

Global Trends and World Development Indicators: Synergy Trends of Key Global Trends: Global Gross Domestic Growth in Relation to Global CO₂ Emissions, Global Electric Power Consumption, Global Population, and Global Schooling Index Data

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Abstract: This article includes global synergy trend analyses based on the world development indicators published by the world bank. in order to understand globalization phenomena, it is good to understand global trends and the interactions between global trends. The empirical study is based on the World Bank global data sets of world development indicators. The synergy analysis method and tool were developed to analyze the synergy between two different trends, but it can be used to analyze simultaneously the synergy between three trends representing the three different dimensions of sustainable development. It is good for decision-makers to be aware - not only of the development of the trends themselves, but decision-makers should be aware also of the interactions between global trends. there may be positive, negative, or no synergy between trends. These three different forms of synergy are therefore always possible. that is why this study is important and interesting. The empirical research delivers synergy analysis results of global trends in relation to global GDP. The critical global synergy analyses are linked to (1) global CO₂ emission, trend, (2) a trend in global electric power consumption, (3) global population trends, (4) population density trends, and (5) two critical global schooling index numbers (global primary completion rate (GPCR) and gender parity index, GPI) trends. This analysis is a unique synergy analysis study and all reported results are for the first time published in this empirical synergy study. This study provides many new results about synergies, which are relevant for global policy-makers and especially for the World Bank and for the United Nations.

KEYWORDS: Global trends, synergy analysis, global GDP, global population, global CO₂ emissions, global electric consumption and global school index data, World Bank data base.

Introduction

This empirical study presents the interaction of key global trends based on synergy analyses. It is good for decision-makers to be aware - not only of the development of the trends themselves, but they should be aware also of the interactions between the trends. That is why this study is important and interesting. In this study, we present empirical findings in terms of interactions based on synergy analyses. The results presented in this study show interactions, from 1972 until 2020. This is a statistical assessment of about two dozen years, which can be considered a long enough period to look at the trends of the global economy.

There may be positive, negative or no synergy between trends. These three different forms of synergy are therefore always possible. The form and direction of synergy trends can change over time and if decision-makers are not aware of the changes in synergy, they can already make the wrong decisions due to this lack of relevant information. For this logical reason alone, this empirical research is important for the global community.

In recent years, it has been noticed that synergy analysis is a very useful methodological approach to studying sustainability challenges and processes [1, 2, 3, 4, 5, 6, 7, 8,]. In the study of sustainable development, a very central issue is the temporal development of economic variables, social development variables, and environmental variables [9, 10, 11, 12, 13, 14, 15, 16, 17, 18]. For example, taking demographic trends into account as part of the assessment of sustainable development challenges is a very broad research theme [19]. The same consideration applies to the progress of climate change and the associated social, ecological, and economic trends and processes. [20]. It is good to note that synergy analyses are always related to knowledge management and decision-making [21]. Several studies have found that sustainability indicators are not always put to good use or are simply not used [22]. Decision-makers should be aware of the synergy between key variables, be it positive or negative synergies [23]. For example, the application and assessment of the well-known nexus model cannot be done properly without synergy analyses [24, 25, 26, 27]. Synergy analyses should be used more integrated into sustainable development policies.

The methodological framework of synergy analysis

When we analyse trends, scenarios, or weak signals we typically analyze dynamic social and economic systems. One key aspect of trend analysis is nowadays the interlinkages of trends. This study focuses on the issue of interlinkages of global trends. The data of the study is from the World Bank's Global Development Indicators database [28]

The Synergy Index is calculated in the following technical way (Data analysis phases in Steps 5-6) above: We can calculate the conventional index number of synergy and average long-run synergy index (see for example [1, 2]). It can be said that there exists a synergy between two factors when their combined effect is greater or smaller than the sum of their separate effects. In mathematical form, this can be expressed as

$$z = ax + by + cxy + d. \quad (1)$$

where x , y and z are variables and a , b , c and d are coefficients that determine how the output z depends on inputs x and y . In this case, we assume a time-invariant system, where the parameters remain constant. If y is 0, the output is determined by x and the coefficients a and d . Coefficients a , b , and d determine the impact of the single inputs on the output. The synergy of the inputs x and y is determined by the component cxy , i.e. the co-effect of both inputs. The idea of synergy indicates choosing variables x and y such that an increase in the value of both variables x and y is desirable and refers to a commonly accepted direction of sustainable development. If we look at a change from A to B in the Fig. 1, (from the original state x_0y_0 to x_1y_1) we can determine the change in the area (Δz) to be

If we look at a change from A to B in Fig. 1 (from the original state x_0y_0 to x_1y_1) we can determine the change in the area (Δz) to be

$$\Delta z = a\Delta x + b\Delta y + c\Delta x\Delta y = y_0\Delta x + x_0\Delta y + \Delta x\Delta y. \quad (2)$$

We can interpret the synergy of the inputs to be determined by the shaded area in Figure 3, which equals $\Delta x\Delta y$. The synergy can also be negative, as is shown in Fig. 1 where the change in y is negative, and $\Delta x\Delta y$ becomes negative. This is a trade-off situation: when one factor increases the other factor decreases. In Figure 3. we have presented 3 basic forms of synergy between two variables.

