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# OPERATIONALIZATION AND ESTIMATION OF BALANCED DEVELOPMENT INDEX FOR POLAND 1999-2016

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## ABSTRACT

Stemming from assumption that Gross Domestic Product is an index oversimplifying economic development and not reflecting socio-economic development, the paper presents conceptualization, operationalization and estimation of Balanced Development Index (BDI), concerning both economic and social development in Poland. Actual values of this index as well as its four composite components (middle-level indexes) are presented for 1999-2013. A statistical model allowing estimation of BDI values as well as short-term forecasts is proposed alongside with the concept of balanced development. Application of this model for 1999-2016 is presented.

**Key words:** socio-economic development, index, economic indicators, social indicators, balanced development, evaluations, predictions.

## 1. Background

Gross Domestic Product has been criticized since the great crisis of 1930s as not reflecting the nature and the trends of socio-economic development and oversimplifying the complexity of economic development itself, even if no social aspects or consequences of it are under consideration (Kuztets 1934, 5-6). However, GDP or a very similar GNP (Gross National Product) have been almost exclusively used and interpreted as general measures of development of nations despite of all this criticism. The serious work towards improving or replacing them started only around 50 years ago. After some decline of interest in such

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endeavours, quite many indexes of development conceived according to "beyond GDP" paradigm (Constanza et al. 2009; Fleurbaey, Blanchet, 2013; Thiry, 2014) have been proposed, applied and published. The most known are Gross National Happiness (Pennock, Ura 2011, Ura et al. 2012), Better Life Index (OECD 2013), Human Development Index (UNDP 2013) as well as work by a group of economists and other social scientists commissioned by French President (Stiglitz et al. 2013). In Poland, the proposal to construct composite index describing both economic and social aspects of development was formulated by G. Kolodko (2008). Some work in this respect was also done in Polish Central Statistical Office (GUS 2011). The latter one, similar to the German proposal (Giesselmann et al. 2013), aimed at providing a comprehensive list of detailed indicators contrary to our project, the aim of which is to construct more general and complex indexes[5].

Several of these projects concern only social indicators, whilst some others combine social and economic ones. Usually, however, even if they do not completely neglect economic aspects of development, they underemphasize them and overemphasize social aspects. Our approach is in line with the 'beyond GDP' paradigm understood not as "apart from GDP" but assigning equal weight to economic and social aspects of development.

The preliminary results of our work, including preliminary version have been already presented (Kozminski et.al., 2014). The project is still in progress. Our current aim is to substantially improve the initially presented index, to analyse and to predict changes in Polish economy and society. Here we will present the composition of the index, the idea concerning a balanced development, the trend of socio-economic development as measured by the index, a statistical model estimating values of the index and a comparison of obtained and estimated values as well as a short-term prediction.

## 2. Constructing the index

A primary and unique advantage of the Balanced Development Index is its composite (synthetic) character, enabling it to simultaneously measure:

- the achieved level of development, covering a wealth of both economic and social aspects;
- the system's functional balance assessed by the degree of convergence measured as standard deviation of the four basic dimensions (realms) of the development.

[5] We use the convention here according to which „index" is understood as a complex, composite measure, while „indicator" is understood as a simple, detailed one. Of course, this is only one of several possible conventions.

Our index concerns four socio-demographic dimensions, two economic and two social ones. Each of these is described by a set of indicators drawn from publicly available statistics and from public opinion research. Detailed indicators are then aggregated into four middle-level indexes, which – in turn – are aggregated into a general index (BDI).

One of the shortcomings of the previously proposed indexes is the neglect of the functioning of national economy in its international context. We consider that to be especially important in the present age of globalization. Our previous analysis, mentioned above, has suggested that the changes in international economic relations and in the global economic environment come before those taking place domestically. Thus, the first group of detailed indicators concerns various aspects of the functioning of Polish economy in its international, globalizing context. We call this group "external economic". The second group of indicators characterizes various aspects of "internal economic" condition. Here, we adhere to the idea that GDP, as an important indicator, is needed but not sufficient to characterize the state of economy. We have also previously discovered that changes in public opinions about expected future conditions come ahead of subsequent evaluations and actual objective social change (Koźmiński et al. 2014). Therefore, social indicators have been grouped into the categories of "social expectations" (public hopes and fears concerning various aspects of economic, political and social life) and "current social situation" (subjective evaluations and objective state of socio-economic conditions).

