ALIGNED ECONOMIC CYCLE OF GLOBAL ECONOMIES

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ABSTRACT
Background: The alignment of economic cycles is created naturally, by the gradual harmonization of the economic development of economies that are open and cooperating with each other, which gradually over decades has led to their significant economic interconnection, to the creation of the so-called global economy. **Aims:** The main aim of this paper is to analyze the impact of individual financial crises on economic cycle alignment as well as the naturally increasing correlation between interacting economies themselves. **Methods:** We have analysed the impact of individual financial crises on economic cycle coherence as well as the naturally increasing correlation between interacting economies. **Sample:** We examined the historical evolution of the correlation on ten-year periods from 1961 to 2020. **Results:** The calculated correlations of the percentage GDP growth of the selected 40 countries with the global percentage GDP growth over the last 61 years have shown that the interconnectedness of major economies has reached an advanced level. **Conclusions:** The higher the correlation of GDP growth of the selected countries with global GDP growth, the higher the effect of economic booms as well as recessions will be multiplied. **Implications:** This analysis has so far failed to include the impact of the admittedly extremely short but extremely sudden and fully global recession caused by COVID 19**.**

Keywords: GDP, economic cycle, correlation, countries

JEL Classification*:* F44, F62, O11

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Introduction

The economic cycle can also be suddenly and strongly linked by exogenous shocks in the form of economic crises, such as the recent COVID crisis or the Global Financial Crisis in 2007-2008. Exogenous global shocks cause a sudden and unexpected drop-in economic activity across continents and countries. However, economic downturns are generally followed by subsequent strong economic growth.

The main tools of research will include gross domestic product, which will be ex-pressed both in nominal and percentage terms, and the calculated correlations of percentage GDP growth between the selected economies. For the correlation analysis, correlation matrices calculated over the whole selected period and average correlations for specific selected time horizons and countries will be used.

Gross Domestic Product (GDP) is a macroeconomic indicator that measures the economic performance of a national economy. Gross Domestic Product represents the market output of all goods and services produced in one year by the factors of production in the territory of a given country.

Correlation is used to determine the statistical dependence of a dependent variable that we need to find from an independent variable that we know or can adjust. Correlation is usually used to estimate the value of the dependent variable, that is, to predict a certain state. Correlation can be simple, then we are establishing a relationship between one independent variable and one dependent variable. It is the most common type of correlation. More complex are the so-called multiple correlations, describing the relationship of one dependent variable from several independent variables. The correlation describes a purely statistical dependence, not a causal one. There may be no direct relationship at all between the independent and dependent variables.

The main aim of this paper is to analyse the impact of individual financial crises on economic cycle alignment and the correlation of interacting economies.

Partial aims are:

- to analyse the evolution of gross domestic product in the selected economies, to examine the historical evolution of the correlation of GDP change over the period 1961 - 2020, to identify correlations for all selected countries to global GDP growth,
- to identify correlations of percentage GDP growth among selected economies,
- to highlight the steadily increasing correlation of the annual percentage change in GDP of global economies and identify the impact of different economic crises on this trend.

Theoretical background

Economic growth as measured by GDP (Gross Domestic Product) has always been a popular macroeconomic indicator and is of great importance for policymaking. In addition, GDP forecasting has become an important task for countries, but the trend of economic fluctuations as well as anti-globalization complicates GDP forecasting, this is also mentioned by Ge and Tang (2020), Cepni et al. (2019), Soufi et al. (2022), Leimbach et al. (2017), Kopoin et al. (2013), Funashima et al. (2020), Chen (2021), Lange (2018).

Gross Domestic Product (GDP) is the value of goods and services produced by a country's population minus the value of goods and services consumed in production. Due Dynan and Sheiner (2018) GDP is also equal to the sum of personal consumption expenditures, gross private domestic investment, net exports of goods and services, and government consumption expenditures and gross investment.

Samuelson and Nordhaus (2007) assess GDP to be the most comprehensive measure of the total output and input of goods and services. They describe the gross investment of government purchases of goods and services, the sum of the monetary values of consumption and net exports produced in a country during a given period.

Changes in a nation’s share in the world GDP is determined by variables that represent international rivalry, such as a nation’s share in exports and financial flows and the typical growth variables in share form. Currency undervaluation is also correlated negatively with GDP share changes mentioned Park et al. (2019), Wang et al. (2022). Due Larionova and Varlamova (2014) influence of economic crisis changes correlation force between macroeconomic factors and indicators of a banking system. Stock market movements are dependent on real-time GDP developments, it is written by Ball and French (2021), Hao et al. (2022), Dong et al. (2021).

Over the past decades, both import and export flows have increased much faster than GDP for almost all countries in the world. This march toward more open economies has been accompanied by a

reorganization of the world's production across different locations: as a share of world GDP, both trade in intermediate inputs and in final goods increased sharply. The increase in the overall density of the world trade network suggests that complex patterns of international propagation could be at play. Empirical studies demonstrate the interdependence of economies at both the economic and the monetary level too. According to Soyres and Gaillard (2022), Himounet (2022), Castañeda and Cendejas (2022), Feldkircher (2015), Engel (2016), Lee and Werner (2018), Hayo and Mierzwa (2022), Lewis et al. (2022) the consequences of these changes in trade patterns for the synchronization of economic activity are important because they can have implications for macroeconomic policies.

The world economy has been undergoing transformational changes in recent decades. Every financial crisis affects the global economy, and the Covid-19 crisis was one of them. The drivers of change are now not only confined to technological progress and globalization trends but also the increasing influence of emerging economic powerhouses, this topic is mentioned by Privara (2022), Liu et al. (2021), Alberola et al. (2021), Jena et al. (2021), Silva et al. (2016), Vu (2020), Ibn-Mohammed et al. (2021), Maital and Barzani (2020), Caruso et al. (2019). According to Dimitras et al. (2015) the empirical study provide evidence that financially distressed companies reduce earnings management manipulation during recession.

