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THE TENSION BETWEEN ADJUSTED NET SAVINGS, SUSTAINABLE GROWTH AND RESOURCE DEPLETION

Abstract. *In this paper, we try to analyse the evolution of sustainable development in developed and emerging countries in the idea that a sustainable approach is good, but not enough to catch the entire process behind development. Our analysis is built on the premise that the economy needs a new approach on the consumption of natural resources and should underline the relation between food security – economic development – agricultural advance - resource allocation. In this idea we built an econometric model of the relation between Adjusted Net Savings (ANS) and Gross Domestic Product per capita by analysing the same process in 34 countries, including developed or emerging ones. We chose Adjusted Net Savings in our process of analysing these premises because ANS consists of Net National Savings, Education Spending, Energy Resource Depletion, Mineral Resource Depletion, Forestry Depletion, CO2 emissions and its damages, and helps us understand the direct and powerful connection between Adjusted Net Saving, Gross Domestic Product and sustainable development, filtering food*

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security and availability through the rational management of resource depletion. The results will highlight the applicability and strong bond between ANS and GDP per capita as development factors.

Keywords: *sustainable development, Adjusted Net Savings, GDP per capita, GDP growth, resource depletion.*

JEL classification: O11, Q01

1. Introduction

The aim was to create an econometric model that incorporates data on the type and intensity of the relationship between Adjusted Net Savings (ANS) and gross domestic product per capita, at a level of sample of 34 countries. The sample of countries includes: Australia, Austria, Belgium, Canada, Czech Republic, Chile, South Korea, Denmark, Switzerland, Estonia, Finland, France, Germany, Greece, Iceland, Ireland, Israel, Italy, Japan, Latvia, Lithuania, Luxembourg, Great Britain, Mexico, New Zealand, Norway, Netherlands, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, United States of America, Turkey and Hungary (Georgescu, 2020).

Adjusted Net Savings (ANS) represents an indicator and an alternative to the traditional indicators (the best example here is the Gross Domestic Product and its calculation methodology (Neve and Hamide, 2007, pp. 39-58) and by making this model we tested the degree to which the evolution of the first indicator - ANS (the dependent variable – Thiry and Cassiers, 2010, pp. 1-21) by the evolution of the most established indicator of economic development, ie Gross Domestic Product/capita (independent variable). It was decided to use GDP/capita to incorporate demographic change into the model.

2. Materials and methods

There are a number of principles on growth policy that create the opportunity for sustainable growth and can accelerate a positive trend for the GDP and GDP per capita, as follows:

1. As in the corporate environment, nations create markets that are in competition with each other, but the international environment needs a combination of market mechanisms with the state's internal regulation system, so the state could develop the working premise and the market could validate it by accepting or rejecting it;
2. There are components that are needed to remain under the protection of public initiative, i.e. the production of public goods (public order, personal security, national defence, road infrastructure, etc.), but public initiative must be supported by private influence because it reduces the risk of allocative inefficiency;

3. Macroeconomic stability represents in the beginning the validation of choosing the right implementation measures, and in the long run achieving economic growth that transforms macroeconomic stability into an achievement of by itself and has as a derivative result by reaching social stability;
4. Sustainable economic growth and the acceleration of GDP per capita must be sustained on an ongoing basis, and this can be done by maintaining the usefulness of involving the private sector in order to keep its interests on the same wavelength as national interests. Ways to maintain state involvement can be done by creating an optimal environment complementary to the financial one, by increasing the efficiency of the social climate, interpersonal relations, access to information, diplomatic rights, avoiding economic disparities created at will, but without encouraging egalitarianism;
5. Creating development programs and public-private partnerships in resource-consuming fields, such as: scientific research, environmental protection, the education system, vocational training, etc. Social welfare is in constant flux on an upward trend if these resource-consuming areas are sustained and continuously improved and in global competition;
6. The appropriate legal framework and the developed multilateral institutional system must be brought into question because they are the ones that help to streamline the public, private, relations and easy connection with the human factor, which results in increasing long-term social welfare. Among those encountered in this segment are: clear, relevant and stable regulations on contractual rights and obligations, labour relations, regulation and strengthening of private-public connections, obtaining, distributing and redistributing income to institutions and the population in a rational and efficient manner;
7. Keeping under control the negative externalities in the idea of staying within the limits of equity, efficiency and evolution of the population, also seen as welfare;
8. Territorial borders for labour and capital transfer have been erased through participation in unions (in the EU and US) and the emergence of multinationals. These processes of globalization must be maintained under the idea of mutual benefit for all countries in the global flow of the economy.

