and poverty among pensioners.

The first dimension was described in general in the introduction to this section. It includes both the level of income and its variance among the pensioner population. The two remaining dimensions are explained below.

Minimisation of poverty risk among pensioners is one of the goals of the pension system in terms of its adequacy. It is a goal which necessitates redistribution (mostly intragenerational but also intergenerational) within the pension system. The need to achieve this goal is obvious and does not require further explanation. On the other hand, the third dimension of pension system adequacy is at a certain variance with the objectives defined by the European Commission. This specifically refers to a goal from the third group of OMC objectives: *Modernisation of Pension System*, namely: Meet the Aspirations for Greater Equality of Women and Men, including in material terms or with regard to the standard of living. It seems, however, that this objective is more concerned with the adequacy of the pension system than its modernisation. This is because it pertains to gender-based variance among pensioners, including the variance of income and poverty.

Another important element of an approach to pension system adequacy is the issue of its measurement: to what extent should it be treated as a characteristic independent of the situation of the working population, and to what extent as a consequence of that situation. This is because the level of pensioners' income is largely determined by their income in the time when they were professionally active. Furthermore, one of the macrofunctions of the pension system is the division of current GDP between the working generation and other generations, including pensioners. This means that pensioners' incomes depend on the one hand on the proportion of income allocation over the lifecycle,

and on the other hand on the current GDP and the proportion of its division between generations. When assessing the adequacy of the pension system, this fact should certainly be taken into account, and the situation of pensioners should be analysed with reference to the situation of the working generation. It is also related to intergenerational solidarity and the resultant need for intergenerational redistribution in the pension system. The assessment of pension system adequacy also requires a relative measurement of income (level and variance), poverty and unequal distribution of income and poverty by gender, through comparison of the indicators describing selected characteristics in the pensioner population with corresponding indicators for the working population. This is because these characteristics, i.e. income, poverty, or inequality of income, may be and probably are a derivative of the same characteristics from the period of professional activity. Let us analyse the described approach using an example. Let us assume that there are two countries: A and B. In country A the poverty rate among pensioners amounts to 20%, and in country B to 25%. Therefore it seems that the pension system of country A is more adequate in terms of poverty. However, if we make another assumption, that in country A in the professionally active group the poverty rate amounts to 25%, and in country B to 20%, it turns out that in country A the risk of poverty decreases after retirement, while in country B it increases, so our view of the adequacy of the pension systems in these two countries may change. Therefore, apart from employing measures which characterise the retired generation, it seems valid also to use measures describing the relation of the values of particular characteristics between the retired generation and the working generation. This is because the pension system does not function in separation from the social and economic reality of a given country, and it should not be expected that, for example, the risk of poverty in a poor and rich country will be similar, although it is probable that the risk of poverty in the two countries does not change or changes in a similar way after attainment of retirement age.

4. Adequacy indicators

As the multidimensionality of a pension system is partly reflected in a set of indicators monitoring the attainment of OMC objectives, included in the aforementioned EC document *Portfolio of Overarching Indicators…* (2006), this set was used as a basis for developing a set of indicators for synthetic measurement of multidimensional adequacy. However, within the proposed concept of measurement, the indicators were selected on the basis of such criteria as importance, information duplication and availability of statistical data; they were then supplemented with the author's own proposed indicators, and divided into three groups according to the particular dimensions of pension system adequacy. As the majority of indicators pertain to specific age groups rather than pensioners specifically, in the case of these indicators it was assumed that the retirement age in the countries under analysis is 65 years for both women and men. Without this assumption, it would have been impossible to measure pension system adequacy using the selected social and economic indicators. It was also necessary for data comparability across analysed countries.

Some indicators used in the analysis are called or interpreted as the change of some variables referring to: poverty, income or inequality of incomes, when reaching the retirement age although the current values of selected variables for population 0-64 (or 50-64) and 65+ are compared (not values of this variables for the same cohort in two different periods). This is a necessary simplification because the data for the same age cohort from different periods (0-64 and then 65+) are unavailable. But it is in accord with the macro functions of the pension system, which is the division of current GDP between the working generation and other generations, including pensioners. The life standard of pensioners is determined not only by their life standard before retirement but also by the economy growth and present GDP shared between generations.