The initial pre-selection of simple indicators, which together formed the initial four middle-level indexes, was largely intuitive (Kozminski et al., 2014). It was, therefore, necessary to analytically and statistically verify the original list. The statistical verification was done first through a correlation analysis (not reported here for the lack of space), then the "Cronbach's α" was applied to measure the internal consistency of the four synthetic indexes and served as a final criterion for including particular indicators in them. The final list of the indicators is as follows:

A. External Economic Indicators
   ($\alpha = .761$)

- size of foreign direct investment (FDI) in Poland,
- WIG 20 (Warsaw Stock Exchange index),
- volume of import,
- volume of export,
- Euro/PLN exchange rate (inverted),
- spread (difference) between the Polish interest rate on 10-year bonds and German bonds (inverted)
- spread between the Polish interest rate on 10-year bonds and US bonds USA (inverted)

B. Internal Economic Indicators
($\alpha$ = .843)

- production of electricity,
- number of dwellings completed,
- increase in real wages,
- Gross Domestic Product,
- size of consumption,
- size of accumulation,
- gross business profitability,
- public debt as GDP% (inverted),
- inflation rate (inverted),
- unemployment (inverted).

C. Social expectations (predictions)
($\alpha$ = .965)

The ratio of positive ("will improve") to negative ("will deteriorate") answers to the questions whether in a year's time the situation will improve or deteriorate with respect to:

- anticipated changes in political situation in Poland,
- anticipated changes in the economic situation in Poland,
- anticipated changes in the overall situation in Poland,
- anticipated changes in the workplace,
- "Will your family live better or worse in a year's time?",
- "Are you afraid or not that you may lose your job?".

D. Current social situation
($\alpha$ = .958)

- attitude to the government (ratio of the number of supporters to opponents),
- assessment of the political situation (ratio of those with 'positive' against 'negative' opinions),
- assessment of the economic situation (ratio of those with 'positive' against 'negative' opinions),
- how the family presently lives (ratio of those answering 'positively' against 'negatively'),
- assessment of situation in the workplace (ratio of those with 'positive' against 'negative' opinions),
- business confidence index,
- people below extreme poverty line (inverted),
- state budget expenditure on social welfare (GDP%) (inverted),
- state budget expenditure on health (GDP%),
- youth (15-24) unemployment (inverted),
- access to Internet (households%),

- birth rate,
- infant deaths (reversed),
- ratio of the population of pre-productive age compared to those of post-productive age,
- people aged 18-59 living in households in which no one is employed (%) (inverted)
- number of tertiary education graduates (public and private combined)
- number of scientific-research employees,
- young people not continuing education (%) (inverted),
- number of homicides (inverted),
- number of thefts (inverted),
- number of Polish students who went abroad on Erasmus grant,
- number of foreign students in tertiary education institutions.

The standardised value was calculated for each of these indicators in the period 1999-2013 (later data were not available). This was done according to a very simple statistical formula:

$$z = \frac{x_t - M}{SD}$$

Where: $x_t$ is the value of an indicator in a year t , M is the average level of an indicator for the period 1999-2013 and SD is the indicator's standard deviation.

High values of Cronbach's α indicated that despite their great number the indicators can be collapsed into composite scales. Thus, non-weighted mean values of the standardised indicators were calculated for each year for the four different domains. They have constituted middle-level indexes. The correlations between them are presented in Table 1.