2.1. GDP and GDP per capita growth developed through Demand and Supply

According to J.M. Keynes Aggregate Demand resulted from spontaneous market mechanisms does not sufficiently provide full employment and economic growth, then state intervention is needed to stimulate effective demand (Keynes, 1937, pp. 209-223). Factors that negatively influence demand are rising prices,

excessive taxation, high interest rates, rising unemployment and others, and state governance must ensure the maintenance and enhancement of consumption (both private and public) and investment.

One of the negative effects of declining Aggregate Demand is the reduction in the use of factors of production, thus increasing the cost of stock and increasing the number of redundancies (increasing the unemployment rate and thus the social cost of the economy) and lowering the price of products that are able to return in the manufacturing flow, but falling prices and long-term demand are holding back economic growth, thus negatively influence GDP per capita. This practice was dominant in the post-Great Depression period and after World War II.

This branch of the practices designated for creating economic growth and a positive push for GDP and GDP per capita is likely to create a process of economic, social and political progress and stability by playing an active role in the efficient use of factors of production at maximum capacity. This method of work was adopted after the '70s in the USA and consisted in stimulating the increase of production of economic agents and producers, thus increasing the supply and as a second round effect the unemployment rate decreased, but in accordance with the investment in advanced equipment and technology (Angelescu and Stanescu, 2004).

The main characteristics of this process are:

1. Stimulating Investments (increased propensity for investment of entrepreneurs);
2. Stimulating Savings by the population (thus increasing the financing pool for investment loans);
3. Loose fiscal policy to favour the growth of production (extensive taxation: a lower percentage rate, but on a higher production volume);
4. Compliance of the minimum wage with the economic and social situation (maintaining competition for the job and maintaining low unemployment rates).

Increasing and push to new limits the GDP and GDP per capita through Supply allows the main role to be given in the "economic game" to the market, the state governance would ensure the direction and regulation of the game, and the productive development would be done under the control of corporate governance, state governance and in line regulations for the monetary system and the banking sector (Bodislav, 2011, pp. 129-140).

3. The econometric model

3.1. Data used for developing the model

The data that was used in the econometric estimates were taken from the World Bank database, these being:

1. Adjusted Net Savings (ANS) - expressed as a percentage of gross national income, for OECD member countries
2. Gross Domestic Product per capita - expressed as a year-on-year growth rate and calculated at the level of the U.S. dollar value in 2010 (reference - constant 2010 USD), similar for all OECD member countries

In order to obtain a balanced panel, a visual analysis of the data obtained was initially used, being decided as the time period used, the interval between 2007 - 2019 (there are no ANS values reported until 2007 for a number of countries – by using the World Bank database).

3.2. Describing the econometric model

Panel models, as presented in this analysis, can be represented in general by the following equation:

$$Y_{\mathrm{it}} = \alpha_i + X'_{it}\beta + \delta_i + \delta_t + \varepsilon_{it} \quad (1)$$

where, Y_{it}represents the dependent variable α is the free floating term of the equation, X'_{it} is a vector of regressors of dimension k, and $\varepsilon_{\mathrm{it}}$ represents the innovations for the transversal units M and observed for a number of T periods of time. The two terms, δ_{i} and δ_{t}, represent the specific effects of models with panel data: fixed effects or random effects (Necula, 2012).

3.3. Descriptive statistics and graphs

In this part, there are presented at graphical level the evolution of the two variables, Adjusted Net Savings (ANS – as percentage of Gross National Income) and Gross Domestic Products/capital (expressed as year on year growth) for the 2007 – 2019 timeframe. The graphs don't highlight the evolution of variables for Iceland and Lithuania, these being excluded because of their lack of statistical data for ANS.