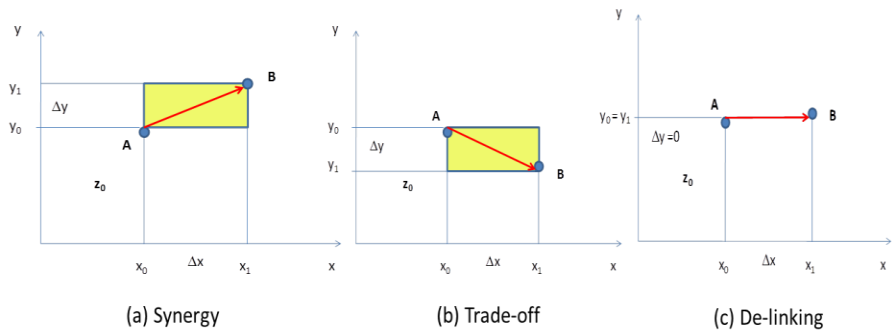


Figure 1. The alternatives of synergy level between two variables, x and y.
The alternatives of synergy level between two variables, x and y.

- (1) Maximum synergy can be obtained when relative changes Δx and Δy are equal.
- (2) In case the change in y i.e. Δy is larger than changes in x i.e. Δx , the quotient must be inverted to estimate the potential synergy ratio.
- (3) Therefore, potential synergy/trade-off between two variables can be measured between -1 to +1.
- (4) Where the negative sign indicates a trade-off between two variables.

Thus, the synergy level can be positive, negative or there is no synergy at all (de-linking). This idea can be applied in health care and industry field, but maybe in other industrial context contexts, too. Interpretation of the results is straightforward: the closer the calculated synergy factor is to 1 the stronger the synergy between the two (or three) variables can potentially be, and the closer the ratio is to -1 the potential for a trade-off is stronger. When the synergy factor is close to 0 there is delinking between the trends. This kind of analysis does not imply that synergy is necessarily good and the trade-off is bad, or vice versa. Such interpretation is case specific; to interpret the results in more depth, we need to determine how we would like the trends to involve.

The results of synergy analyses

In this chapter, we present the key findings of global and regional synergy analyses. We report very succinctly and briefly, because the space for presenting the results is limited

The synergy between GDP capita and electricity consumption per capita, and CO₂ emissions

Figure 2 shows a synergy analysis between variables GDP per capita and global electricity consumption.

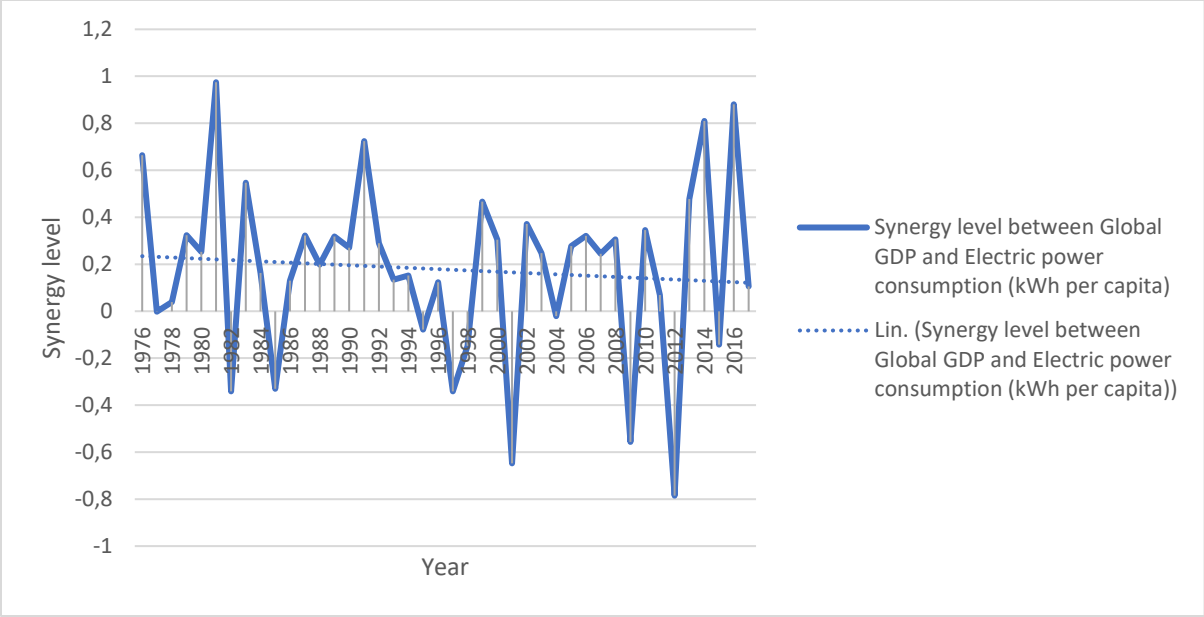


Figure 2: Synergy level between global GDP and global electricity consumption per capita.

The key result based on Figure 2 is that the level of synergy between the two variables has been slightly decreasing over the period of the years 1976-2017, under review.