**Table 1.** Correlations between mid-level components of the general BDI index, 1999-2013 (Pearson's r above diagonal; Spearman's rho below diagonal; Cronbach's α = .870)

| | External economic | Internal economic | Public expectations | Current social situation |
|---|---|---|---|---|
| External economic | x | .807** | .627** | .688** |
| Internal economic | .689** | X | .545* | .943** |
| Public expectations | .682** | .382 | x | .516* |
| Current social situation | .650* | .854** | .575* | x |

*) Significant at .05 level. **) Significant at .01 level.

Only one out of twelve correlation coefficients, namely Spearman rho between the internal economic situation and public expectations, falls below .5 and is statistically insignificant due to a very small number of observations, even

though that correlation (.382) is of the level usually considered quite high in social sciences. Moreover, its equivalent among Pearson's correlations (.545) is statistically significant. The relatively low correlation, as compared to others (though still not negligible), between the current economic situation and public expectations indicates that the latter do not perfectly reflect economic situation of the nation. However, the expectations are strongly related to the external economic situation and to current social conditions. High correlations as well as high Cronbach's α (.870) of the four middle-level indexes allow computing the general BDI as their unweighted mean.

## 3. The general description of the index and its trend

As already stated, we have not applied different weights in calculating our indexes, neither to detailed variables contributing to middle-level indexes, nor to middle-level indexes constituting to the general one. High correlations between them did not allow for determining the weights by applying statistical criteria, such as often used factor analysis, the results of which are very unstable when colinearity occurs. Moreover, in substantive terms, high correlations between components suggest their more or less equal contribution to the higher-level index. On the other hand, we restrained ourselves from subjectively and intuitively assigning different weights, especially to middle-level indexes which we consider to be equally important. The changes in four middle-level indexes and their means constituting the BDI are presented in Figure 1.

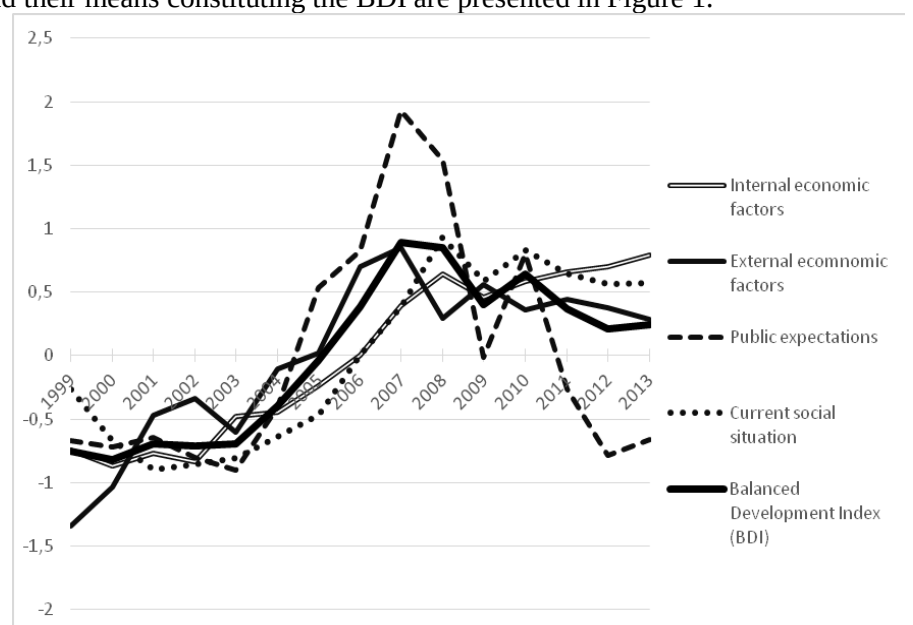


**Figure 1.** The four standardized components of Balanced Development Index (BDI), Poland 1999-2013

It is clear that the changes occurring in Poland take place in a similar manner for all four dimensions of development but with different amplitude. Thus, changes in the general index, calculated as an average, illustrate well the course of socio-economic development in Poland depicted by middle-level indexes. An important point of clarification is needed here. Economists and politicians emphasise the steady although slow GDP growth in Poland during and after the world financial crisis (see Fig. 2). However, the overall socio-economic index shows a slight downward trend since 2007, with some fluctuations. This downward trend is caused mostly by social trends, especially by worsening public expectations, and – to a much lesser but substantial extent – by external economic circumstances (functioning in international economic environment), while current economic situation measured by a middle-level composite index improves slightly since 2009 after a temporary decline.