The set of sub-indicators of adequacy is shown in Table 1.

Table 1. Indicators of pension system adequacy

Pensioner Income Indicators – *PI*		
Symbol	Name of indicator	Source
PI1	Median relative income ratio of elderly people	*Portfolio of Overarching Indicators…* (European Commission 2006)
PI2	Aggregate replacement ratio (excluding other social benefits)	*Portfolio of Overarching Indicators…* (European Commission 2006)
PI3	Relative inequality of income distribution ratio	Author's proposition
PI4M *PI4F*	Net pension wealth by gender	OECD
Pensioner Poverty Indicators- *PP*		
PP1	At-risk-of-poverty rate of older people (after social transfers)	*Portfolio of Overarching Indicators…* (European Commission 2006)
PP2	Change in at-risk-of-poverty rate of older people after retirement (after social transfers)	Author's proposition
Pensioner Gender Differences Indicators - *GD*		
GD1	Gender differences in the at-risk-of-poverty rate of older people (after social transfers)	*Portfolio of Overarching Indicators…* (European Commission 2006)
GD2	Gender differences in aggregate replacement ratio	*Portfolio of Overarching Indicators…* (European Commission 2006)
GD3	Change in at-risk-of-poverty rate of older people after retirement by gender (after social transfers)	Author's proposition
GD4	Median relative income ratio of elderly people by gender	Author's proposition
GD5	Relative difference in net pension wealth by gender	Author's proposition

Source: own compilation.

The first group of indicators of pension system adequacy consists of income indicators. **The median relative income ratio of elderly people (65+) (*PI1*)** is the quotient of the median of average disposable income per household member in the population aged 65+ and the median of corresponding income in the population aged 0–64. A median, in contrast to a mean, disregards the extreme values of a characteristic. This means that in the event of a strong right-sided asymmetry of income, the small fraction of people with the highest income does not determine the median value. Therefore, the median relative income ratio indicates the relative change in income which occurred upon reaching retirement age (65+). *PI1* is a stimulant variable ((larger the better) and a value exceeding 1 means that the

median of pensioners' incomes is higher than the median of incomes in the population aged 0–64. A value equal to 1 means that the income medians in the two groups are at the same level, and a value below 1 indicates that the income median of pensioners is lower. The indicator under analysis, which is based on disposable income, includes all types of income – not only from pensions, but also from work, self-employment, transfers and other sources. In general terms, it might be said that a value of this indicator greater than 1 means that the income situation upon reaching retirement age is improved, a value equal to 1 means it remains unchanged, and a value less than 1 means it deteriorates.

The aggregate replacement ratio (*PI2*) is defined by Eurostat as the relation between the median of pension benefits in the 65–74 age group and the median of salaries in the 50–59 age group, excluding social transfers (in this case, pensions are treated as income, not transfer). This indicator is a measure of pension system adequacy, but only with reference to the level of benefits paid out from this system. It does not include other types of income obtained by pensioners, including work earnings, income from capital invested outside the pension system, etc. *PI2* is a stimulant variable. It is hard to determine the extent to which the pension benefit should replace income from work. Assuming that an adequate pension system in terms of income is one that enables pensioners to obtain broadly-defined income, i.e. not just pension benefits, but also income from work or transfers, it should not be inferred that an adequate pension system is one guaranteeing a replacement rate of at least 1. This indicator should be interpreted in rather general fashion, i.e. higher values indicate a greater adequacy of the pension system in terms of income. A supplementary measure to that under discussion is the **aggregate replacement ratio including other social transfers**, which refers not only to the value of pension benefits, but to benefits from the entire social security system to which pensioners are entitled. However, there are currently no statistical data for this indicator; according to the Eurostat website these data are under preparation. This means that in the future it will be possible to make use of the information contained in this indicator.

