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## Problems of Quantifying Public Goods in the Healthcare Sector<sup>1</sup>

**Abstract:** A market system does not automatically lead to an optimum allocation of public goods. Market-based exchange will always lead to a deficit of a public good compared with the socially optimal level. We argue that public goods in each sector of the economy constitute an isomorphic, socioeconomic system that is not a “black box.” Thus, in order to determine the deficit of public goods, it is first necessary to investigate the available quantities versus the quality of those goods, because their performance is not only a function of public spending. There is no generally accepted methodology for doing this and there are no universal methods for quantifying public goods. The aim of this work is to develop a universal methodology for the quantification of public goods in ordinal categories, taking into account both the amount and quality of a good and budgetary valuing. In the empirical part, the authors identify various models (assets structures) of healthcare financing, using a set of OECD countries as an example. The authors also investigate to what extent these models influence the value of public goods in that sector. Composite measures have been computed for both the amount and quality of public goods. Subsequently, an agglomerative cluster analysis and a multifactorial analysis of variance are performed. Although the studied systems are diverse and reflect different social choices, the analyses show that the effectiveness of a healthcare system depends not only on the level of public financing, but also on its structure.

**Keywords:** public goods, health policy, healthcare system, public sector efficiency

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## Introduction

The quantification of public goods is among the most complex problems in the theory of public choice. Quantification is an act of counting, measuring and valuing that maps qualitative features into a set of numbers and values. There are certain goods and services in the economy which have the specific features of being “non-rivalrous” and “non-excludable”, and are called *public goods*. The concept of public goods represents a certain generalisation. In economic theory four types of goods are distinguished: private, common, club, and public. The criteria for this taxonomy encompass four properties: “rivalrous”, “non-rivalrous”, “excludable” and “non-excludable”<sup>2</sup>. According to a narrow definition, “pure” public goods are taken to be those which are non-rivalrous and non-excludable [Ulbrich, 2003, p. 67]. In practice, however, few such goods exist in the economy (examples may include national defence, law and order, and security). We therefore extend this definition to include so-called merit goods, which from a physical standpoint might be private goods, but as a result of social doctrine and of the social policy implemented by the public authorities, are supplied to a citizen even when he or she does not accept that fact. They include most of the goods financed by the public sector, particularly in the fields of education and healthcare, but also, in accordance with the latest concepts, in agriculture.

A market system does not automatically lead to the optimum allocation of public goods. Market-based exchange will always lead to a deficit of a public good compared with the socially optimal level [Osiatyński, 2006, p. 55]. It is commonly known that individuals have no incentive to disclose their true demand for non-excludable goods. Therefore, some economists are very pessimistic as to whether it is possible to assess people’s preferences for public goods [Frey et al., 2009]. The absolute (cardinal) value of a public good depends on individual utility functions, and hence it is difficult to make an objective determination of such a value, or an approximation of individually experienced welfare. However, a vast literature exists which reflects on attempts to estimate utility functions for public goods. Essentially, three avenues have been pursued: revealed preference methods (i.e. the hedonic method and the defence expenditure approach), stated preference methods (e.g. the contingent valuation method), and the Life Satisfaction Approach (a method of valuing the psychological costs of public bads) [Kahneman and Thaler, 2006; Kahneman

<sup>2</sup> A good is non-rivalrous if consumption of the good by an individual has no negative effect on consumption by other individuals, whereas a good is non-excludable if it is not possible to exclude an arbitrary consumer from the consumption of that good [Klimowicz, Bokajała, 2012, p. 98].

et al., 1997]. A common point of these approaches is the need for microeconomic data which reveal the demand for public goods, which is always a very debatable issue. Thus, an “ordinal”, or relative value of a public good is not as highly questionable as its “cardinal” (absolute) value. It is objectively possible to identify which public goods are more, or less efficient in terms of satisfying public needs (considering both the availability of healthcare services and their quality), but there is not a generally accepted methodology for doing this.

Economists usually assume that public spending should translate into the highest performance of the public sector. When we consider public spending on the one hand and performance indicators on the other, we are assuming that the set of public goods together with its attributes – availability, sequence of provision and complementarities – is not significant. In actual fact, however, this is not true. The authors attempt to fill this gap, adopting a different approach to estimating the efficiency of PG provision. This distinguishes three dimensions of the process of PG quantification: public spending (valuing healthcare goods), the available amount of public goods (counting), and measures of public goods quality (measuring).

This attempt to quantify public goods comes up against the problem that increases in the amount and availability of public goods do not always go hand in hand with their quality. Hence the chief aim of this work is to develop a universal methodology for the quantification of public goods in ordinal categories, taking account of both the amount (the package of provided public goods) and quality of those goods. The definition of synthetic measures of the amount and quality of public goods enables the computation of a specific measure of the efficiency of supply of such goods. At the next step, the financial determinants of that process can be identified. The present work, however, has not only a methodological dimension. The authors have attempted to apply the developed methods in order to investigate the process of supply of public goods in the healthcare sector in OECD countries. This study serves as a preliminary investigation of the following research hypothesis: the outcome of healthcare systems in terms of the health of the population is determined not only by the value of expenditure on healthcare, but also by the composition of the assets for which those funds are allocated. Apart from the question of the level of expenditure on healthcare, whether measured on a relative or absolute basis, an issue of fundamental importance is the proper allocation of the funds earmarked for healthcare. It has been stated [Getzen, 2000, p. 492] that the allocation of resources is absolutely the key and most important issue in health economics.