The data presented in Figure 1 indicate that the variability of middle-level index of public expectations, which can be interpreted in terms of optimism and pessimism concerning the future, is much greater than the variability of the other three synthetic components of the index. This is the reason of already pointed out relatively low (though still not low in absolute terms) correlation between public expectations and economic situation.

The comparison of changes in GDP and BDI is especially important. This may be not statistically sound, since the first contributes to the second one, but such a comparison gives the idea about differences between both indexes as measures of development. As shown in Figure 2, the difference between standardized values of GDP and BDI has been recently increasing.

Two slowdowns (albeit not recessions) in economic development measured by GDP occurred twice in Poland during the investigated period: a weaker one (2000-2003) and a harsher one (2008-2009), though no full recovery is apparent until 2013.

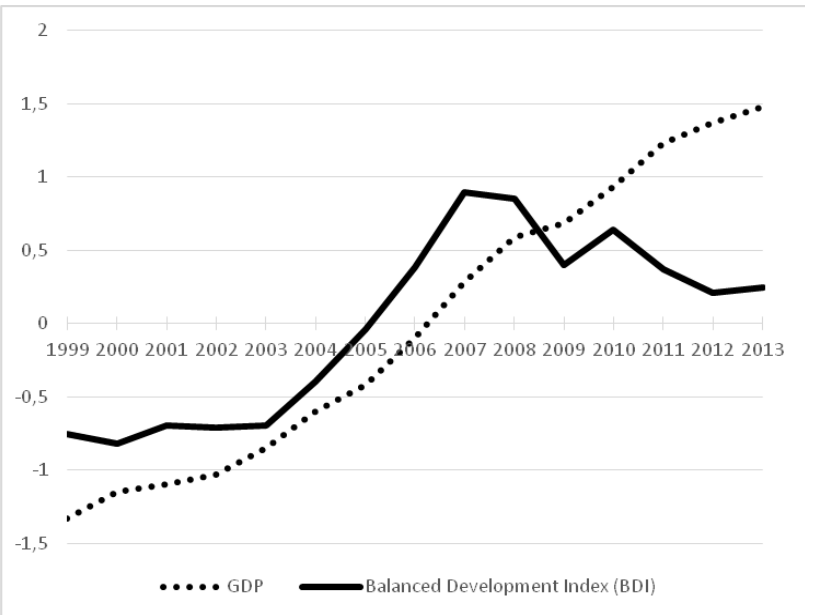


**Figure 2.** Changes in GDP and BDI, Poland 1999-2013 (standardised)

At the same times, the composite BDI index shows the first slowdown stronger than GDP and then the decline not shown by GDP whatsoever. In the first case, BDI suggests the stagnation while GDP was still growing, though at a smaller rate (by 3.9% in 2003). In the second case we see apparent BDI decline (with minor fluctuations only) despite the fact that GDP grew by 5.1% in 2008, 3.9% in 2010 and 4.3% in 2011. While the decline of socio-economic index has stopped in 2013, the gap between GDP and BDI remains quite big. The ability to show this discrepancy is in our opinion a very valuable feature of our synthetic index, which indicates the state of both the society and the economy much better than GDP does it.