The relative inequality of income distribution ratio (*PI3*), being the author's proposition for a pension system adequacy indicator, is an indicator of the inequality of the income distribution ratios (*II*) of the 0–64 and 65+ age groups. This indicator is expressed by the following formula:

$$PI3 = \frac{II_{0-64}}{II_{65+}}$$

The inequality of income distribution ratio in a given age group is defined by Eurostat as the quotient of the total incomes of the 20% of people with the highest incomes, and the incomes of the 20% of people with the lowest incomes. A higher value of this ratio indicates a higher variance of income in a given age group. The ratio is one of the indicators of pension adequacy, and according to the European Commission it should help assess the attainment of OMC objectives. It should be noted, however, that pensioners' incomes are largely a consequence of their incomes from the period of professional activity. Thus an analysis of income distribution in the 65+ population in separation from the distribution in the 0–64 population represents a certain simplification, as the distribution of pensioners' incomes was largely shaped during the period of professional activity. Therefore, when analysing the distribution of pensioners' incomes, it is advisable to compare it to the distribution of income in the younger population, and thus to answer the question of whether the pension system increases the differences in incomes, does not affect them, or reduces them in comparison to the younger generation. The proposed relative inequality of income distribution ratio is the quotient of the inequality of income distribution ratios in the 0–64 population and in the pensioner population. The choice of the 0–64 age group is due to the availability of data on this population – there is no available inequality of income distribution ratio for the 50–64 population. A value of the ratio less than 1 means that the inequality of income among pensioners is higher than in the 0–64 age group; a value equal to 1 means that the variance is the same in both age groups; and a value higher than 1 means that income inequality among pensioners is lower than in the 0–64 population. In simpler terms, a value less than 1 means that the pension system increases the differences in income, while a value greater than 1 means that the system levels out these differences. A pension system should certainly not widen these

differences, neither should it level them out excessively, as they are derivative of the income generated during the period of professional activity, as well as of thrift and foresight about financial security in old age. For this reason, *PI3* will be treated as a nominant variable (nominal the best) with a desired value of 1. It should be added that the income considered in all inequality ratios is disposable income, calculated for a household per household member. The income includes not only salaries, but also all kinds of transfers in both analysed populations.

At this point it is worth noting that in the case of the *PI3* indicator, as in the case of other indicators proposed by the author and discussed in the further part of the paper, representing relations of specific variables calculated for the 65+ population and the younger population, the information used comes from a given period/point in time, rather than data pertaining to the same population in two different periods/points in time, and thus incorporates a time shift. Even though these indicators are interpreted as a relative change in the status of a specific variable characterising a population as a result of reaching retirement age and starting to draw income from the pension system, it is technically impossible to refer the value of a given characteristic of the pensioner population to the value of this variable describing the same population while still professionally active. There are two basic reasons for this. First of all, we cannot obtain adequate statistical data concerning the 65+ population from the period when its members were professionally active, as there is no upper limit determined with reference to this age range. Second, there would be a risk that some years ago the selected indicators were estimated according to a different methodology. Thus adopting the aforementioned simplification is necessary, and it is also substantively well-founded. Namely, as was mentioned before, the pension system on a macroscale is defined as an instrument for the division of current GDP. Therefore certain changes, e.g. in poverty rates among the pension-age population in relation to corresponding poverty rates in the same population while still professionally active, may stem from a country's economic growth and consequently socio-economic growth, rather than from the adequacy of the pension system. Relating poverty rates among pensioners to poverty rates in the professionally-active population in the same period/at the same point in time results in the measurement being made with the assumption of the same GDP, and thus reflecting the current division between pensioners and the younger generation.

Another indicator to be considered in the context of pension system adequacy, and one of a predictive nature, is the **net pension wealth by gender (*PI4M* and *PI4F*)**, estimated by OECD (2005) as the current value of future streams of pension benefits upon the deduction of taxes and social insurance contributions. The indicator is expressed as a multiple of annual average gross salary in a given country. Its estimation takes into account the country's statutory retirement age and average life expectancy. In comparative analyses, the indicator serves as a prognosis of the variance of future pension benefits among the currently working generation and it is a stimulant variable. Due to the absence of full statistical data, this indicator is not included in the analysis described in this paper.