### **Different Approaches to Quantifying Public Goods**

In general there are four different approaches found in the subject literature which have been applied to the quantifying of public goods:

- 1) the life satisfaction approach (LSA);
- 2) revealed or stated preference methods;

- 3) assessments of the efficiency and the usefulness of public sector activities;
- 4) methods of valuing externalities.

The LSA correlates the degree of public goods with individuals' reported subjective well-being and evaluates them directly in terms of life satisfaction. Thus, reported subjective well-being can serve as an approximation for individually experienced welfare [Gruber and Mullainathan, 2005; van Praag and Baarsma, 2005; Alesina et al., 2004; Frey et al., 2009; Di Tella and MacCulloch, 2001, 2005, 2006; Luechinger, 2009; Levinson, 2012]. For example, A. Levinson [2012] has combined air quality data with individuals' self-reported levels of "happiness", as a function of their demographic as well as economic characteristics and the current air quality. The estimated function is used to calculate the average marginal rate of substitution between annual household income and air quality that makes respondents equally happy. Revealed or stated preference methods are quite similar, since they employ utility functions for pairs of chosen goods, one of which is a public good. However, these methods have substantial weaknesses, linked to the following three facts:

- individuals have no incentive to disclose their true preferences as regards public goods;
- virtually no microeconomic data are available for some public goods;
- it is impossible to estimate an utility function for isomorphic sets (vectors) of public goods.

The third group of methods is commonly used to measure the ability of a country's public sector to provide high-quality goods and services in a cost-effective way. To measure productive efficiency an input-oriented DEA model is usually used, where the inputs (i.e. public spending) are minimized and the outputs are held at their current levels [e.g. Afonso et al., 2005; Afonso and Aubyn, 2005; Antonis et al., 2011]. Different performance indicators are used as outputs. In order to capture qualitative differences among educational systems, Hanushek and Kimko [2000] have constructed a public goods quality indicator. Afonso et al. [2005] have proposed a set of composite indicators of public sector performance, defined as the outcome in relation to the resources employed. In the healthcare sector, the infant mortality rate and life expectancy at birth are often used as the output indicators [Giordano and Tommasino, 2011]. Most studies conclude that public spending could be much smaller and, assuming that the output remains constant, more efficient than today [e.g. Gwartney et al., 2002; Tanzi and Schuknecht, 1997, 2000]. These conclusions may be biased to some extent. The cited authors assume that the selected performance indicators are (or should be) a function of public spending. In fact, as we have already mentioned, the public funds provide a package of goods and services, and this determines the output. Thus, both the amount and quality of public goods should be analysed to assess the efficiency of the public sector. Sometimes it turns out that changes in the structure or sequence of public goods provided by the authorities translate into higher performance even when public spending stays unchanged. The amount of PGs is a very sensitive variable, since it correlates directly to the life satisfaction

of society much more than the performance indicators do. Voters do not care as much about the “life expectancy” indicator as about the present availability of doctors. Thus, policymakers primarily consider the broadly understood amount of public goods which can be delivered, rather than their overall performance. For that reason, the synthetic measures of PG amounts should be well examined, and not omitted, in analysis of public sector efficiency. There are at least two situations which would be undesirable in the process of PG provision. One is the case where policymakers willingly increase the amount of public goods without regard to their quality. When public funds are limited, this occurs at the expense of the long-term performance of the public sector. On the other hand, if there is an *ad hoc* need to enhance a performance indicator, the simplest way to do that is to decrease the PG amount and cut public spending, without regard to the quality (which diminishes while the performance indicator simultaneously increases). Many authors point out that the transparency of government practices across the globe will increase as a result of stronger public pressure to use resources more efficiently [Heller, 2003; Joumard et al., 2004]. However, the improvements in commonly used performance indicators may be illusory if the quantities of delivered PGs are not optimised.

In the last group of quantifying methods, PGs are treated as externalities. There are six different methodologies for the valuation of externalities: 1) general systems analysis, 2) the social fabric matrix, 3) direct cost, 4) contingent valuation, 5) travel cost, and 6) the property approach [Hayden, 1989]. However, if we consider the adopted definition of PGs (i.e. merit goods, which from a physical standpoint could be private goods, but as a result of social doctrine and of the social policy implemented by the public authorities, are supplied to citizens), it is clear that they are not externalities.

The overall amount of PGs (understood as the package of complementary goods and services delivered by the public authorities) appears to be an important but underestimated variable in the process of PG provision. This is a view taken by only a few authors, such as Flores [et al., 1998]. He formalises what to the majority of economists is a basic economic intuition, that the quality of a public good is dependent upon the package in which it is provided. Flores infers that the sum of the independent valuations of PGs always differs from the costs of provision for a package of PGs.