## 4. Balanced development

Our idea of balanced development is based on an economic concept of equilibrium and rests upon the assumption that a certain minimum level of balance is needed to steer the system. According to the theory of Liapunov (1992), imbalances occur when individual elements excessively diverge from one another. However, some level of imbalance is needed for a change in the system (its development included). Disruption of the equilibrium is reflected in the growth of standard deviations of measured growth components. The perfect equilibrium is usually associated with a stagnation, though "dynamic equilibrium"

is also possible, defined as a parallel growth in different realms not changing the proportions between them. Our assumption is that some imbalances may pull the general index both up and down and have a positive as well as a negative effect. Imbalance is needed to knock the system out of stagnation but when it grows too much and over a long period of time, then this threatens the controllability of the system, its susceptibility to managerial impulses and stops its further development. We do not hypothesize about the optimum level of imbalance, but simply include its measure into our prediction model in order to see when the developmental trends does change. We are interested in the balance (understood as equilibrium, i.e. mutual adjustment and agreement measured as co-variation) between four domains of development embraced by BDI. Standard deviation between four middle-level indexes is used as a measure of balance.

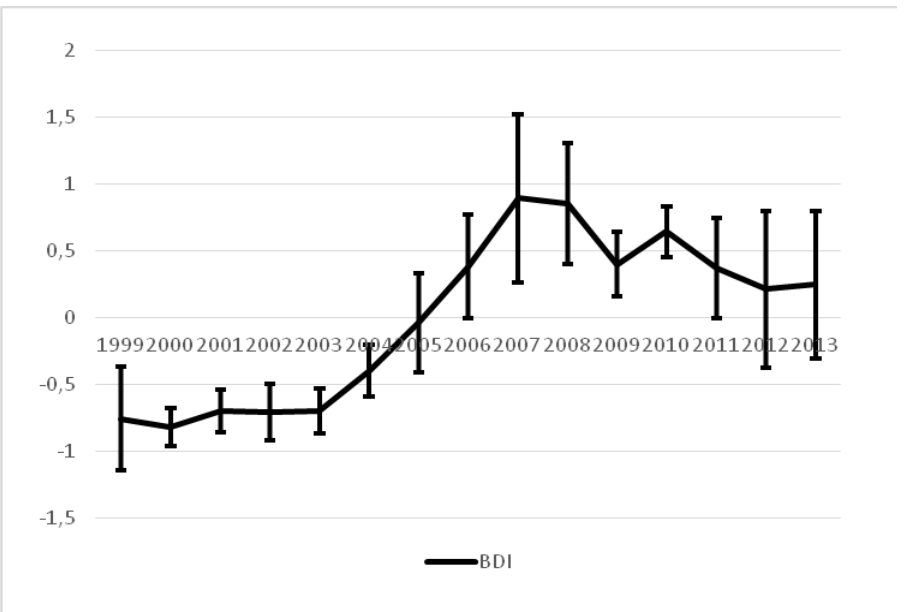


**Figure 3.** Changes in BDI and standard deviations of its four components, Poland 1999-2013

In accordance with our hypothesis, the changes from growth to decline, or vice versa, are taking place in the time of increase in the standard deviation and thus in conditions of imbalance. The period of a relative stagnation, or at least a slowdown in growth, was characterised by a high balance at the beginning of the 21st century. The beginning of economic crisis of 2007-09 was marked by a rising imbalance. The standard deviation exceeded .55 in 2007. This indicates a very high imbalance, and so the possibility of worsening the previously improving general socio-economic situation in the following years or - at best - halting further development. We still should see whether a similar rapid increase

in imbalance in 2012 will lead to the next reversal in the trend and in overall improvement of the situation in the forthcoming years. A slight improvement in 2013 may support such hypothesis. We can attempt to give an answer to this question based on our statistical model, presented below in the section devoted to forecasting.

## 5. Forecasts

A disadvantage with most of econometric forecasting methods is that they primarily predict "average" phenomena, free from discontinuities and other changes that essentially alter the course of studied processes. Fortunately, such rapid changes occurred during the period we examined, so we can try to analyse them and to predict further development taking them into account. We have attempted to design a model that allows not only for the description of current trends, but also for forecasting its change by anticipating the points where an excessive drift of all or some of the four middle-level indicators occurs. Although the beginning and the acceleration of growth demand a certain loss of socio-economic balance, it can result in a loss of control over the system and reverse the trend, if this loss of balance is too long and far-reaching. The danger of a decline may occur in conditions of imbalance growing after a period of development. There is the other side of the coin in this respect, since some imbalances occurring after a period of socio-economic decline may result in future development. Thus, we believe that the imbalance may incur both negative and positive changes in developmental trends. However, attempting prophecy or a simple extrapolation of known trends is a risky business. This is a reason of not attempting long-term predictions, which would be impossible anyway because of lack of statistical basis.