The second group of indicators of pension system adequacy consists of pensioner poverty indicators. **At-risk-of-poverty rate of older people (65+) after social transfers (*PP1*)** is an indicator of the fraction of people with disposable income amounting to less than 60% of median income in the entire population. The rate is a measure of the capacity of the social security system to provide elderly people with benefits at a level regarded as the minimum (meaning one ensuring a standard of living above the poverty line). It takes accounts of all social transfers, including pension benefits. A supplementary indicator to *PP1* might be the **At-risk-of-poverty rate of older people (65+) before social transfers**, which does not include social transfers. Its possible use in the analysis should be preceded by an assessment of the similarity of the two indicators in the group of countries under study. In the analysis described in the paper, the correlation between the two indicators is very high and amounts to 0.90, which indicates a very high similarity, and thus a similar information potential between the two variables. Therefore the analysis will only employ *PP1*, so as to avoid repeating the same information and contributing it twice to the synthetic indicator. Both at-risk-of-poverty rates should be treated as a destimulant variables (smaller the better), as lower values indicate a higher adequacy of the pension system.

The above two at-risk-of-poverty rates in the pensioners' age group take no account of similar rates in the age groups of the professionally active. This means that by analysing the values of these indicators, we learn what percentage of people aged 65+ are at risk of poverty, but we do not know if this risk increases upon reaching retirement age, or remains at a similar level as during the period of professional activity. Consequently there is no information as to whether the pension system increases, decreases, or does not affect the probability of having income below the line regarded as the minimum adequate income for the elderly. If pensioners' incomes are viewed from a broad perspective, and include, apart from pension benefits from the public and private systems, also possible income from work, capital or social transfers, they should also be compared to similar incomes of people of productive age. One might propose the **change in at-risk-of-poverty rate at the age of 65+ (*PP2*),** representing the relation between at-risk-of-poverty rates (*RP*) among people aged 50–64 and older people (65+) (after social transfers). This rate is expressed by the following formula:

$$PP2 = \frac{RP_{50-64}}{RP_{65+}}$$

If the value is below 1, the risk of poverty increases upon reaching retirement age; if it is equal to 1, it means that the risk is unchanged; and if the value exceeds 1, the risk decreases upon reaching retirement age. If we consider pensioners' entire disposable income, and assume that the pension system is supposed to provide this income in the form of benefits or (in addition) enable it to be obtained in another way, the pension system is adequate in this dimension if the value of the proposed indicator (stimulant variable) is equal to or greater than 1.

The last group of indicators of pension system adequacy are indicators of gender differences in pensioner income and poverty. This group is based on indicators from the two first groups. They may be divided into indicators which do not refer to the variance of the situation of men and women in the working population, and those which do. It is worthwhile to supplement the first approach with the second one, because (as was signalled earlier) incomes during retirement are largely determined by incomes in the working period. Therefore the differences in pensioners' incomes result from differences in their incomes during the period of professional activity. Taking into account the indicators of variance in the situation of men and women during the working period helps to determine whether or not the pension system widens these differences.

One of the indicators of gender difference which does not refer to the income situation of pensioners while they were professionally active is **gender differences in the at-risk-of-poverty rate of older people (*GD1*).** This indicator represents the difference between the values of these rates for men and women. A positive value of the indicator means that men are more at risk of poverty than women, and a negative value indicates the opposite. The indicator should be treated as a nominant variable with a desired value of 0, meaning that gender does not affect the risk of poverty.

Other indicators from the third group of adequacy indicators refer the income situation of pensioners to the situation of the working population. **Gender differences in aggregate replacement ratio (*GD2*)** indicates the difference in replacement ratios for men and women. A positive value means that incomes of male pensioners replace their past earnings to a greater extent than in the case of women, and a negative value indicates the opposite. *GD2* is a nominant variable with a desired value of 0, meaning that gender does not affect the replacement rate.

Moreover, one might suggest two further indicators in this group, in accordance with the approach adopted earlier that incomes in the pension system and differences in these incomes are derivative of the incomes and differences in the period of professional activity. The first of these is the **change in at-risk-of-poverty rate of older people after retirement by gender (*GD3*).** This indicator is calculated by dividing the at-risk-of-poverty (*RP*) quotient of male (M) pensioners and female (F) pensioners by the at-risk-of-poverty quotient of men and women in the 50–64 age group, i.e.:

$$GD3 = \frac{\frac{RP_{M\,65+}}{RP_{F\,65+}}}{\frac{RP_{M\,50-64}}{RP_{F\,50-64}}} = \frac{\frac{RP_{M\,65+}}{RP_{M\,50-64}}}{\frac{RP_{F\,65+}}{RP_{F\,50-64}}}$$

If the value of the indicator is equal to 1, it means that after retirement (assuming that the retirement age is 65 for both men and women) the relation between the risk of poverty among men and women is the same as before reaching retirement age. The indicator provides no information on whether the risk of poverty among women or men has increased, decreased, or remained unchanged, but it does inform as to whether the relation between the risk of poverty among male and female pensioners has changed in comparison with the period of professional activity. It is desirable that the pension system not affect this relation, so the indicator is a nominant variable with a desired value of 1.