### **Public Goods in a Healthcare System**

In the healthcare sector, most medical goods and services do not have the characteristics of pure public goods, since there exist both rivalry in their consumption and the possibility of exclusion from consumption [Mucha, 2006, p. 11]. Applying the above-mentioned criteria for the classification of goods, it is possible to identify certain areas of healthcare which have the features of pure public goods. These include, in particular, activities in the area of public

health, such as quality control of drinking water, reduction of the incidence of infectious diseases through environmental actions, as well as health education and prophylaxis. Information concerning healthcare is also a public good. Dilemmas concerning the categorisation of goods as public or private arise in relation to goods which satisfy only one of the two criteria. It is noted that healthcare has the features of what are called *merit goods*, as a result of the existence of external effects relating to the consumption of medical goods and services. Hsiao identifies the following types of merit goods in healthcare [Hsiao, 1995, pp. 127–128]: basic healthcare services, vaccinations, and preventive services. Based on the above criterion, it must undoubtedly be concluded that individually obtained health benefits go beyond the scope of individual utility, forming an area of social utility. Improvement in health measures leads to a reduction in both individual and communal losses resulting from illness, as well as return to work, growth in productivity, and growth in household savings. In this context two fundamental questions arise, concerning (1) the range of accessibility of medical services (healthcare providers, medical personnel, modern equipment) and (2) the range of services financed from public funds. There is still no answer to the question of whether all individually consumed health services should be classified as merit goods, or whether some should be excluded from that category – and if so, according to what criteria. In essence this is a question concerning the scope of the “basket” of health services financed from public funds. Determination of the structure and quality of the basket is a complex process of choices involving multiple criteria, not only economic, but also clinical, epidemiological and ethico-axiological. In the process of identifying the amount of public goods we propose taking into account such variables as the number and profile of healthcare providers, the amount, profile and degree of specialisation of medical personnel, and the equipment at the disposal of healthcare providers. These groups of indicators determine the amount and scope of services financed using public funds. It is assumed here that the amount of public goods in healthcare, such as medical benefits, is the result of a production process in which human and material capital are directly involved. Hence, in order to create a synthetic measure of the amount of public goods, the real resources (human and material) of the healthcare system are taken into account. Their selection was dictated by both theoretical indications [see Annel and Willis, 2000] and data availability.

In turn, the quality of public goods ought to be evaluated using measures of the level of health in society. Particular measures of state of health which ought to be taken into account include men’s and women’s average life expectancy at birth and in selected age ranges, infant deaths per 1000 live births, indices of disease incidence and prevalence, and mortality rates (calculated by age, sex and cause) [Laskowska, 2012]. The quality of public goods in healthcare is understood in terms of the maintenance or improvement of the health of the population. Such an approach to the quality of healthcare systems is widely encountered in the literature [see Arah et al., 2003; Evans et al., 2009]. The

selection of variables for inclusion in the synthetic PG indicator (cf. Table 2) was dictated by theoretical premises [see Kelley and Hurst, 2006] and by practice in OECD countries [see Kelly, 2007]

### **Efficiency of Supply of Public Goods in a Healthcare System as a Measure of Their Ordinal Value**

Economic efficiency has for some time been the subject of increasing interest in healthcare research [Hollingsworth and Peacock, 2008]. In economic studies relating to the healthcare sector the concept of efficiency is understood in diverse ways. It is generally asserted that actions in the healthcare sector are effective if the use of specific material, personal and financial inputs enables the achievement of maximal positive health effects or the production of a maximal amount of health services [Liu and Mills, 2007, p. 377]. The following methods of determining efficiency in healthcare can be found in the literature: analysis of the function of health production, evaluation of medical procedures, calculation of the size of induced demand, and identification of the level of unjustified consumption of services. Questions of efficiency are being addressed more and more frequently as a consequence of the dynamic growth in health-related expenditure. The evaluation of efficiency is particularly important in the context of reforms of healthcare systems, since the rationality of the various organisational solutions implemented in developed countries in the past three decades has not yet been unambiguously evaluated [cf. Joumard et al., 2010].

The concept of efficiency of supply of public goods as proposed here, being a relation between quantitative measures of public goods (non-financial) and health effects in the healthcare sector, entails seeking answers to the following questions: (1) what combination of medical and non-medical goods and services ought to be produced in the economy? and (2) what medical goods and services ought to be produced in the healthcare sector? Justification for this procedure is provided by the growing social need for reliable information concerning the functioning of healthcare on a national scale [Jacobs et al., 2013, p. 35]. It is hard to identify any research of this nature in the literature [Brick et al., 2010, p. 80], and the proposed approach has not previously been used in empirical studies. From this standpoint, the analysis carried out here is of the nature of a pilot study. We believe that the applied approach enables an objective evaluation – and, importantly, one that is comparable between various systems – of the relative value of public goods in the healthcare sector. The proposed index of efficiency makes possible, at a subsequent stage, the computation of a function of efficiency of healthcare provision in which the explanatory variables are financial inputs. Such a function would serve as a tool for the absolute evaluation of public goods in the healthcare sector, and would enable, among other things, the optimisation of budgetary expenditure for these purposes.

## Methodology

The work involved the application of a research procedure developed by the authors which can be used for the valuation of public goods in various sectors of the economy (as well as for testing the hypothesis put forward in the introduction). The procedure includes the following steps:

- 1) Computation of synthetic measures of the amount of public goods in a given sector based on the criteria referred to above – a matrix for a set of countries, taxonomic analyses.
- 2) Computation of synthetic measures of the quality of public goods in accordance with the above remarks – a matrix for a set of countries, taxonomic analyses. The synthetic measures of quality and amount of public goods were determined by Hellwig's method [Borkowski et al., 2003, pp. 62–65].
- 3) Normalisation of the synthetic measures, by a zero unitarisation method, for the purpose of their comparison, retaining the non-negativity of values of the normed features.
- 4) Computation of an indicator of the efficiency of supply of public goods as a relation of the normed synthetic measures of quality and amount – for a set of countries.
- 5) Identification of the structure of the financing of public goods in the sector in question – a matrix of indicators of structure for a set of countries.
- 6) Cluster analysis of territorial units (countries) according to the criterion of structure of financing of public goods, to identify similar models of institutional valuation of public goods. The tool used to analyse healthcare expenditure in OECD member countries is the health accounts system. The basis for the calculation is the International Classification for Health Accounts (ICHA), which enables information to be presented simultaneously according to payers (who spends money on healthcare), suppliers of medical services and goods (who receives the funds), and functions of medical services and goods (what we are paying for). Considering the purpose of the study, an analysis was made of public expenditure by function and the level of public expenditure on healthcare expressed as a percentage of GDP. The following seven variables were selected for cluster analysis and underwent standardisation: public expenditure on healthcare as a percentage of GDP ( $X_1$ ), expenditure on individual healthcare (including medical and rehabilitation services)<sup>3</sup> ( $X_2$ ), on long-term care ( $X_3$ ), on auxiliary services ( $X_4$ ), on medicines and other medical products ( $X_5$ ), other expenditure on actions relating to prophylaxis and public health ( $X_6$ ), and administrative functions ( $X_7$ ). The analysis of the structure of expenditure by function made it possible to answer the question of what type of expenditure absorbs the greatest amount of funds given a certain total amount of expenditure as a percentage of GDP.

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<sup>3</sup> Medical services are taken to include hospital treatment, same-day treatment, outpatient treatment, and health services provided at the patient's home.

- 7) Computation of descriptive statistics, including average values of the measures of amount, quality and efficiency (from steps 1, 2 and 4) within the identified clusters (classes), assuming that these classes are an institutional predictor of the process of supply of public goods.
- 8) Performance of analysis of variance of ANOVA/MANOVA type, to test the hypothesis that the average measures of amount, quality and efficiency from steps 1, 2 and 4 differ between the different models of financing of public goods (identified in step 6). In these analyses the qualitative predictor is the classes (clusters) from step 6, and the dependent variables are the measures from steps 1, 2 and 4. The goal of these analyses is, firstly, to determine the statistically significant relations between the structure of financing of the goods and their amount, quality or efficiency of supply; and secondly, to determine to what degree the particular models of financing are responsible for the variation in the measures describing the process of creation of public goods (contrast analysis).
- 9) Identification of optimum models for the financing of public goods in a national system from the standpoint of quantitative, qualitative and efficiency-related criteria.

The above algorithm was used to analyse the healthcare systems of OECD countries (29 countries in total). In spite of organisational and financial differences, these states can be analysed together, as they share the common values of availability and accessibility of high-quality care, fairness and solidarity [Field, 1973, pp. 763–785]. In view of the unavailability of information on the financing structure in the case of Ireland, Israel, Italy, Turkey and the United Kingdom, these countries were omitted from the analysis, but the remaining sample is representative for the OECD countries. The financial data analysed were obtained from the OECD Health Data site and the WHO Statistical Information System (WHOSIS), as averages over the period 2007–2014.

As a result, a set of variables was obtained which enabled the determination of a synthetic measure of the amount of public goods (Table 1), as well as a set of variables enabling the determination of a synthetic measure of their quality (Table 2) and a set of variables reflecting the structure of public financial inputs by function in the set of OECD countries.

**Table 1. Diagnostic Variables Enabling Determination of a Synthetic Measure of Amount of Public Goods**

Code	Diagnostic Variable	Contribution Type
Synthetic measure of amount of public goods		
X <sub>1</sub>	Practising doctors per 1000 inhabitants	positive
X <sub>2</sub>	Practising midwives per 1000 inhabitants	positive
X <sub>3</sub>	Practising nurses per 1000 inhabitants	positive
X <sub>4</sub>	Practising dentists per 1000 inhabitants	positive
X <sub>5</sub>	Number of public hospitals per million inhabitants	positive

Code	Diagnostic Variable	Contribution Type
Synthetic measure of amount of public goods		
X <sub>6</sub>	Number of beds in public hospitals per 1000 inhabitants	positive
X <sub>7</sub>	Computer tomographs per million inhabitants	positive
X <sub>8</sub>	MRI scanners per million inhabitants	positive

Source: based on data from OECD Health Data 2014 and the WHO Statistical Information System.

**Table 2. Diagnostic Variables Enabling Determination of a Synthetic Measure of Quality of Public Goods**

Code	Diagnostic Variable	Contribution Type
Synthetic measure of quality of public goods		
X <sub>1</sub>	Life expectancy of women at birth	positive
X <sub>2</sub>	Life expectancy of women after 65 years of age	positive
X <sub>3</sub>	Life expectancy of men at birth	positive
X <sub>4</sub>	Life expectancy of men after 65 years of age	positive
X <sub>5</sub>	Life expectancy in HALE at birth (both sexes)	positive
X <sub>6</sub>	Deaths from cardiovascular diseases per 100 000 population (standardised values)	negative
X <sub>7</sub>	Deaths from malignant neoplasms per 100 000 population (standardised values)	negative
X <sub>8</sub>	Infant deaths per 1000 live births	negative
X <sub>9</sub>	Probability of death in age range 30–70 from circulatory diseases, neoplasm, diabetes or chronic respiratory diseases (%)	negative
X <sub>10</sub>	Self-assessment of health by age and sex: Good/very good, women 15–24 years (% population – raw data)	positive
X <sub>11</sub>	Self-assessment of health by age and sex: Good/very good, women 25–44 years (% population – raw data)	positive
X <sub>12</sub>	Self-assessment of health by age and sex: Good/very good, women 45–64 years (% population – raw data)	positive
X <sub>13</sub>	Self-assessment of health by age and sex: Good/very good, women 65+ (% population – raw data)	positive
X <sub>14</sub>	Self-assessment of health by age and sex: Good/very good, men 15–24 years (% population – raw data)	positive
X <sub>15</sub>	Self-assessment of health by age and sex: Good/very good, men 25–44 years (% population – raw data)	positive
X <sub>16</sub>	Self-assessment of health by age and sex: Good/very good, men 45–64 years (% population – raw data)	positive
X <sub>17</sub>	Self-assessment of health by age and sex: Good/very good, men 65+ (% population – raw data)	positive

Source: as in Table 1.