Our predictive model assumes that BDI value in year t depends on three factors:

- BDI value in the preceding year (t-1),
- change in BDI value between years (t-2) and (t-1),
- change in standard deviation of four BDI components in years (t-2) and (t-1).

As we do not expect large changes in BDI value from year to year, the relationship between $BDI_t$ and $BDI_{t-1}$ is assumed to be linear. The other two variables (both deltas) are, in turn, expected to have curvilinear, namely "S-shaped" (with two bends) relationship with BDI (which is represented by cubic polynomials in the model). As can be seen in Equation 2, the signs of highest order terms in both polynomials ($b_4$ and $b_7$) are negative, which indicates a curve that is first concave upward and then concave downward as the value of predictor increases **(**Cohen et al., 2003). This means that – with all other factors held constant - the increase in BDI delta as well as the delta of BDI's standard deviation in previous year results in drop in the BDI value. Then the trend

reverses bigger deltas to co-occur with higher values of BDI. However, this is also up to a point (the second bend of the curve).

Our proposed model is as follows:

In its general form:

Eq. 1 $BDI = b_0 + b_1 BDI_{t-1} + b_2 \Delta BDI + b_3(\Delta BDI)^2 + b_4(\Delta BDI)^3 + b_5 \Delta SD + b_6(\Delta SD)^2 + b_7(\Delta SD)^3$

Specific values of the equation's coefficients for the period under analyses are:

Eq. 2 $BDI' = -0{,}082 + 0{,}686\, BDI_{t-1} + 0{,}229 \Delta BDI + 2{,}59(\Delta BDI)^2 - 1{,}102(\Delta BDI)^3 + 0{,}962 \Delta SD - 1{,}636(\Delta SD)^2 - 20{,}855(\Delta SD)^3$

where :

$BDI'$ - BDI value in the year t (predicted),

$BDI_{t-1}$ - value of BDI in the previous year (t-1)

$\Delta BDI$ - $BDI_{t-1} - BDI_{t-2}$ (Difference between the BDI value during the previous year and two years earlier),

$\Delta SD$ - $SD_{t-1} - SD_{t-2}$ (Change in the standard deviation of the index's components between the previous year and two years ago),

$SD_{t-1}$ - (Standard deviation of BDI components in the previous year) (t-1).

The basic premise here is to assume a curved shape of the relationship between the pace of development and the change of its degree of balance. We assume an "S" shape of basic relations between the two. The total consistency of imbalance is not conducive for development. Development requires some growth in imbalance in one or a few areas. However, too large imbalance in conditions of too quick growth causes an "overheating of the system", a lack of control and "fragility" and may lead to stagnation or decline. On the other hand, we assume that the imbalance occurring in conditions of prolonged stagnation or decline prevent excessive freezing and causes the trend to reverse to developmental one, so the cycle reverse.

Determining how one or the other (overheating and freezing) causes a trend to reverse is a matter of empirical analysis. Previous experience allows us to formulate an assumption that the desired level of balance, measured through the standard deviation of the four BDI components, is about .4. Until now, an imbalance at this level has always been associated with BDI rise during the next year. Deviations far above (such as .67 in 2007) or below (e.g. .17 in 2001) this level tend to be followed by a worsening or stagnation of socio-economic conditions. Our hypothesis is that high imbalance following the period of stagnation or decline should result in development, while high imbalance following period of growth should result in stagnation or decline. All in all, BDI constitutes a tool-box (Noll 2011) rather than a single universal tool, since it

allows for analyses of its changes as well as changes in its four composite components, their interrelations (including incongruence) and their influence on the generalised socio-economic development.