Another adequacy indicator proposed by the author is **the median relative income ratio of elderly people (65+) by gender (*GD4*)**, being the quotient of the median relative income ratios (*MRI*) of men (M) and women (F) in the 65+ age group:

$$GD4 = \frac{MRI_{M\,65+}}{MRI_{F\,65+}}$$

A value of *GD4* equal to 1 means that the relation between the incomes of men aged 65+ and men aged 0–64 is equal to the relation between the incomes of women aged 65+ and women aged 0–64. This means that broadly-defined pension income replaces the income from the period of professional activity of men and women in the same degree. *GD4* is a nominant variable with a desired value of 1, which means that the pension system neither widens nor levels out the differences between the incomes of men and women. The indicator gives no information as to whether the incomes of men or women increased or decreased on reaching the age of 65.

Another indicator which might be usefully employed in the measurement of this dimension of pension system adequacy is the **relative difference in net pension wealth by gender (*GD5*)**, also proposed by the author. The indicator represents the relation between the quotient of pension wealth (*PE*) of men (M) and women (F), and the quotient of the average annual net earnings (*AE*) of men and women:

$$GD5 = \frac{\frac{PW_M}{PW_F}}{\frac{AE_M}{AE_F}}$$

Comparing only the pension wealth itself would have been an excessive simplification, as the differences are derivative of current earnings. Referring the differences in these indicators to the differences in current earnings of men and women makes them more comparable, and thus the major cause of variance will be the difference in retirement age and life expectancy of men and women. *GD5* is a nominant variable with a desired value of 1, meaning that the expected relation between the incomes of male and female pensioners will be similar to that from the period of professional activity.

5. Measurement of adequacy of pension systems of selected European countries

5.1. Measurement Method

The diagnostic indicators were selected on the basis of substantive criteria, i.e. the measurement of pension system adequacy was performed based on the sub-indicators presented in Table 1 (except for those for which no statistical data was available, i.e. pension wealth indicators), as these variables represent the most important characteristics of the multidimensional adequacy of a pension system, according to the adopted definition. All sub-indicators were subjected to transformation (stimulation) in order to unify their character, namely to make a higher value more desirable in the case of all variables. This means that they will all affect the synthetic indicator in the same direction. Following the transformation, a higher value of a sub-indicator translates into a higher value of the synthetic indicator, and consequently a greater adequacy of the pension system. The destimulant variables were transformed using the following formula:

$$x_{ij}^{'} = \max_i x_{ij} - x_{ij}$$

Nominant variables were transformed according to the following formula:

$$x_{ij}^{'} = -\left| x_{ij} - x_{ij}^{N} \right|.$$

where x_{ij}^{N} denotes the nominal value of variable X.

Variables were standardised using the following unification formula:

$$z_{ij} = \frac{x_{ij} - \min_i x_{ij}}{\max_i x_{ij} - \min_i x_{ij}}.$$

Aggregation of sub-indicators into a synthetic indicator of adequacy was performed in two stages – similarly as in the case of HDI, for example – by first calculating the synthetic indicators for individual dimensions, and next calculating the general synthetic indicator. Although in the case of HDI the calculation formula has recently come to employ the geometric mean, this study employs an arithmetic mean formula (the type previously used for HDI). The first step was to calculate the synthetic indicators for individual dimensions of adequacy as arithmetic means of sub-indicators, according to the following formulae:

$$PI = \frac{1}{3}\left(PI1 + PI2 + PI3\right),$$

$$PP = \frac{1}{2}\left(PP1 + PP2\right),$$

$$GD = \frac{1}{4}\left(GD1 + GD2 + GD3 + GD4\right).$$

Next, a synthetic indicator of adequacy of the pension system (*APS*) was calculated as the arithmetic mean of the synthetic indicators for particular dimensions:

$$APS = \frac{1}{3}\left(PI + PP + GD\right)$$

The presented approach to the measurement helps to provide a more detailed assessment of adequacy, as the result includes not just a synthetic indicator of adequacy, but also synthetic indicators of its individual dimensions. Thus conclusions may be formed with reference both to the broadly-defined multidimensional adequacy of the pension system, and specifically to incomes, poverty, and gender differences in pensioners' material situation.