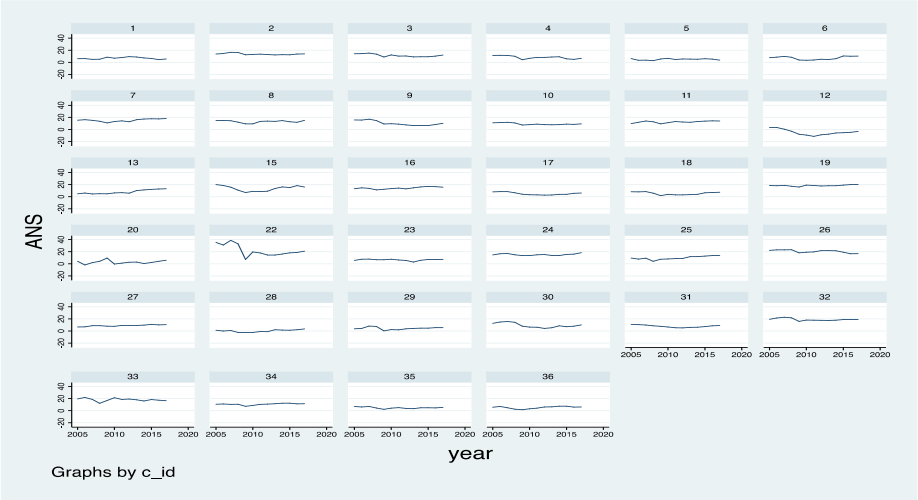

Figure 1. The evolution of ANS between 2007 and 2019 for OECD members (excluding Iceland and Lithuania)

Source: Own processings using Stata 17, Eurostat data

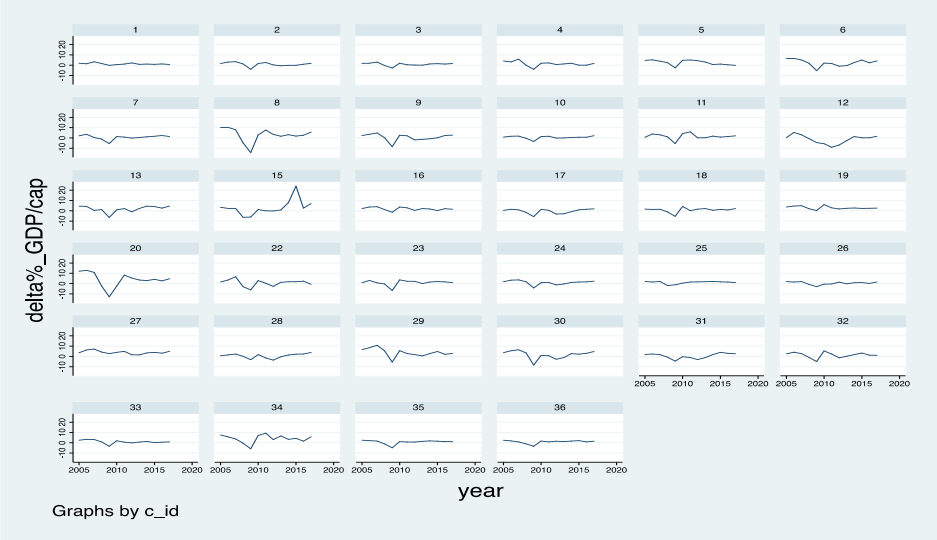

Figure 2. The evolution of GDP between 2007 and 2019 for OECD members (excluding Iceland and Lithuania)

Source: Own processing using Stata 17, Eurostat data

3.4. Model specification and estimations

The following equation presents the panel-type model, which incorporates the presented variables:

$$ANS_{it} = \alpha_i + \beta * GDP/capita_{it} + \varepsilon_{it} \quad (2)$$

where ANS is the Adjusted Net Savings, GDP/capita is the Gross Domestic Product per capita, α and β are the regression coefficients, and ε_{it} is the error value term.