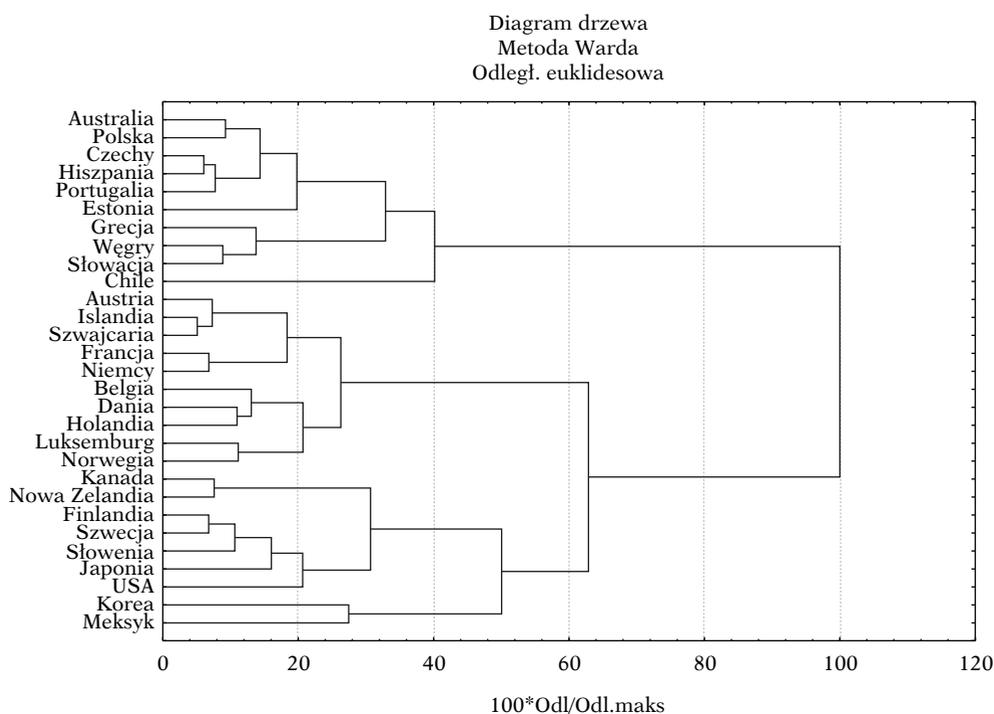
In this way an ordinal valuation was made of the public goods relating to the healthcare system, this being a basis for finding absolute determinants of the values of those goods, e.g. the structure of their financing.

### Results and Discussion

Let us recall that the purpose of the analysis was to test the hypothesis that the qualitative predictor which determines the relative value of the supplied public goods is the structure of financial inputs in the public sector for a given public good, bearing in mind that the absolute size of those inputs is limited.

As a result of agglomerative cluster analysis (using the Ward method) three clusters of OECD countries were identified according to the above structure of expenditure on healthcare ( $X_1 - X_7$ ) – cf. Figure 1 and Table 3.

Figure 1. Clusters of OECD Countries According to Level and Structure of Financing



Source: produced using the Statistica program based on data from OECD Health Data and the WHO Statistical Information System (2007–2014).

The disjointness of the clusters was verified using the Silhouette index  $S(i)$  as recommended by Gatnar and Walesiak [2004] (1):

$$S(i) = \frac{b(i) - a(i)}{\max[a(i); b(i)]} \tag{1}$$

where:

$a(i)$  is the average distance of object  $i$  from other objects assigned to class  $P$  in the classification;

$b(i)$  is the average distance of object  $i$  from objects of the class  $R$  located closest to that object.

The index  $S(i)$  takes values in the range  $\langle 0,1 \rangle$ , and the critical value was taken to be 0.50.

**Table 3. Characteristics of Clusters of Similar Countries According to the Criterion of Size of Public Expenditure on Healthcare as Percentage of GDP and Structure of Financial Inputs to Healthcare (Average Values of Features)**

No.	Class	Public Expenditure on Healthcare as % of GDP	Structure of Financial Inputs to Healthcare (% of total)*					
		$X_1$	$X_2$	$X_3$	$X_4$	$X_5$	$X_6$	$X_7$
1.	A	<b>5.35</b> ↓	<b>66.7</b> ↑	<b>3.85</b> ↓	<b>7.51</b> ↑	<b>17.54</b> ↑	<b>2.14</b> ↓	<b>2.26</b> ↓
2.	B	<b>8.04</b> ↑	<b>56.55</b> ↓	<b>21.95</b> ↑	4.35	<b>11.56</b> ↓	2.3	3.29
3.	C	6.56	63.16	10.87	<b>2.7</b> ↓	12.9	<b>5.21</b> ↑	<b>5.17</b> ↑

\*  $X_2$  – medical and rehabilitation services;  $X_3$  – long-term care services;  $X_4$  – auxiliary services in healthcare;  $X_5$  – medical products for outpatients;  $X_6$  – prophylaxis and public health;  $X_7$  – administration of healthcare and insurance.