5.2. Study Period and Subjects

Data were collected for three periods (years): 2005, 2007 and 2009. Measurement of three close periods will serve a validation function. It is assumed that pension system adequacy does not change over a short time span, and so the results for the years under analysis should be similar. The occurrence of significant discrepancies will suggest the need for repeated validation of the statistical data and calculations in order to check for mistakes made at the data collection or measurement stage. In addition, performing the measurement with reference to several years will increase the generality of the conclusions.

The analysis concerned 26 European countries: Belgium, the Czech Republic, Denmark, Germany, Estonia, Ireland, Greece, Spain, France, Italy, Cyprus, Latvia, Lithuania, Luxembourg, Hungary, Malta, the Netherlands, Austria, Poland, Portugal, Slovenia, Slovakia, Finland, Sweden, the United Kingdom and Norway. The selection of these European countries results from the availability of statistical data in Eurostat databases.

5.3. Measurement Results

Table 2 presents the values of synthetic indicators for individual dimensions of adequacy, the values of the synthetic indicator *APS*, and ranks of particular countries in terms of pension system adequacy in 2005, 2007 and 2009.

Table 2. Values of *APS* and ranks of countries in terms of pension system adequacy.

Country	2005					2007					2009				
	PI	*PP*	*GD*	***APS***	**Rank**	*PI*	*PP*	*GD*	***APS***	**Rank**	*PI*	*PP*	*GD*	***APS***	**Rank**
Luxembourg	0.81	0.69	0.73	**0.74**	**2**	0.82	0.84	0.90	**0.85**	**1**	0.70	0.98	0.67	**0.79**	**1**
Hungary	0.70	0.82	0.64	**0.72**	**3**	0.72	0.84	0.50	**0.69**	**4**	0.73	0.96	0.59	**0.76**	**2**
Netherlands	0.59	0.80	0.89	**0.76**	**1**	0.55	0.60	0.86	**0.67**	**5**	0.55	0.66	0.81	**0.67**	**4**
France	0.75	0.47	0.76	**0.66**	**7**	0.88	0.59	0.76	**0.74**	**2**	0.94	0.61	0.70	**0.75**	**3**
Germany	0.70	0.58	0.72	**0.67**	**5**	0.63	0.61	0.71	**0.65**	**7**	0.56	0.65	0.80	**0.67**	**5**
Austria	0.91	0.51	0.57	**0.66**	**6**	0.91	0.57	0.50	**0.66**	**6**	0.88	0.52	0.54	**0.65**	**6**
Poland	0.62	0.98	0.48	**0.69**	**4**	0.67	0.97	0.55	**0.73**	**3**	0.53	0.65	0.53	**0.57**	**11**
Malta	0.68	0.43	0.81	**0.64**	**8**	0.69	0.51	0.61	**0.60**	**8**	0.50	0.48	0.85	**0.61**	**8**
Belgium	0.45	0.39	0.95	**0.60**	**11**	0.55	0.41	0.85	**0.60**	**9**	0.50	0.41	0.89	**0.60**	**9**
Portugal	0.66	0.34	0.85	**0.62**	**9**	0.65	0.42	0.73	**0.60**	**10**	0.61	0.50	0.57	**0.56**	**12**
Greece	0.60	0.35	0.77	**0.57**	**14**	0.50	0.48	0.74	**0.58**	**12**	0.34	0.47	0.90	**0.57**	**10**
Czech Republic	0.49	0.73	0.51	**0.58**	**13**	0.44	0.75	0.57	**0.59**	**11**	0.35	0.69	0.60	**0.55**	**14**
Slovakia	0.55	0.71	0.54	**0.60**	**10**	0.55	0.65	0.49	**0.56**	**13**	0.43	0.56	0.50	**0.50**	**16**
United Kingdom	0.46	0.38	0.79	**0.54**	**17**	0.50	0.36	0.75	**0.53**	**16**	0.44	0.42	0.79	**0.55**	**13**
Spain	0.62	0.31	0.81	**0.58**	**12**	0.54	0.36	0.79	**0.56**	**14**	0.37	0.40	0.53	**0.43**	**21**
Italy	0.68	0.40	0.62	**0.57**	**15**	0.66	0.46	0.46	**0.52**	**17**	0.68	0.46	0.51	**0.55**	**15**
Ireland	0.39	0.28	0.69	**0.45**	**21**	0.44	0.38	0.63	**0.48**	**20**	0.59	0.60	0.72	**0.64**	**7**
Finland	0.53	0.41	0.55	**0.49**	**19**	0.52	0.39	0.70	**0.54**	**15**	0.54	0.37	0.47	**0.46**	**17**
Denmark	0.36	0.36	0.81	**0.51**	**18**	0.36	0.38	0.83	**0.52**	**18**	0.25	0.33	0.77	**0.45**	**18**
Sweden	0.70	0.49	0.47	**0.55**	**16**	0.76	0.51	0.30	**0.52**	**19**	0.67	0.38	0.27	**0.44**	**19**
Slovenia	0.61	0.43	0.24	**0.42**	**22**	0.67	0.46	0.18	**0.44**	**21**	0.61	0.42	0.27	**0.44**	**20**
Norway	0.61	0.37	0.28	**0.42**	**23**	0.57	0.46	0.17	**0.40**	**22**	0.57	0.44	0.16	**0.39**	**22**
Latvia	0.46	0.50	0.44	**0.47**	**20**	0.33	0.34	0.38	**0.35**	**23**	0.11	0.08	0.48	**0.22**	**26**
Estonia	0.32	0.49	0.38	**0.40**	**24**	0.23	0.31	0.46	**0.33**	**24**	0.24	0.26	0.30	**0.27**	**25**
Lithuania	0.31	0.57	0.25	**0.38**	**25**	0.26	0.34	0.28	**0.30**	**26**	0.24	0.44	0.36	**0.35**	**23**
Cyprus	0.30	0.00	0.66	**0.32**	**26**	0.31	0.00	0.68	**0.33**	**25**	0.28	0.00	0.59	**0.29**	**24**