In the first phase, the stationarity of the used data was tested using the Levin-Lin-Chu test (Levin et al, 2002, pp. 1-24). As mentioned earlier, the panel is well balanced, because the countries for which there were no statistical records in all the years analysed were excluded (Iceland and Lithuania), and the Levin-Lin-Chu test is one that is used for the panels well balanced. The test results for each variable entered in the model are presented in the following table:

Table 1. Levin-Lin-Chu test for the ANS variable

```
Levin-Lin-Chu unit-root test for ANS
------------------------------------
Ho: Panels contain unit roots                Number of panels  =     34
Ha: Panels are stationary                    Number of periods =     13

AR parameter: Common                         Asymptotics: N/T -> 0
Panel means:  Included
Time trend:   Not included

ADF regressions: 1 lag
LR variance:     Bartlett kernel, 7.00 lags average (chosen by LLC)
------------------------------------------------------------------------------
                     Statistic      p-value
------------------------------------------------------------------------------
 Unadjusted t       -11.2735
 Adjusted t*         -5.6500        0.0000
------------------------------------------------------------------------------
```

Source: Own calculations using Stata 17 and Microsoft 365 - Excel

Table 2. Levin-Lin-Chu test for the GDP variable

```
Levin-Lin-Chu unit-root test for GDP_gr
---------------------------------------
Ho: Panels contain unit roots                Number of panels  =     34
Ha: Panels are stationary                    Number of periods =     13

AR parameter: Common                         Asymptotics: N/T -> 0
Panel means:  Included
Time trend:   Not included

ADF regressions: 1 lag
LR variance:     Bartlett kernel, 7.00 lags average (chosen by LLC)
------------------------------------------------------------------------------
                     Statistic      p-value
------------------------------------------------------------------------------
 Unadjusted t       -17.6454
 Adjusted t*        -11.4457        0.0000
------------------------------------------------------------------------------
```

Source: Own calculations using Stata 17 and Microsoft 365 - Excel

The null hypothesis of the Levin-Lin-Chu test is that the tested variable has at least one unit root (Levin et al, 2002, pp. 1-24). Due to the values of p statistically (0.000) for both economic indicators, the null hypothesis can be rejected in favour of the alternative hypothesis: both variables are stationary.

Next, to decide which type of panel can be used, either with fixed effects or with random effects, we will use the estimates of both typologies in the Hausman test. In the model with fixed effects the estimator "within" was used, and in the one with random effects the estimator "GLS".

Table 3. Panel estimation for fixed effects

```
Fixed-effects (within) regression               Number of obs      =       442
Group variable: c_id                            Number of groups   =        34

R-sq:                                           Obs per group:
     within  = 0.1436                                         min =        13
     between = 0.0091                                         avg =      13.0
     overall = 0.0336                                         max =        13

                                                F(1,407)           =     68.24
corr(u_i, Xb)  = 0.0087                         Prob > F           =    0.0000

------------------------------------------------------------------------------
         ANS |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
      GDP_gr |   .3410958   .0412897     8.26   0.000     .2599282    .4222634
       _cons |   9.424175   .1409963    66.84   0.000     9.147003    9.701346
-------------+----------------------------------------------------------------
     sigma_u |  5.8666037
     sigma_e |  2.6667831
         rho |  .82875168   (fraction of variance due to u_i)
------------------------------------------------------------------------------
F test that all u_i=0: F(33, 407) = 62.91                     Prob > F = 0.0000
```

Source: Own calculations using Stata 17 and Microsoft 365 - Excel

Table 4. Panel estimation for random effects

```
Random-effects GLS regression                   Number of obs      =       442
Group variable: c_id                            Number of groups   =        34

R-sq:                                           Obs per group:
     within  = 0.1436                                         min =        13
     between = 0.0091                                         avg =      13.0
     overall = 0.0336                                         max =        13

                                                Wald chi2(1)       =     68.68
corr(u_i, X)   = 0 (assumed)                    Prob > chi2        =    0.0000

------------------------------------------------------------------------------
         ANS |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
      GDP_gr |   .3413661   .0411924     8.29   0.000     .2606306    .4221017
       _cons |   9.423772   1.022143     9.22   0.000     7.420408    11.42713
-------------+----------------------------------------------------------------
     sigma_u |  5.9098477
     sigma_e |  2.6667831
         rho |  .83082623   (fraction of variance due to u_i)
------------------------------------------------------------------------------
```