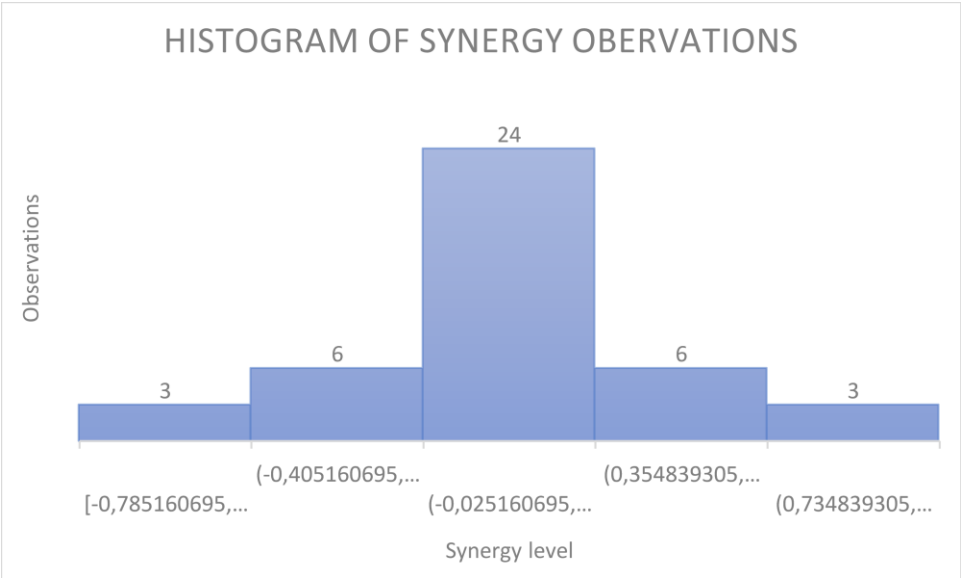


Figure 3. Histogram of synergy observations between global GDP and global electricity consumption per capita.

Figure 3 shows the histogram of the findings of synergy analysis (global GDP and global electricity consumption). It indicates that the observations are normally distributed. Most of the synergy findings fall between values $-0,025$ - $+0,35$ (24 observations).

In Figure 4, we have reported the results of the synergy development between GDP and global CO₂ emissions.

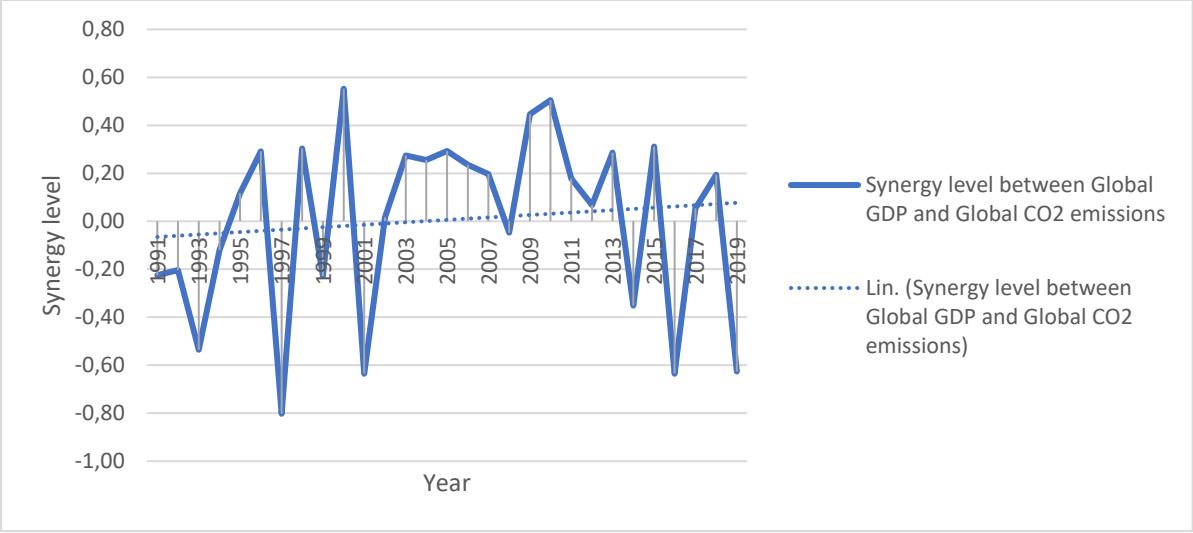


Figure 4: Synergy level between global GDP and global CO₂ emission.

In Figure 4, we see a slight upward trend in synergy. In Figure 4, it is interesting to see that after the year 2011, the synergy trend has clearly turned negative. This is a significant finding in terms of global climate policy. In Figure 5, we have reported the history of the findings of synergy analysis of these two key climate policy variables. It indicates that the observations are not normally distributed. We see that histogram is negatively skewed in this case.