Source: produced using the Statistica program based on data as in Figure 1.

Each cluster is characterised by descriptive statistics of the process of supply of public goods (cf. Table 4). Class A contains 10 countries. This is a diverse group in terms of the organisation of the health system. Applying the most recent typology proposed by Rothgang and Wendt (the RW Typology) [Rothgang et al., 2010; Bohm et al., 2012, p. 19], this class is dominated by countries in Central and Eastern Europe inheriting the former Semashko system (Poland, the Czech Republic, Estonia, Hungary, Slovakia), currently classified as social health insurance (SHI) systems.

**Table 4. Descriptive Statistics of the Process of Supply of Public Goods**

Level of factor	N	Synthetic Measure of Amount of Public Goods			Synthetic Measure of Quality of Public Goods			Index of Efficiency of Supply of Public Goods		
		Mean	SD	St.err.	Mean	SD	St.err.	Mean	SD	St.err.
A	10	<b>0.5044</b> ↓	0.1719	0.0543	<b>0.4018</b> ↓	0.3158	0.0999	<b>0.8040</b> ↓	0.6249	0.1976
B	10	<b>0.6420</b> ↑	0.2235	0.0707	<b>0.7571</b> ↑	0.1175	0.0372	1.3377	0.6189	0.1957
C	9	0.5088	0.2747	0.0916	0.5596	0.2906	0.0969	<b>1.4009</b> ↑	0.7481	0.2494

Source: produced using the Statistica program based on data as in Figure 1.

The group also includes two countries from Southern Europe (Spain and Portugal) which have a national health service (NHS) system, along with two countries with diversified systems of healthcare (Greece and Chile), and Australia, which has a system based on national health insurance (NHI). This group of countries is distinguished on the one hand by having the highest value for the number of public beds per 1000 inhabitants (average 4.09),

and on the other by the lowest numbers of nurses per 1000 inhabitants (average 6.35) and the lowest indicators of medical equipment per million inhabitants. As regards health quality results, this is also the group with the lowest indices of life expectancy, among both women and men, in various age ranges. Causes for concern include the high values for cardiovascular disease deaths per 100 000 inhabitants and infant deaths per 1000 live births – these are almost twice as high as in the other groups of countries. Also the subjective self-assessment of state of health, particularly among the elderly, is poorest in this group – only 25% of women and 30% of men aged over 65 rate their health as good or very good. The weak health quality results are accompanied by low public expenditure on healthcare, both as a percentage of GDP (average 5.35%) and per capita (average \$ 1222). At the same time, class A has the lowest synthetic measures of quality, amount and efficiency of supply of public goods (cf. Table 4). This may be a result of the financing structure adopted, with the highest proportion of expenditure going on medical and rehabilitation services and medical products for outpatients, and the lowest proportion on prophylaxis and public health. It should be noted that the structure of services financed from public funds is to some extent a reflection of the health policy being implemented. In the case of this group of countries, a cause for concern is the marginal share accounted for by long-term care services, which, in view of the ageing population, may lead to exacerbation of systemic problems. Moreover, an argument for an increase in expenditure on nursing and care services and on long-term care is the growing incidence of chronic diseases (rheumatoid arthritis, obstructive pulmonary disease, diabetes, stress-related diseases). The increasing incidence of chronic diseases among people of younger age indicates a need to increase expenditure on disease prevention programmes and to implement them more effectively.

Class B also consists of 10 countries. Dominant among them are countries with a system based on social health insurance (SHI): Austria, Switzerland, France, Germany, Belgium, the Netherlands and Luxembourg. The remaining three are Northern European countries – Iceland, Denmark and Norway – which have a national health service (NHS) system. Countries in group B have the highest indices of medical personnel per 1000 inhabitants, where the number of nurses per 1000 inhabitants is more than twice as large as in the countries of group A. As regards health quality results in various sex and age groups, in these countries both the objective measures (life expectancy, death rates) and subjective health assessments are better than in the other two groups. These good results are accompanied by relatively high public expenditure on healthcare, both as a percentage of GDP (average 8.04%) and per capita (average \$ 2974.30). The financing structure is matched to demographic and epidemiological trends. This is the group of OECD countries that has the highest average proportion of the population aged 80 and over, which means that a high proportion of expenditure is allocated to long-term care services [Oliveira Martins and Maisonneuve, 2006]. Class B also has the highest value

for the synthetic measures of amount and quality of public goods, although it did not attain the highest efficiency of supply of public goods.

Class C consists of 9 countries. This is the most diverse group in terms of organisation, financing and regulation of the healthcare system. The countries in this class represent five different systems according to the RW typology: (1) Canada and New Zealand have national health insurance (NHI) systems; (2) Finland and Sweden have national health service (NHS) systems; (3) Japan and Korea have social health insurance systems; (4) the United States has a private health system (PHS); (5) Slovenia and Mexico have diversified healthcare systems which cannot be assigned definitively to any of the standard types. The countries in this group have the lowest numbers of doctors per 1000 inhabitants (average 2.72) and of beds in public hospitals per 1000 inhabitants (more than 1.5 times fewer than in the countries of group A). On the other hand, these countries have the highest indicator values for medical equipment per million inhabitants. Health quality results in these countries are good: above all they have the lowest probability of death in the 30–70 age range from circulatory diseases, neoplasm, diabetes or chronic respiratory diseases (%) and a low rate of deaths from malignant neoplasms per 100 000 inhabitants. Self-assessment of health in these countries among women and men up to 45 years of age is relatively low (lower by 15 percentage points on average than in the other analysed groups of countries). Public financial inputs are at an average level for the analysed set of countries, at around 6.5% of GDP. Paradoxically, this class has the highest indicator of efficiency of supply of public goods, resulting from the fact that the quality of the public goods is moderate, while their amount is relatively low. The question arises as to whether this might not be the optimum direction of evolution for model (class) A, bearing in mind the accompanying budgetary limitations. The post hoc analysis and contrast analysis, as described below, will be helpful in answering this question.

