Calculation Of Economic Well-Being Using Nonparametric Approach

Andrea Vondrová, Ing., PhD
Eduard Nežinský, Ing., PhD
University of Economics, Faculty of National Economy,
Department of Economic policy, Slovakia

Abstract

The aim of this paper is to present the analysis of measurement of economic well-being by the index of economic well-being for selected OECD countries. The report also outlines trends in the four domains of economic well-being that create the index. The domains are consumption, wealth, economic equality, and economic security.

Furthermore, the paper offers an analysis of the sensitivity of our results to the choice of weights assigned by means of data envelopment analysis (DEA) model to these four domains and a description of the performance of the index of economic well-being compared to GDP per capita through the most recent recession that caused declines in both, real GDP per capita and the index of economic well-being.

Keywords: Economic well-being, IEWB, quality of life, DEA model

Introduction

In the current period, is very commonly pointed out that in a globalized economy the indicator of GDP respectively GDP per capita is not sufficient for measuring well-being of individuals and there is a need to define new measurement that will remove its shortcomings. Although the creators of the national accounts may protest that indicator of gross domestic product measures the aggregate money value of economic output and this indicator has never been intended for use as a full measure of economic well-being, but it is often being used so. In our opinion, generated alternative indicators can be divided into two groups, depending upon whether the indicators have been created to govern or to complement values of GDP or the indicators are designed to replace the GDP.

In this paper we focus on the index of economic well-being (IEWB). In 1998, the Centre for the Study of Living Standards (CSLS) released the first empirical estimates for Canada of the Index of Economic Well-being

(Osberg and Sharpe, 1998), a composite index based on a conceptual framework for measuring economic well-being developed by Osberg (1985).

The index attempts to construct better measures of effective consumption and social accumulation. It combines different approaches which include the current prosperity that is based on consumption, sustainable accumulation, and social issues (reduction in inequalities and protection against social risks). Environmental issues are addressed by the cost of CO_2 emissions per capita and inequality is measured by the Gini index and a level of poverty.

Finally, four key social risks are identified, including unemployment, risk of disease, poverty, single parents and pensioner poverty. The costs are estimated as the probability that the individuals are currently in the state of financial emergency and there is a need for compensation by the social system e.g. risk of unemployment is assessed by multiplying the level of unemployment and average income of unemployed from the social system.

The framework of the IEWB is based on two main ideas. First, economic well-being has multiple dimensions and an index should reflect that fact by aggregating measures of the various domains of economic well-being. Second, an index of economic well-being should facilitate public policy discussion by aggregating across the domains of economic well-being in a way that respects the diversity of individual values. Individuals differ (and have a moral right to differ) in the relative weights they assign to different dimensions of economic welfare, and an index should be useful to all individuals irrespective of those value differences (Osberg, Sharpe, 2011).

While focusing on the economic aspects of well-being we do not undervalue the importance of non-economic issues. Same as the authors of the IEWB, we are inspired by the idea that a better measurement of a better standard of living is needed if economic and social trends are to be combined into an index with larger ambitions.

The hypothesis is that indices of well-being can help policy makers to come to reasonable answers about social choices if information is presented in a way that highlights the objective trends in major dimensions of well-being and thereby helps policy makers to come to summative judgments but also respects potential differences in values (Osberg, Sharpe, 2009).

Methodology and data

For assessing the economic well-being we used data from the World Bank, UNSD Statistical Databases, and Databases of European Commission as well as data from Statistical Office of the Slovak republic. *T*he assumption is based on the fact that current prosperity is based on consumption, sustainable accumulation, and social topics. Weights are assigned based on the Center for the Study of Living Standards – CSLS: per capita

consumption (0.4), the stock of wealth (0.1), equality (0.25), and economic security (0.25). Although these weights reflected observed aggregate proportions for consumption and savings, the authors were criticized for a bias against sustainability because of the low weight for the stocks of wealth. Therefore we also offer a sensitivity analysis of our results to the choice of weights allocated through DEA model and we describe the performance of the economic well-being compared to GDP per capita.

DEA method allows evaluating the effectiveness of individual producer within the given group of data. DEA method is in comparison with statistical and other methods relatively new non-parametric method, which is one of the possible approaches for evaluating the efficiency and productivity of homogeneous production units. DEA model allows an individual assessment of the effectiveness of individual production units with respect to the entire set of units, which belongs among its greatest advantages.