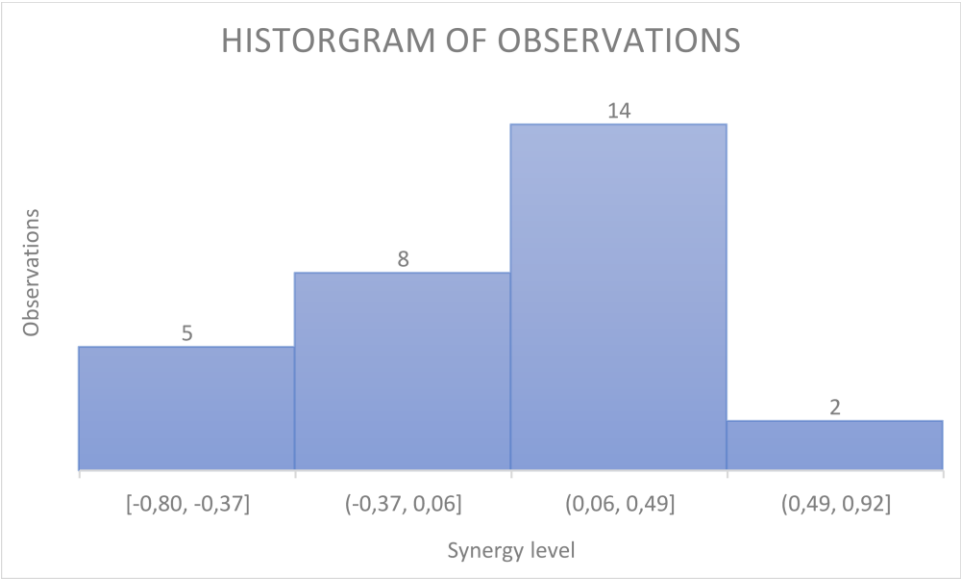


Figure 5. Histogram of synergy observations between Global GDP and Global CO₂ emission.

Most of the synergy findings fall between +0.06 - +0.49 (14 observations, see Fig. 5). This result indicates that the synergy between economic growth and carbon dioxide emissions has been strong during this period under review. In recent years we have observed a turning point in the transformation of synergy in a negative direction. This important histogram of global synergy trend analysis informs us that there have been 13 negative synergy observations and only 2 very positive observations.

Synergy between GDP per capital and global population and global population density

Figure 6 reports synergy analysis results between Global GDP and Global population.

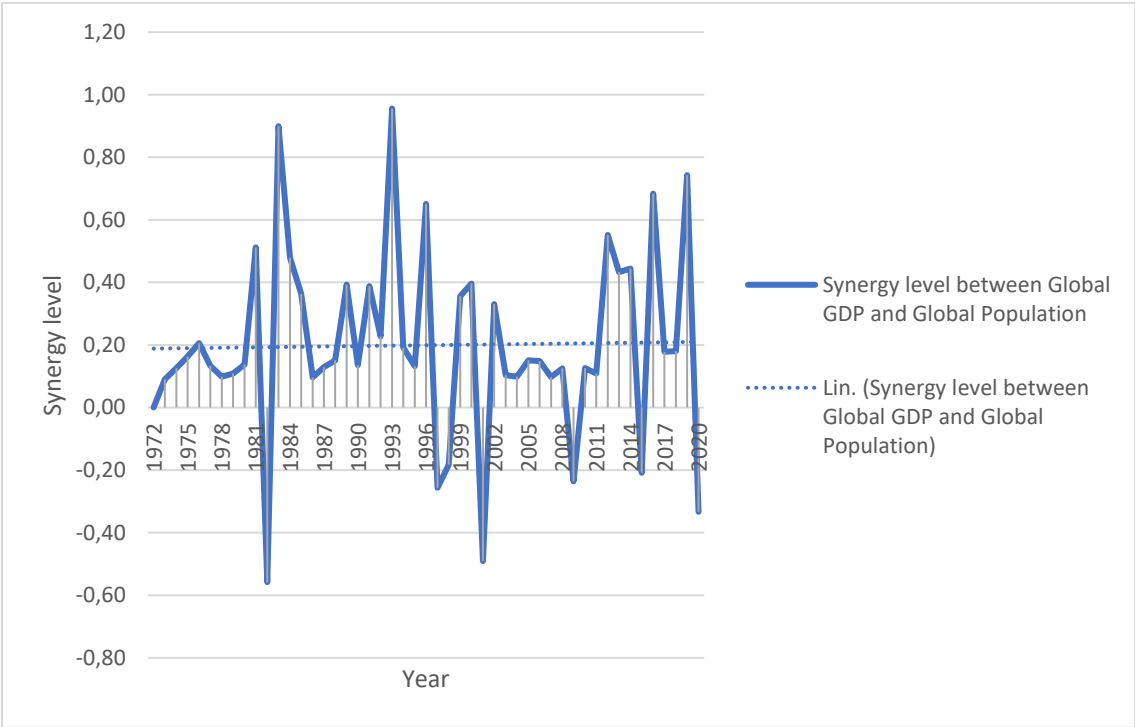


Figure 6: Synergy level between Global GDP and Global population.

The linear synergy trend curve has been fairly flat and not clearly upward-sloping or clearly downward-sloping. Of course, this is a significant scientific result, which has now been achieved through the application of global synergy analysis. Synergy trend level is +0,20. On the other hand, the Fig. 6, also shows that there have been large variations in the level of synergy.

In Fig. 7 we present a histogram of the synergy analysis between these two key variables. Fig. 7 reveals that most of the observations fall between positive synergy values +0,04 - +0,34 (26 observations). We see that histogram is positively skewed (Fig. 7). This empirical result is not a big surprise for scholars of energy economics.