Multidimensional significance tests lead to the rejection of the null hypothesis of the equality of vectors of means of the measures of amount, quality and efficiency of public goods, in favour of the alternative hypothesis, that they differ significantly (which confirms the hypothesis stated above) – cf. Table 5.

**Table 5. Multidimensional Significance Tests**

	Test	Value	F	Effect	Error	p
Classes for expenditure structure as qualitative predictor	Wilks	0.63582	2.0328	6	48	0.079353
	Pillai	0.38974	2.0170	6	50	0.080729
	Hotelln.	0.53258	2.0416	6	46	0.079073
	Roy	0.44154	3.6795	3	25	<b>0.025360</b>

Source: produced using the Statistica program based on data as in Figure 1.

There are certain doubts as regards the assumption of homogeneity of covariance in the multidimensional space (Box's M test indicates grounds to reject such an H0 in favour of the hypothesis that the covariances are not homogeneous, although the tests of homogeneity of variance of Hartley, Cochran and Bartlett confirmed that homogeneity). However, the single-dimensional results indicate the significance of the variation in the variable representing quality of public goods (at significance level 0.05) and, with smaller probability, in that representing efficiency (only at a significance level of 0.15). Hence we continue the analysis in relation to the quality of public goods.

**Table 6. Single-dimensional Results for Dependent Variables**

	Degrees of Freedom	Synthetic Measure of Quality of Public Goods				Indicator of Effectiveness of Supply of Public Goods			
		SS	MS	F	p	SS	MS	F	p
Structure of healthcare expenditure	2	0.63365	0.31683	4.8536	<b>0.01618</b>	2.1001	1.0501	2.03269	0.15128
Error	26	1.69719	0.06528	–	–	13.4314	0.5166	–	–
Total	28	2.33084	–	–	–	15.53154	–	–	–

Source: produced using the Statistica program based on data as in Figure 1.

Post hoc tests showed that a change in the healthcare financing structure from model A to B indeed has a significant effect on the quality of public goods. Spending on health per capita in model A is nonetheless more than 2.5 times lower than in model B, and it is hard to achieve any improvement in the quality of public goods in the sector without additional sources of financing. In this context, in those of the studied countries having model A, reforms can be recommended with the aim of seeking additional sources of financing for healthcare: increased health-related social security contributions, introduction of co-payment or additional health insurance (supplementary and complementary) [Borisova, 2011, pp. 326–354]. Nonetheless, the increase in the amount of money going to the sector should be accompanied by a change in the existing financing structure, justified by demographic and epidemiological trends. The data show that an increased proportion of expenditure on long-term care, at the expense of other areas of individual healthcare, and also an increase in the proportion of expenditure going on prevention and public health, produce better quality in healthcare, which in turn will increase the efficiency of supply of public goods in the sector. The results obtained agree with research carried out for the OECD countries in 2008 [OECD, 2010]. Contrast analysis (cf. Table 8) showed that such a change of model explains almost 100% of the variation in the quality of public goods.

Separate attention should be given to the countries that conform to model C. This class has the highest efficiency of supply of public goods. However the analysis shows that the efficiency of supply of public goods in healthcare is

increased here by means of minimisation of inputs – the amount of public goods – while their quality remains relatively low. Considering the goals and values of healthcare systems, this is not a desirable model. It is nonetheless interesting to note that the financing structure differs from that found in the other clusters. Above all, a positive aspect, in the face of the aforementioned epidemiological trends, is the relatively high proportion of financing going on prophylaxis and public health. A cause for concern, however, is the fact that these countries make a relatively high proportion of expenditure on system administration, which does not translate directly into quality and availability of medical services.

**Table 7. Tukey's HSD Test; The Variable "Index of the Quality of Public Goods"; Approximate Probabilities for Post Hoc Tests. Error: Intergroup MS = 0.06528, df = 26.000**

	Classes for Expenditure Structure	A	B	C
1	A		<b>0.012198</b>	0.384091
2	B	<b>0.012198</b>		0.231117
3	C	0.384091	0.231117	

Source: produced using the Statistica program based on data as in Figure 1.

**Table 8. Evaluation of Contrasts for the Synthetic Measure of Quality of Public Goods**

	Synthetic Measure of Quality of Public Goods				-95.00%	+95.00%
	Evaluation	St.err.	t	p	Conf.b.	Conf.b.
CONTR.1 A vs. B, i.e. 1; - 1; 0	-0.355308	0.114260	-3.10964	<b>0.004503</b>	-0.590172	-0.120443
<b>*SS<sub>contrast</sub>/SS<sub>effect</sub></b>	<b>0.99</b>					

Source: produced using the Statistica program based on data as in Figure 1.

To conclude, mention should be made of the estimator of the variance of the dependent variable explained by the independent variable in the whole population, for the quality of public goods (coefficient  $\omega = 0.21$ ). This means that the assets structure explains 21% of the variation in the synthetic measure of quality in the studied population. This suggests that consideration should be given to other variables which determine the efficiency of supply of public goods in the healthcare sector. These undoubtedly include demographic processes, socioeconomic development, and lifestyle [Joumard et al., 2008], but this is a subject for further research.