In addition to the allocation of units on effective and ineffective scale, we are able to identify the source of inefficiency for the ineffective organizational units and also identify the way in which the unit could reach efficient scale.

For purposes of calculating optimal weights is sufficient to use the modification of the basic model proposed by A. Charnes, W.W. Cooper, E. Rhodes (1978), named in accordance with the authors' names CCR. The idea is based on the evaluation of the efficiency as a proportion as of virtual aggregate output and virtual aggregate inputs. Adhere to the used terminology we assess the effectiveness of *j* individual decision-making units (DMU) transforming *m* inputs to *n* outputs. Each DMU (indicated by an index of 0) addresses optimization problems with a focus on outputs:

$$\min z_0(\mathbf{u},\mathbf{v}) = \frac{\sum_{i=1}^{m} x_{i0} v_i}{\sum_{r=1}^{s} y_{r0} u_r} \text{ with restrictions}$$

$$\frac{\sum_{i=1}^{m} x_{ij} v_i}{\sum_{r=1}^{s} y_{rj} u_r} \geq 1 \qquad (j = 1, 2, ..., n)$$

$$u_r \geq \varepsilon \qquad (r = 1, 2, ..., s)$$

$$v_i \geq \varepsilon \qquad (i = 1, 2, ..., m),$$

where z_0 is the objective function expressing the efficiency of the inverse relationship in terms of inputs and outputs, x_{ij} input *i* used by *j* DMU and the element y_{ij} is the *i* output produced by DMU of *j*. E is small positive number Added to the limits in order to identify so-called weak

efficiency. The transfer of the problem to the linear form we achieve by the Charnes-Cooper transformation of variables using substitution:

$$\mu_r = tu_r \qquad (r = 1, 2, ..., s)$$

$$\nu_i = tv_i \qquad (i = 1, 2, ..., m),$$

$$t = \frac{1}{\sum_{r=1}^{s} y_{r0} u_r}$$

The resulting linear program has the form:

$$\min f_0(\mathbf{v}) = \sum_{i=1}^{m} x_{i0} \nu_i$$

with limitations $\sum_{i=1}^{m} x_{ij} \nu_i - \sum_{r=1}^{s} y_{rj} \mu_r \geq 0 \qquad (j = 1, 2, ..., n)$

$$\sum_{r=1}^{s} y_{rj} \mu_r = 1$$

$$\mu_r \geq \varepsilon \qquad (r = 1, 2, ..., s)$$

$$\nu_i \geq \varepsilon \qquad (i = 1, 2, ..., m)$$

Standardization of outputs $\sum_{i=1}^{m} y_{r0} \mu_r = 1$ gives the output orientation of model.

The interpretation is based on the construction of indicator. Efficient units will be f_0=1. Given the limitation is the smallest possible value of effectiveness, ineffective thus define the unit of f_0>1.

For the purpose of construction of optimum weights of the IEWB we perceive individual states as independent decision-making unit and the output for the task are the individual sub-indices. For simplicity, the inputs will be put equal to 1. Since the IEWB is indicated in the scale from 0 to 1, it can be recognized as an efficiency index with fixed weights $\mu_r = 1/4$. Comparable index of efficiency we get as the inverse value of the objective function: $\varphi = 1/f_0$, which is also within the range of 0 to 1.

Condition $\sum_{r=1}^{s} y_{rj} \mu_r = 1$ gives scope for interpreting the results in a way that testifies about the contribution of each input (sub-indices) to overall efficiency. The sub-indexes weighted by optimal weights $y_{rj} \mu_r$ are in the output of software referred to as Weighted Data. Ratio

$y_{rj}\mu_r \Big/ \sum_{r=1}^{s} y_{rj}\mu_r = y_{rj}\mu_r$ can be interpreted in a way that testifies about the relative contributions of individual sub-indices to the overall efficiency of composite index. It is evident that countries assess for themselves the 'good' indicators with higher weights.

The basic reason why this issue is important is fact that we measure variables that have in the ground state significantly different units. Otherwise, if we did not set weights, the composite index would focus on variables with high range and small but significant changes in the value will not significantly affected the composite index.

If the variables are aggregated without individual weights, higher explicit weights are with respect to the variables that have a larger extent as their percentage increases.