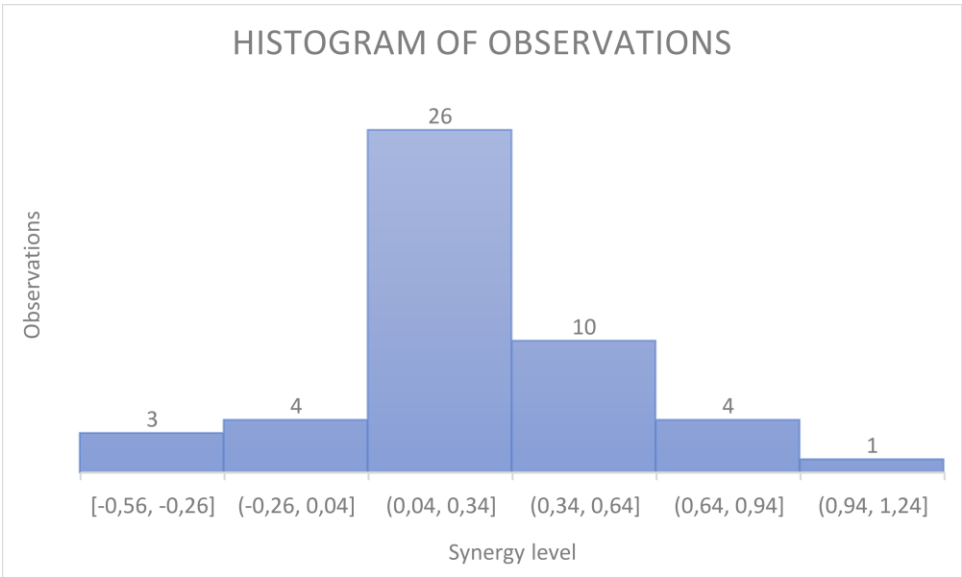


Figure 7: Histogram of synergy observations between global GDP and global population.

Most of the observations in Fig. 7 are clearly positive synergy observations and only 7 synergy observations are negative. This finding indicates that the synergy between the variables (global GDP and global population) has been mostly positive.

In Fig. 8 we have reported a synergy analysis between global GDP and global population density.

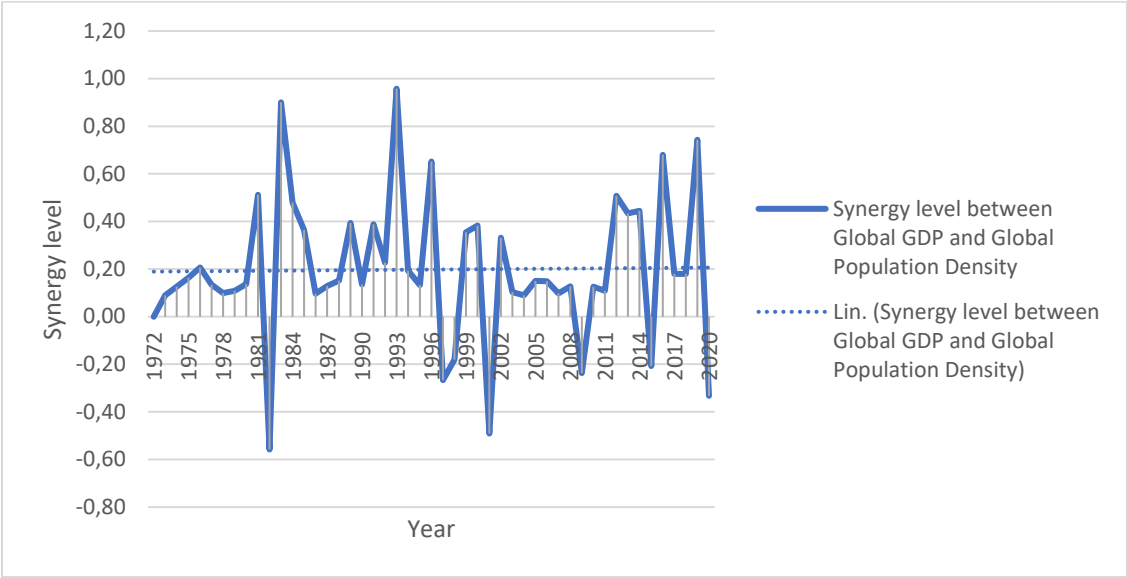


Figure 8: Synergy level between Global GDP and global population density.

The linear synergy trend curve has been fairly flat, and not clearly upward-sloping or clearly downward-sloping. The trend synergy level is +0,20. Of course, this is a significant scientific result, which has now been achieved through the application of global synergy analysis. On the other hand, Fig. 8 also shows that there have been large variations in the level of synergy. Top positive synergy observations have been over +0,9 and top negative observations have been near -0,6. Thus, synergy variations have been considerable.

In Fig. 9 we report a histogram of synergy observations between global GDP and global population density. We see that histogram of synergy observations is positively skewed in the world.