Source: own calculations based on EUROSTAT data

An analysis of the results shown in Table 1 reveals that the most adequate pension systems in the years under study were those of Luxembourg, Hungary, the Netherlands, France, Germany and Austria. At the opposite end of the scale, the countries with the least adequate pension systems were Cyprus, Lithuania, Estonia, Latvia, and – interestingly – Norway. The analysis of synthetic indicators of individual dimensions indicates that Norway has very strong differences in the material situation of male and female pensioners, evidenced by a very low value of the synthetic indicator *GD* in the years under study. On the other hand, the very high rank of Hungary results from the very good situation (in comparison with the other countries under study) in terms of poverty among pensioners, with very favourable values of the relevant indicators.

Also worthy of note is the high stability of the results over time, which is shown by the similar values of *APS* for most countries in consecutive periods and similar ranks on the list. In the case of all stimulant variables, the value of the Pearson coefficient of correlation with *APS* was positive, and in the case of destimulant variables it was negative, which shows that all sub-indicators adequately influence the value of the synthetic measure.

Referring to the aforementioned studies which aim to evaluate pension system adequacy on the basis of a one-dimensional approach, with the replacement rate as dominant indicator, it was verified whether there is high conformity between the ordering of pension systems exclusively according to the replacement rate (*PI2*) and according to *APS*. For comparison purposes, the conformity of *APS* and other sub-indicators used in the assessment of pension system adequacy was also studied. In order to do that, the Spearman rank correlation coefficient was used, as the assessment concerned only the conformity of countries' ranking by two different indicators, without regard to the analytical form of the possible relation between the indicators. Unified values of sub-indicators were used. The results are shown in Table 3.

Table 3. Spearman rank correlation coefficients between *APS* and particular unified sub-indicators.