Source: Own calculations using Stata 17 and Microsoft 365 - Excel

The final result of the Hausman test are presented in the following table (Huasman, 1978, pp. 1251-1271). The null hypothesis for the test is the one that shows that the panel presents random effects, meanwhile the alternative is the one with the panel for fixed effects. The value for p-statistic (0,924) leads to an acceptance of the null hypothesis of the test, the preferred panel being the one with random effects, that tops the one with fixed effects.

Table 5. Hausman test's estimation (random effects vs. Fixed effects)

```
                 ---- Coefficients ----
             |      (b)          (B)            (b-B)     sqrt(diag(V_b-V_B))
             |     fixed        random       Difference          S.E.
-------------+------------------------------------------------------------
      GDP_gr |    .3410958     .3413661       -.0002703        .0028328
------------------------------------------------------------------------------
                           b = consistent under Ho and Ha; obtained from xtreg
            B = inconsistent under Ha, efficient under Ho; obtained from xtreg

    Test:  Ho:  difference in coefficients not systematic

                  chi2(1) = (b-B)'[(V_b-V_B)^(-1)](b-B)
                          =          0.01
                Prob>chi2 =        0.9240
```

Source: Own calculations using Stata 17 and Microsoft 365 - Excel

In the next step we went on with testing the panel with random effects, in the idea of obeying the hypothesis for the classical model: the lack of cross-section dependence between groups (the Pesaran test (Pesaran, 2007, pp. 265-312)) and the absence of autocorrelation errors (the Woolridge test (Woolridge, 1992, pp. 452-475)).

Table 6. Estimations of post-processing of econometrical testing

```
Pesaran's test of cross sectional independence =     10.756, Pr = 0.0000

Average absolute value of the off-diagonal elements =     0.401

Wooldridge test for autocorrelation in panel data
H0: no first order autocorrelation
    F(  1,      33) =     35.265
          Prob > F =      0.0000
```

Source: Own calculations using Stata 17 and Microsoft 365 – Excel

It is processed the fact that from the estimations for panel tests with random effects it exhibits the cross-section dependence inside the panel (the probability of the Pesaran test), and also, by auto-correlating the errors.

To solve this problem, we went on with the reshuffling the model by using the robustness option for grouping (clustering) errors depending on the code of each analysed country. The new estimations will be:

Table 7. Estimations for the panel with random effects with the option for clustering errors depending on the country's code

```
Random-effects GLS regression                   Number of obs      =       442
Group variable: c_id                            Number of groups   =        34

R-sq:                                           Obs per group:
     within  = 0.1436                                         min =        13
     between = 0.0091                                         avg =      13.0
     overall = 0.0336                                         max =        13

                                                Wald chi2(1)       =     11.10
corr(u_i, X)   = 0 (assumed)                    Prob > chi2        =    0.0009

                                    (Std. Err. adjusted for 34 clusters in c_id)
------------------------------------------------------------------------------
             |               Robust
         ANS |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
      GDP_gr |   .3413661   .1024383     3.33   0.001     .1405907    .5421415
       _cons |   9.423772   .9920757     9.50   0.000     7.479339    11.3682
-------------+----------------------------------------------------------------
     sigma_u |  5.9098477
     sigma_e |  2.6667831
         rho |   .83082623   (fraction of variance due to u_i)
------------------------------------------------------------------------------
```

Source: Own calculations using Stata 17 and Microsoft 365 - Excel

It could be seen that the Wald indicator (Wald, 1940, pp. 144-175) from the new estimations changed, the coefficients not having huge differences compared with the initial ones. The following graph shows the initial values compared to the regression line (adjusted values). From this graph it is very clear that Luxembourg has the highest rates of Adjusted Net Savings, followed by the Nordic countries, while in the other part of the ranking we find countries such as Greece, Portugal or Latvia.