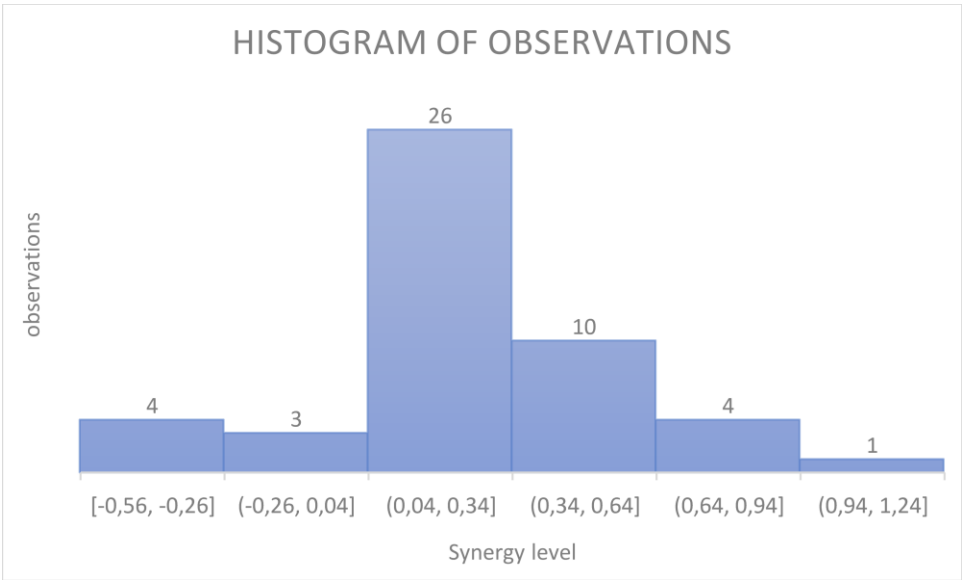


Figure 9: Histogram of synergy observations between global GDP and global population density.

Majority of synergy values are between 0,04-0,34 (26 observations). Figure 9 informs us that most of the findings are positive synergy observations. We can cautiously conclude from this result that the development of global urbanization (with increasing population density) contributes to global economic growth, because of observed positive synergy levels.

Synergy between GDP per capital and global primary completion rate

In Figure 10 we report synergy level between global GDP and global primary completion rate, total (% of relevant age group).

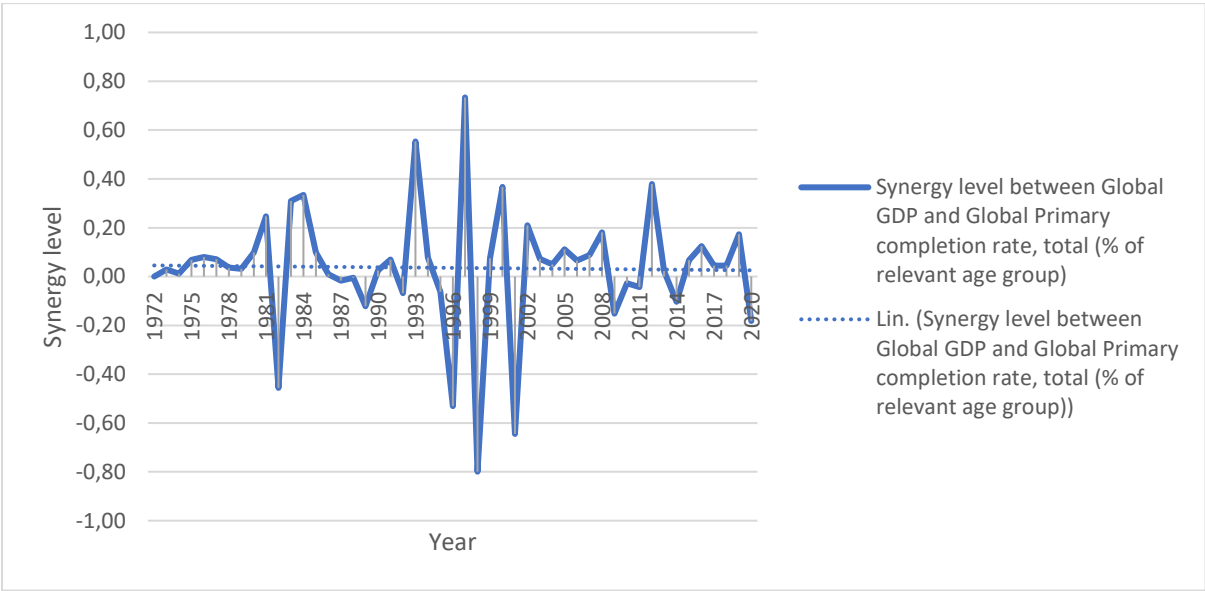


Figure 10: Synergy level between Global GDP and Global Primary completion rate.

Again, In Fig. 10, we observe a linear curve of smooth synergy, as well as large synergy variations in the historical review. The synergy level has not risen to a very high synergy level in terms of trend. It's only a little above zero. A large period of instability in terms of synergy development for the number of years in 1993-2002, when the fluctuations in synergy were really large.

In Fig. 11 we report a histogram of observations between global GDP and global primary completion rate (GPCR).