In order to forecast BDI changes, it was necessary to predict the standard deviation of its four components. For this purpose, we used the formula:

Eq.3 $SD' = b_0 + b_1 S_{t-1} + b_2 \Delta S + b_2 (\Delta S)^2 + b_2 (\Delta S)^3$

Eq.4 $SD' = 0{,}145 + 0{,}817 S_{t-1} + 1{,}167 \Delta S - 2{,}614 (\Delta S)^2 - 21{,}147 (\Delta S)^3$

(Notation as above).

The soundness of the proposed model is proven by a comparison of actual and estimated trends in the past. Our model reproduces the actual (empirically established) shape of the BDI curve very accurately. The Pearson's r correlation between the actual values and those estimated by the model is as high as .961. (Spearman's rho: .918) Our estimates accurately indicate the points where the trend was changing, with an annual delay only observed in 2001 and 2003. From 2005 to 2012, actual and estimated curves completely overlap, even during the time of frequent fluctuations between 2007 and 2010. This has allowed us to predict the eventual change in the developmental trend for a short time period at least. The model allows us to estimate of IBD three years ahead. In conditions of extreme uncertainty caused by world-wide economic turbulences, we have not been tempted to make long-term predictions. The results presented in Figure 4 compare the observed and the estimated BDI curves up to 2013 and the estimates for the 2014-2016 period. We predict the sharp decline in the BDI value will come to a halt and perhaps the value will even slightly improve in 2014, for which no actual data existed in the time of the analysis.

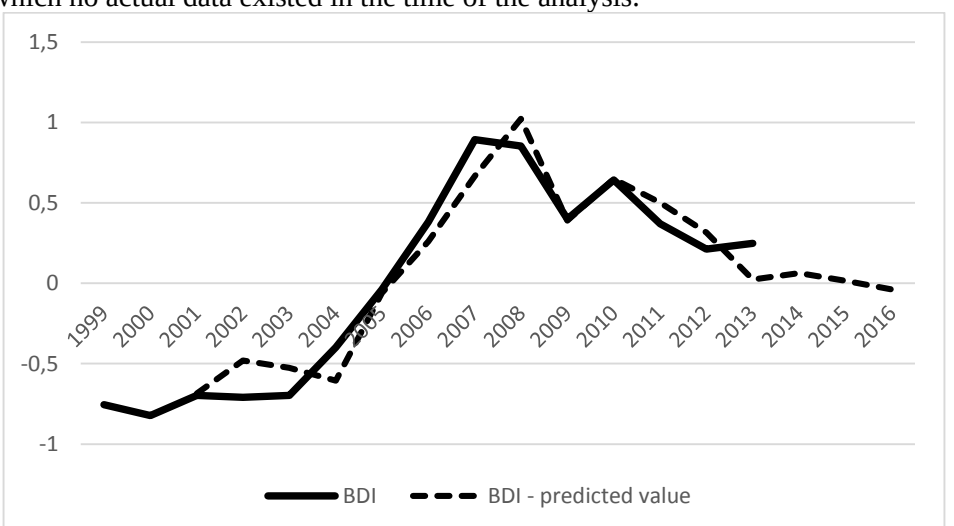


**Figure 4.** The actual and predicted course of socio-economic development, measured by BDI, 1999-2016

## 6. Conclusions

Although the time-scale during which we observed the dynamics of our indicators is short, it still gives a valuable picture of Polish socio-economic development. It covers tumultuous changes occurred during the 1999-2013 period, including the 2007 outbreak of the most serious financial and economic world crisis since 1929. Thus, the index underwent a severe stress test. All statistical models estimating and predicting complex processes may instigate various arguments. The ultimate proof for them is the consistency with empirically observed trends. Our model seems to pass this test, especially that the trend changes its direction quite often. The estimated BDI values correspond to the actual ones, which makes the short-term prediction reliable. In substantive terms, BDI suggests that socio-economic changes are less positive than those suggested by GDP growth itself, and that public expectations vary much more than the actual situation measured jointly by objective and subjective indicators.

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