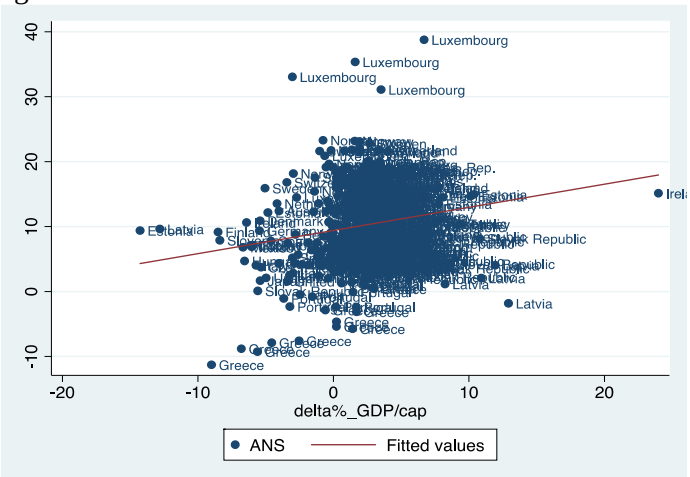

Figure 3. The model's point cloud

Source: Own calculations using Stata 17 and Microsoft 365 - Excel, Eurostat data

4.Results and discussion

Following the econometric modelling and the Hausman test, we decided that the panel model with random effects is the one that can explain the relationship between Adjusted Net Savings and the growth rate of Gross Domestic Product per capita. It could be seen from the tests run after processing the model that it disrupts the assumptions of the classic panel model and therefore, to correct this situation we resorted to a re-estimation of the model, containing a clustering of errors by country. As a result of the probabilities of the t test, it turned out that both coefficients - the Adjusted Net Savings (% of GNP) and the GDP growth rate per capita, together with free term are significantly different from 0. The probability of the F test across the model showed that the model used is a robust one. The adjusted model equation is given below:

$$ANS_{it} = 9{,}423 + 0{,}341 * GDP\_gr_{it} \quad (3)$$

The estimates resulted in a coefficient of determination of "within" (R2) of approximately 0,143. Its role is to explain to what extent the model created for the variation within each panel is responsible, or in other words, the fact that the model shown can explain the intensity of the connection only at country level and no influence of GDP per capita growth can be identified on ANS between panels (or at global level). The Adjusted Net Savings can be explained at individual level and at the level of each panel, in a percentage of 14.3%.

It can be said about the progress of the two variables that they are positively correlated, but the evolution of GDP per capita has the ability to explain very little of the evolution of Adjusted Net Savings. These estimates may suggest a fringe between the most important indicator of economic growth used globally, GDP, and other indicators of sustainable development, recently introduced in the literature, as is the case with Adjusted Net Savings.

In order to improve the econometric model proposed during this research, other records/data can be added over time to correlate the evolution of variables, or other macroeconomic indicators that could be related to the subject studied can be considered.

5.Conclusions and recommendations

Although the level of happiness and life satisfaction did not increase at the same time as GDP (Goossens et al., 2021), the increased wealth allowed significant developments in scientific and medical knowledge and technology that, in combination with an improved diet, reduced infant mortality and increased life expectancy. As a result, the global population has increased from about one billion in 1804 to 7.8 billion in 2020 and is expected to increase further to 9.6 billion by 2050 (UN, 2012). Such a dramatic increase in population, purchasing power and consumption already has an unprecedented impact on the demand for natural

resources and especially for metals, minerals and fossil fuels, which were consumed more in the twentieth century than in all other centuries together; in addition, demand will continue to grow for them. This article was based on econometric testing by creating and testing an econometric model that shows the functionality between the evolution of the Gross Domestic Product per capita (an important element in giving a country or nation the status of a developed country) and the relationship with Adjusted Net Savings (another important element in describing a country as developed), and in particular in terms of the fact that the Adjusted Net Savings include natural resources depletion, energy depletion, forest depletion and carbon dioxide emissions.

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