Sub-indicator	2005	2007	2009
PI1	**0.71**	**0.74**	**0.73**
PI2	0.47	0.52	0.33
PI3	0.13	0.24	0.31
PP1	**0.54**	**0.67**	**0.70**
PP2	**0.51**	**0.73**	**0.76**
GD1	**0.64**	0.48	**0.65**
GD2	0.23	0.38	0.23
GD3	0.23	0.24	0.28
GD4	0.29	0.38	**0.51**

Source: own calculations based on EUROSTAT data

It turns out that replacement rate (*PI2*) is not the indicator which ranks the adequacy of pension systems with the greatest conformity with *APS*. In fact this is another sub-indicator, *PI1* – median relative income ratio of elderly people. Other indicators: *PP1* – At-risk-of-poverty rate of older people (after social transfers), *PP2* – Change in at-risk-of-poverty rate of older people (after social transfers) and *GD1* – Gender differences in the at-risk-of-poverty rate of older people (after social transfers) also rank the pension systems in a more similar order to *APS* than the replacement rate does. This means that although the replacement rate is one of the most important indicators of multidimensional adequacy of a pension system, it is not the most representative indicator of this adequacy.

6. Conclusions

The multidimensional approach of the European Commission to the issue of pension system adequacy (which can be also understood to mean the effectiveness of pension system when assessing its ability to realize income objectives) is well-founded, since assessment of this adequacy exclusively

on the basis of the replacement rate, regardless of its definition and scope (including broader or narrower pensioner incomes), is one-dimensional and thus overly simplified. This approach is more relevant in the assessment of pension benefits or pensioners' incomes than in the evaluation of pension system adequacy. The synthetic approach to adequacy opens new possibilities for many other analyses in the field of pension security, including comparison of adequacy in various pension regimes. A drawback of the presented approach is the relativity of the assessment of adequacy, which is very difficult to avoid. This stems from the fact that we do not know the optimum values of many sub-indicators (apart from nominant variables), and we merely indicate the desirable direction of changes in their values: growth in the case of stimulant variable and decline in the case of destimulant variables. Thus the assessment made on the basis of *APS* is one made against the background of the objects under study. One might additionally create a model and anti-model of an adequate pension system, which would be characterised respectively by the best and worst values of the individual sub-indicators, and adopt these two hypothetical systems as reference points in the assessment of adequacy. Nonetheless, the evaluation would still be relative, as both the model and anti-model would have been developed on the basis of information about the objects under study. Therefore a system recognised as most adequate in the group of studied objects may prove inadequate in relation to other objects from outside the studied group.

References

Barr N. (1987) 'The Economics of The Welfare State', Weidenfeld and Nicolson, London.

Barr N., Diamond P. (2006) 'The Economic of Pensions', *Oxford Review of Economic Policy* 22 (1): 15-39.

Blake D. (2006) 'Pension Economics', John Wiley & Sons, West Sussex, England.

Borella M., Fornero E. (2009) 'Adequacy of Pension Systems In Europe: An analysis based on comprehensive replacement rates', *Social welfare policies*, ENEPRI Research Reports.

European Commission (2003) 'Adequate and sustainable pensions', Luxembourg.

European Commission (2006) 'Portfolio of Overarching Indicators and Streamlined Social Inclusion, Pensions, and Health Portfolios', Brussels.

Guisso L., Japelli T., Padula M. (2009) 'Pension Risk, Retirement Saving and Insurance', Centre for Studies in Economics and Finance, Working Paper No. 223, Naples, Italy.

Holzmann R., Ufuk G. (2009) 'Adequacy of Retirement Income after Pension Reforms in Central, Eastern and Southern Europe', World Bank, Washington.

Holzmann, R., R. Hinz (2005) 'Old-Age Income Support in the Twenty-first Century: An International Perspective on Pension Systems and Reform', Web Version of 18 February 2005, World Bank.

Hurd M.D., Rohwedder S. (2008) 'The Adequacy of Economic Resources in Retirement', MRRC-Working Paper No. 2008-184.

Mintz J.M. (2009) 'Summary Report on Retirement Income Adequacy Research', Research Working Group on Retirement Income Adequacy of Federal-Provincial-Territorial Ministers of Finance.

OECD (2005) 'Solving the pension puzzle', OECD Policy Brief, March.

Zaidi A. (2010) 'Sustainability and adequacy of pensions in EU countries. A cross-national perspective', European Centre for Social Welfare Policy and Research, Vienna.