## Conclusion

The authors have achieved the goals of the work in relation both to methodology and to the verification of the hypothesis put forward in the introduction. The methodological proposal is the research procedure (described

in the section on methods) serving to make a quantification of public goods by determining their amount (resulting in availability of healthcare services), quality and efficiency, followed by identification of the financial determinants of value so defined (on the assumption that the public goods are of the nature of merit goods funded from the national budget). It should be noted that the above methodology is fairly universal, that is, it can be used to analyse the process of creation of public goods in various sectors of the economy.

Usually, the performance measures of healthcare are perceived as outputs of public spending. In the authors' view, this is a highly simplified approach. As the above discussion shows, in the healthcare sector public funds do not pay directly for the "change in life expectancy" or other performance indicators, but provide a number of doctors and nurses per 1000 inhabitants, a number of public hospitals and patients' beds, a number of computer tomographs and other equipment, etc. They all belong to a package of complementary merit goods which contribute to healthcare performance, but do not ensure its definitive quality. We argue that the public goods in each sector of the economy constitute an isomorphic, socio-economic system which is not a "black box". There is a missing element in the frontier analyses of public sector efficiency commonly encountered in the literature.

In the empirical dimension, the analysis confirmed the hypothesis stated in the introduction. Although the analysed healthcare systems are diverse and reflect different choices of a social nature, the efficiency of a healthcare system, determined by the high quality of public goods, is dependent not only on the amount, but also on the structure of public financing (assets). Since the assets structure explains only 21% of the variation in the synthetic measure of healthcare outcome, some consideration should be given to other variables which determine the efficiency of supply of public goods in the healthcare sector. These undoubtedly include demographic processes, socioeconomic development, and lifestyle [Joumard et al., 2008], but this is a subject for further research. On the other hand, the aforementioned 21% may form a basis for substantial economies in public spending, given that improvement in this area does not require any additional outlay. From this standpoint, the authors' research confirms that optimising the structure of assets ought to be the first step to improving healthcare efficiency.

In the light of ongoing demographic changes, the rapidly increasing prices of healthcare and expensive changes in medical technology, it is projected that public expenditure on healthcare in the OECD countries as a proportion of GDP may rise by between 3.5 and 6 percentage points by the year 2050 [OECD, 2010, p. 2]. The budgetary pressure which appeared following the crisis of 2008 increases the need for reforms of healthcare systems, especially since public spending on healthcare is among the largest categories of government expenditure. In 2012 in the OECD countries it averaged 9% of GDP and accounted for more than 15% of all central public expenditure. Governments are striving on one hand to maintain balanced national budgets, and

on the other to achieve social goals, which undoubtedly include the health of society. With these aims in mind, emphasis is placed on the need to improve the financial efficiency and stability of healthcare systems, while at the same time increasing their effectiveness and ability to satisfy social needs. However, it has not yet proved possible to develop an ideal healthcare system, suited to every country, in which the necessary balance would be achieved between the amount of public funds available for healthcare and the amount and range of services which could, by means of those funds, be delivered to the population free of charge or for partial payment. The proposed direction of action, based on the analysis carried out, involves strengthening the efficiency of systems of healthcare through intensification of financing and action in such areas as long-term care, prophylaxis and public health.

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## PROBLEMY KWANTYFIKACJI DÓBR PUBLICZNYCH W SEKTORZE OCHRONY ZDROWIA

### Streszczenie

System rynkowy nie doprowadza samoczynnie do optymalnej alokacji dóbr publicznych. Wymiana rynkowa zawsze będzie prowadzić do niedoboru dobra publicznego w porównaniu z poziomem społecznie optymalnym. Autorzy stawiają tezę, że dobra publiczne w każdym sektorze gospodarki stanowią izomorficzny, społeczno-ekonomiczny system, który nie jest „czarną skrzynką”. Dlatego też, w celu określenia deficytu dóbr publicznych konieczna jest kwantyfikacja dostępnych ilości w relacji do jakości tych dóbr, ponieważ efektywność sektora publicznego nie jest tylko funkcją wysokości nakładów budżetowych. Niestety, nie ma w tym względzie powszechnie akceptowanej procedury badawczej, a uniwersalne metody kwantyfikacji dóbr publicznych w zasadzie nie istnieją. Celem artykułu jest opracowanie uniwersalnej metodyki w tym zakresie, biorącej pod uwagę ilość i jakość dóbr publicznych oraz ich waloryzację przez środki budżetowe. W części empirycznej autorzy zidentyfikowali różne modele finansowania ochrony zdrowia na przykładzie zbiorowości krajów OECD, odpowiadając na pytanie, na ile determinują one wartość dóbr publicznych w tym sektorze? Opracowano mierniki syntetyczne dla ilości i jakości dóbr publicznych, wykonano analizę skupień oraz wieloczynnikową analizę wariacji. Mimo iż badane systemy ochrony zdrowia są zróżnicowane i odzwierciedlają różne wybory o charakterze społecznym, to, jak pokazała przeprowadzona analiza, efektywny system ochrony zdrowia uzależniony jest nie tylko od wysokości, lecz również od struktury publicznego finansowania.

**Słowa kluczowe:** dobra publiczne, polityka zdrowotna, system ochrony zdrowia, efektywność sektora publicznego

**Kody klasyfikacji JEL:** H41, H870, P00

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