Our motivation for setting the weights using the method DEA in comparison with weights settled by authors is the fact that the increase in the value of some variables such as the flow of consumption is equivalent to an increase of total well-being, while increases in other variables such as unemployment are equivalent to decline in the overall welfare.

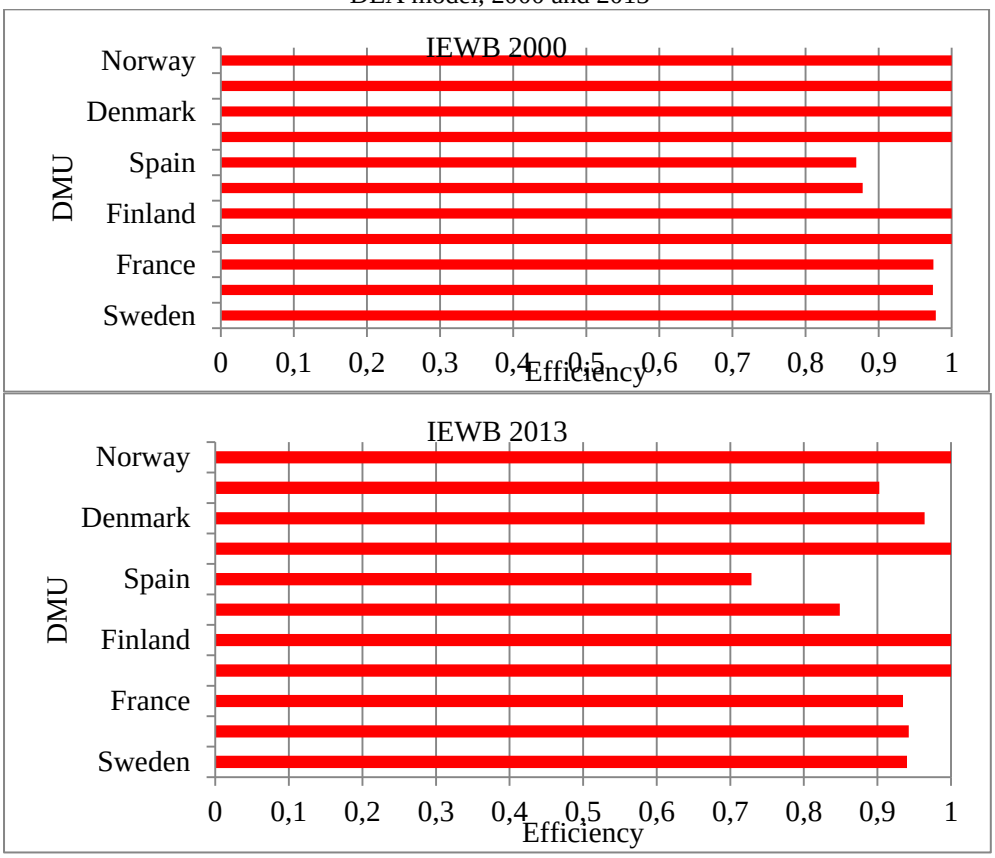
In this case, the variables are standardized in a way that an increase in standardized weights corresponds to an increase in overall well-being.

Results

In this part of paper we explore the sensitivity of our results to the choice of the weights that are assigned to the four domains of well-being. The aim of the analysis is through DEA method to evaluate the sensitivity of our results to the choice of the weights of these four domains, respectively what is the potential for improvement of their achieved level of economic well-being.

Non-parametric approach provides a relative measure that considered the selected set of DMU, which represents 11 countries included in the analysis. Inputs to the model are individual indicators of overall well-being (consumption flows, wealth stocks, inequality measures and economic security). Efficient scale is composed of countries that have managed to fully transform the achieved level of economic well-being to their economic performance. This means that countries located on the border of efficiency (according to Pareto-Koopmans interpretation) can increase their overall economic well-being only by reducing low quality of one of the four indicators of IEWB.

Figure 1: Effectiveness of selected OECD countries based on weights specified using the DEA model, 2000 and 2013



Source: Centre for the Study of Living Standards; own calculation

Efficient scale consists of countries that have managed to transform the achieved quality of their sub-indexes into their overall economic well-being. In 2000 the efficient scale consisted of six countries - Norway, United Kingdom, Finland, Netherlands, Denmark and Germany but in 2013 only four countries has been efficient - Norway, United Kingdom, Finland, Netherlands (Figure 1). We are able to conclude that DEA model identified four effective countries in 2013 and six in 2000 from eleven observed countries**.** If other countries would want to achieve the level of efficiency frontier they would have to reduce the low quality of other indicators of IEWB. In the case of countries which are below the level of efficiency it is possible to identify the potential for improvement. The potential for improvement is the percentage that is captured in Table 3 for both years.