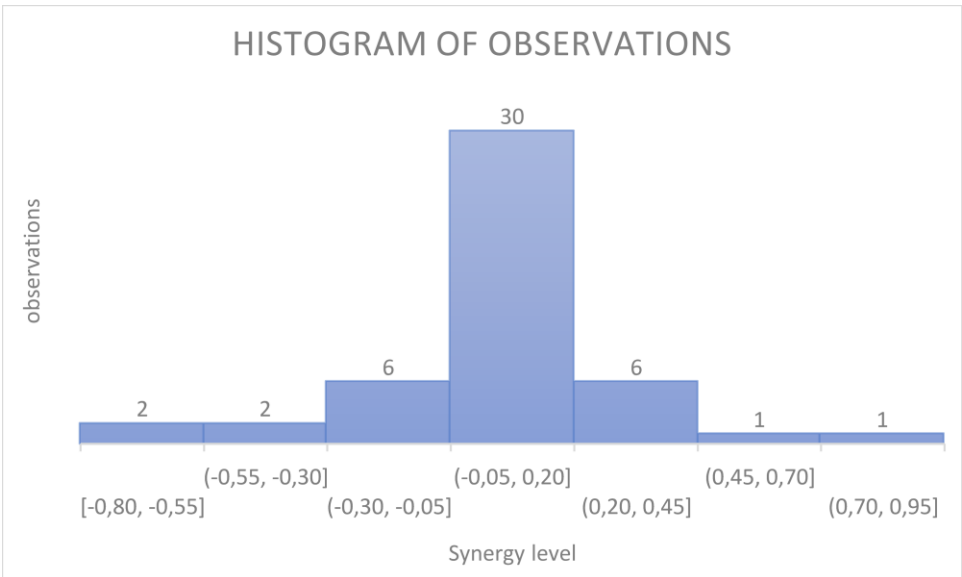


Figure 11. Histogram of synergy observations between global GDP and global Primary completion rate (GPCR)

The histogram indicates that synergy observations are normal distributed for these critical variables. Most of synergy observations are between -0,05 - +0,20 (30 observations).

In Fig. 12 we have reported synergy level between Global GDP and global school enrolment, primary and secondary (gross), gender parity index (GPI). In Fig. 12, we observe almost a linear curve of smooth synergy, as well as large synergy variations in the historical review. The synergy level has not risen to a very high level in terms of trend. It's only a little above zero. A large period of instability in terms of synergy development for the number of years in 1993-2002, when the fluctuations in synergy were really large. This result is parallel to the previous schooling indicator analysis.

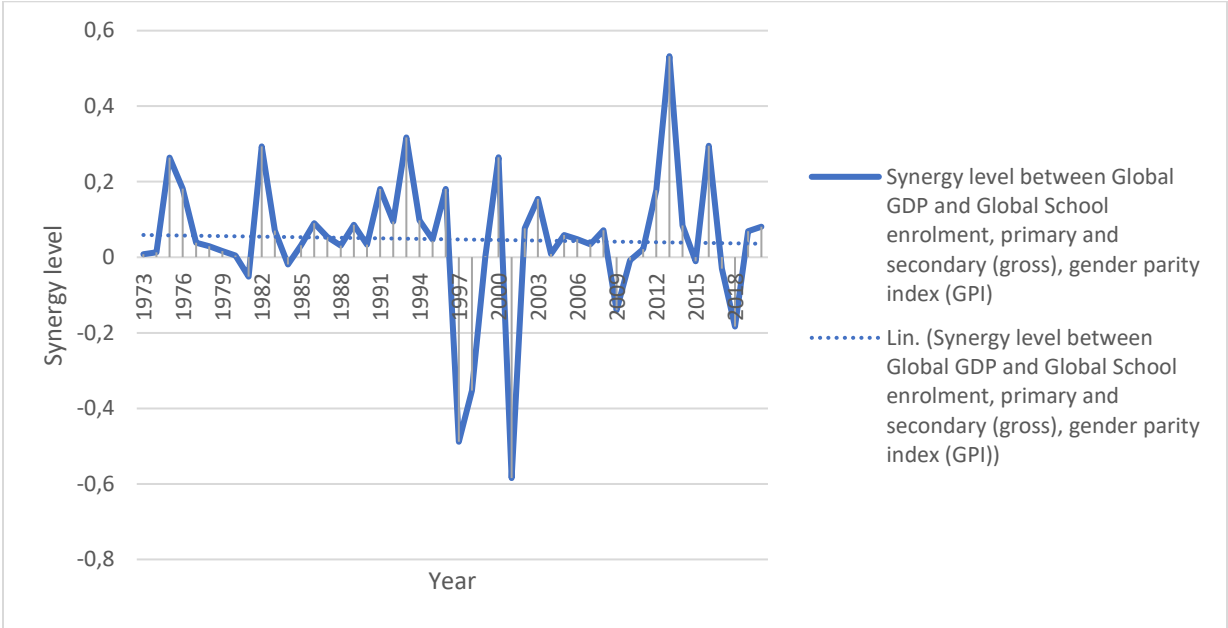


Figure 12. Synergy level between Global GDP and Global School enrolment, primary and secondary (gross), gender parity index (GPI).

In Fig 13 a histogram of synergy observation between Global GDP and Global School enrolment, primary and secondary (gross), gender parity index (GPI) is reported.