Table 1: Decomposition of inefficiency of selected OECD countries, 2000 and 2013

2000 Rank	DMU	Well-being Index	Consumption Flows	Wealth Stocks	Inequality Measures	Economic Security
1	Norway	1	0,8890618	0,1109382	0	0
1	Germany	1	0,5167114	0,0983	0,3850049	0
1	Denmark	1	0	0,0922	0,7329203	0,1748837
1	United Kingdom	1	1	0	0	0
1	Netherlands	1	0,9302798	0,0697	0	0
1	Finland	1	0,1525022	0	0,8474978	0
7	Sweden	0,9781696	0	0	0,000895	0,9991049
8	France	0,974991	0,2991838	0	0,3850241	0,3157921
9	Belgium	0,9741954	0,2730929	0	0,3894896	0,3374175
10	Italy	0,8781527	0,5591578	0	0	0,4408422
11	Spain	0,8694694	0,6285728	0	0,0708	0,3006132
2013 Rank	DMU	Well-being Index	Consumption Flows	Wealth Stocks	Inequality Measures	Economic Security
1	Norway	1	0,9623236	0,0377	0	0
1	United Kingdom	1	1	0	0	0
1	Finland	1	0,0147	0	0,9853118	0
1	Netherlands	1	0,5022404	0	0,4977596	0
5	Denmark	0,9641148	0	0	0	1
6	Belgium	0,9426633	0,1520423	0	0,7380753	0,1098824
7	Sweden	0,940089	0	0	0,5638304	0,4361696
8	France	0,9347215	0,1420636	0	0,7466627	0,1112737
9	Germany	0,9026324	0	0	0,5676372	0,4323628
10	Italy	0,8489234	0	0	0	1
11	Spain	0,7288666	0,9839292	0,0161	0	0

Source: Centre for the Study of Living Standards; own calculation

As stated in Table 1, a strong need for improvements in IEWB can be mainly seen in Spain and Italy. Decomposition of inefficiency indicates that despite the differences in the achieved overall economic well-being in the surveyed economies, the potential for enhancement of various areas of IEWB indicators is not relatively equally distributed.

This means that improvements in the overall economic well-being must be understood comprehensively. The achieved well-being is not the result of only one indicator but has to be achieved by improvement in all four areas of well-being. Different values of overall well-being in countries reflect not only the differences in amenities of components of well-being of surveyed countries but also in quality of their economic performance. Based on data from the previous table, we are able to conclude that DEA model

identified four effective countries in 2013 and six in 2000 from eleven observed countries.

As already mentioned before, based on weighted data we are able to interpret which relative contributions of individual sub-indices contribute to the creation of overall well-being. In general, by comparing the relative contributions of the various sub-indices, we can conclude that surveyed countries achieve their efficiency primarily based on consumption flow in 2000 and in 2013 achieved efficiency is result mainly of consumption flows and inequality measures. On the other hand, the economic security participates on the construction of overall well-being with the smallest share. Its share significantly decreased in the creation of overall economic well-being in 2013 compared to 2000, which is also due to a negative average growth rate of this sub-index.

Value judgments regarding the importance of the different domains of economic well-being can matter, but in the alternative scenarios presented here, they have no significant effect on the rankings of countries according to the Index of Economic Well-being. Our main results are fairly robust comparing the overall well-being and the average annual growth of GDP per capita, but the results of these two scenarios of weighting scheme are almost similar. Norway has the highest Index value under both weighting schemes, followed by United Kingdom and Finland, while Spain is always on the bottom. The results for Denmark are particularly sensitive to the weights on economic equality and security relative to those on consumption and wealth (Table 1).

Table 2: The ranking of countries under the three ways of measuring economic well-being

Rank	Average annual growth of GDP per capita	Average annual growth of overall well-being	DEA model
1	Norway	Norway	Norway
2	Germany	United Kingdom	United Kingdom
3	Sweden	Finland	Finland
4	Finland	Belgium	Netherlands
5	Spain	Sweden	Denmark
6	Netherlands	Netherlands	Belgium
7	Denmark	France	Sweden
8	Belgium	Germany	France
9	France	Italy	Germany
10	United Kingdom	Denmark	Italy
11	Italy	Spain	Spain

Source: own calculations

Conclusion

Although economic well-being has increased between 2000 and 2013 in every country under first weighting scheme (with the exception of Spain),

under the second scheme overall well-being has decreased over the given period of time. Across the selected countries of OECD, rising economic well-being was driven by growth in consumption and stocks of wealth. In most of the countries, however, the growth of economic well-being was hindered by declines in economic equality and security. These trends were driven by rising income inequality and increased private expenditures on health care in most countries. An important objective of the Index of Economic Well-being is to make explicit value judgments that underline composite indicators of well-being by making the choice of weights for the four domains as transparent as possible. We tested the sensitivity of our baseline results to two alternative weighting schemes and found out that our key baseline results are not so different in almost all countries. In general, consumption and wealth have increased faster over time than economic equality and security (if the latter two increased at all), so economic well-being grows faster when the consumption and wealth domains are weighted heavily relative to the equality and security domains. In all eleven countries, the Index grew faster over the 2000-2013 period under the first weighting scheme than under the second one (in which equality and security receive the smallest weights among the domains).

Economic well-being has increased in every country over the 2000-2013 period except of Spain. Norway had always the highest level of economic well-being, while Spain always ranked in the bottom position.

The Index of well-being is still in progress, it needs to undergo further modifications for the choice of weights but it still captures more aspects of economic well-being than real GDP does, and therefore is a step ahead in the right direction.

Acknowledgment

This article is a part of research project VEGA 1/0810/15: Input-output analysis of European integration

This article is a part of research project VEGA 1/0313/14: Relation between efficiency and equity – implications for economic policy.

This article is a part of research project VEGA 1/0431/16: Economic growth and social and environmental impacts.

References:

Cooper, W. – Seiford, L. M. – Tone, K. (2007). Data Envelopment Analysis. A Comprehensive Text with Models, Applications, References and DEA-Solver Software. 2.vyd. Springer, 2007. ISBN: 978-0-387-45281-4.

Database of the Index of Economic Well-being for Selected OECD Countries and Alberta, 1980-2013, Available from Internet: http://www.csls.ca/iwb/oecd.asp

Goosens, Y. a kol. 2007. *Alternative progress indicators to Gross Domestic Product (GDP) as a means towards sustainable development*. Luxemburg: Európsky parlament, 2007. Available from Internet: http://www.europarl.europa.eu

North, D. C. (1990). *Institutions, institutional change, and economic performance.* Cambridge University Press, Cambridge; New York. ISBN 978-05-2139-734-6.

North, D.C. (1991). Institutions. *The Journal of Economic Perspectives*, Vol. 5, No. 1. (Winter, 1991), pp. 97-112.

North, D. C. (1993). The new institutional economics and development. *Economic History Paper Series 9309002*, EconWPA. Available from Internet: http://129.3.20.41/eps/eh/papers/9309/9309002.pdf

North, D. C. (1994). Economic Performance Through Time. *The American Economic Review*, *3*, s. 359-368. Available from Internet: file:///F:/SINGAPOUR/north%20(1)%20Economic%20Performance%20Through%20Time%5E.pdf.

Osberg, L. a Sharpe, A. 2011. CSLS Research Report 2011-12, *Moving from a GDP-based to a Well-Being based metric of Economic Performance and Social Progress? Results from the Index of Economic Well-Being for OECD Countries, 1980-2009* Available from Internet: http://www.csls.ca/iwb/oecd.asp

Osberg, L. a Sharpe, A. 2009. CSLS Research Report 2009-11, New Estimates of the Index of Economic Well-Being for Selected OECD Countries, 1980-2007Available from Internet: http://www.csls.ca/iwb/oecd.asp

Sharpe. A., Salzman. J., 2003. *Methodological Choices Encountered in the Construction of Composite Indices of Economic and Social Well-Being*, CSLC Available from Internet: http://www.csls.ca/events/cea2003/salzman-typol-cea2003.pdf

Tone, K. 2001. A slack-based measure of efficiency in data envelopment analysis. *European Journal of Operational Research*, vol. 130, pp. 498–509.