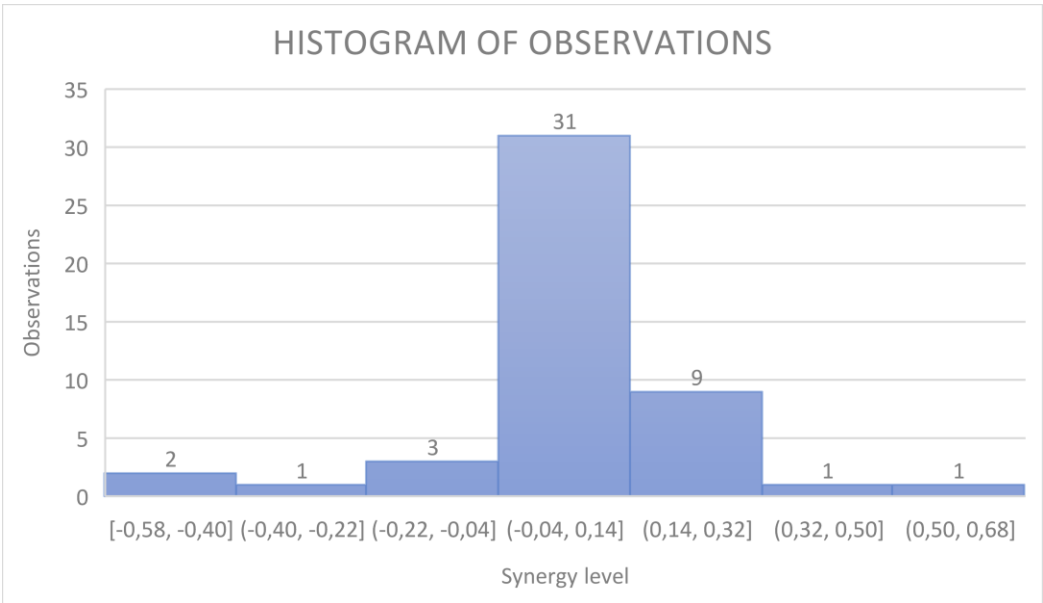


Figure 13. Histogram of synergy observations between Global GDP and Global School enrolment, primary and secondary (gross), gender parity index (GPI).

The majority of synergy measurement findings are according to our historical review between -0,4- - +0,14 (31 observations, see Fig. 13). There are 9 observations between +0,14 - +0,32. We see that histogram is positively skewed. Mostly the synergy observations between the variables have been positive. Cautiously, we can estimate that the increase in the level of education has been creating positive synergy for global economic growth. This is a policy-relevant finding.

Conclusions

In Fig. 14 we report a statistical summary of six synergy analyses we reported in this article. A key finding is that all observed long-run average synergies were observed to be positive. The smallest deviations we observed were in the cases of two key schooling indicators. Considerable synergy deviations we observed with global population and global population density. Demographic change and urbanisation are having considerable impacts on GDP per capita developments. These demographic variables are global drivers of economic growth. Global synergy analyses verify this kind of policy assessment.

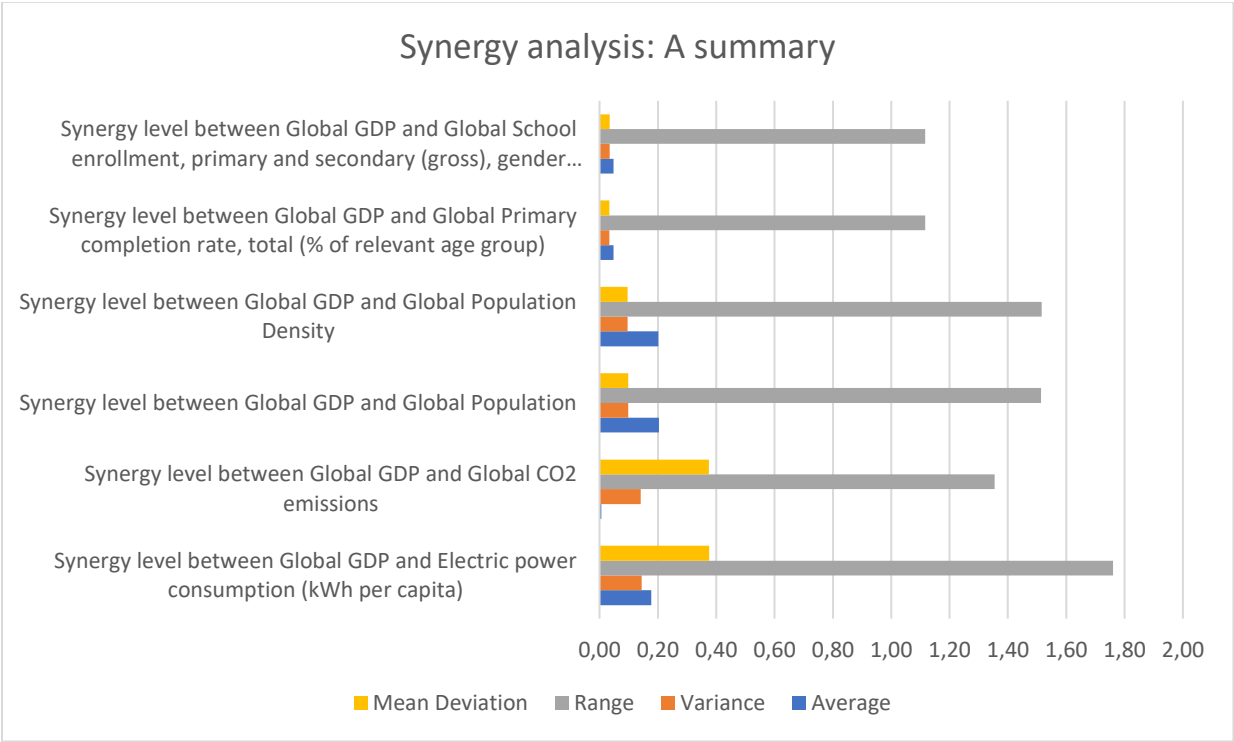


Figure 14. Global trends synergy analysis: A summary of results.

In this study, we have conducted synergy analyses for some key global trends. The results are quite interesting and raise numerous needs for further research.

One interesting thing about synergy analyses is that we can observe turning points in the interaction between synergy trends. Perhaps the most significant synergy trend turning point was found in terms of global GDP development and global carbon dioxide emissions.

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