Frankel and Rose (1998), Baxter and Kouparitsas (2005), Imbs (2004), Kose and Yi (2006), Calderón et al. (2007), Inklaar et al. (2008), Di Giovanni and Levchenko (2010), Duval et al. (2016), Liao and Santacreu (2015) mentioned that the sensitivity of GDP comovement to an increase in bilateral trade flows evolves over time. An increase in trade intensity is associated with an increase in cross-country GDP correlation.

Methodology

The methodology for this research follows a structured approach, delineated into discrete units to enhance clarity. The three main sections are:

1. Research Intent:
   - The study aims to examine the historical evolution of correlation between global economies over ten-year periods from 1961 to 2020.
   - The primary focus is on understanding the impact of economic crises on the correlation and identifying patterns in the annual percentage change in GDP.
2. Sample Description:
   Selection Criteria:
   - Economies with a significant GDP level (>200 billion USD) are included.
   - The analysis is limited to 40 countries.
   - Data points cover 61 years, but countries with missing data for periods longer than 10 years are excluded.
   - Specific exclusions: Canada (28 years), Russia (29 years), Switzerland (20 years), Poland (30 years), Israel (26 years), Vietnam (24 years), Romania and the Czech Republic (both 30 years).

   Groupings:
   - Correlation analysis is conducted among economies based on GDP levels and political classifications (e.g., High Income, Middle Income, Low Income, Upper Middle Income, OECD, EU, Latin America & Caribbean).
3. Analytical Methodologies:
   Data Source:
   - Annual percentage change in GDP is obtained from the World Bank (2022), utilizing data on GDP growth at market prices based on constant local currency and expressed in U.S. dollars.
   - GDP values for ranking and analysis are derived from the World Bank (2022) at purchaser's prices, expressed in constant 2015 prices in U.S. dollars.

   Software:
   - The analysis is conducted in MS Excel.

   Correlation Analysis:
   - The impact of individual financial crises on economic cycle coherence is assessed.
   - Correlation analysis is performed before and after each crisis.

   Data Handling:
   - Imputed data substitutions are applied for missing values in some countries, using the average GDP growth over the entire reporting period.

- World aggregate GDP percentage growth is calculated for 220 countries.
- The number of reporting years used in the analysis is 61, resulting in a total of 2,501 data points (1.16% imputed as substitutions).

Summary Calculations:

- Simple arithmetic mean and median are employed for correlation summary calculations due to the homogeneity and low dispersion of values in the dataset.

The Bloomberg database serves as the primary source for the data used in this analysis.

This methodology ensures a systematic and comprehensive approach to exploring the correlation evolution among global economies and the impact of economic crises over the specified period.

Results and discussion

The first results of the analysis carried out include the identification of correlations for all selected countries to global GDP growth. The average correlation for all selected countries to global GDP growth reached the following levels in each ten-year period, which we have recorded in Figure 1.

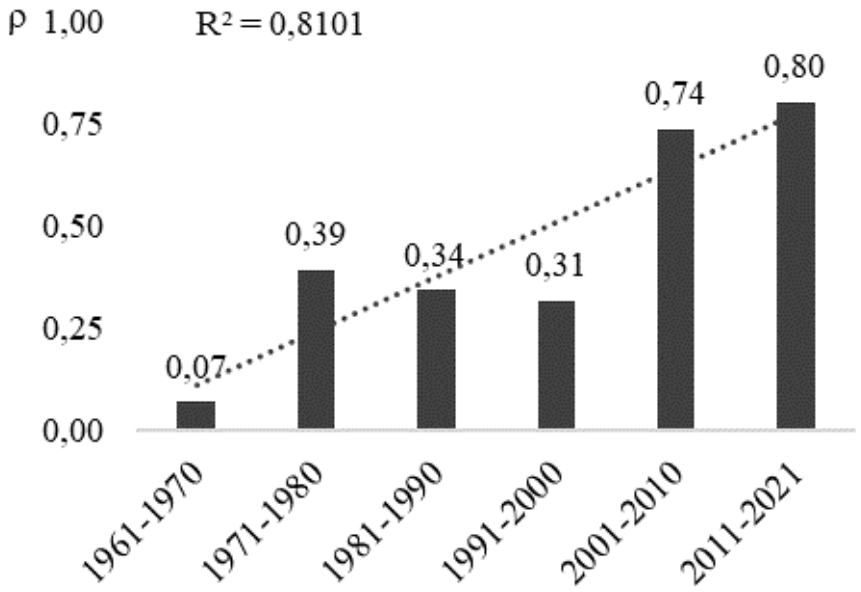

Figure 1. Evolution of the average correlation for all selected countries to global GDP growth, showing the slope of the linear regression line and the R-squared value
Source: *authors, (based on World Bank data)*

The gradual harmonisation of the evolution of the GDP correlation for all selected countries to global GDP growth is also evidenced by the gradually decreasing number of countries with a negative correlation over time. In the period 1961-1970, 15 countries (which is 37.5% of the total number of countries) achieved a negative correlation of GDP to world GDP growth, in the period 1971-1980 10 countries (25.0%), in the period 1981-1990 6 countries (15.0%), 10 countries (25.0%) in the period 1991-2000, 1 country - Nigeria (2.5%) in the period 2001-2010, and 1 country - Egypt (2.5%) in the period 2011-2021, which, however, achieved a negative correlation only at the minimum level of -0.02. The correlation of percentage GDP growth for the selected countries with global GDP growth in the selected time periods is shown in Figure 2.

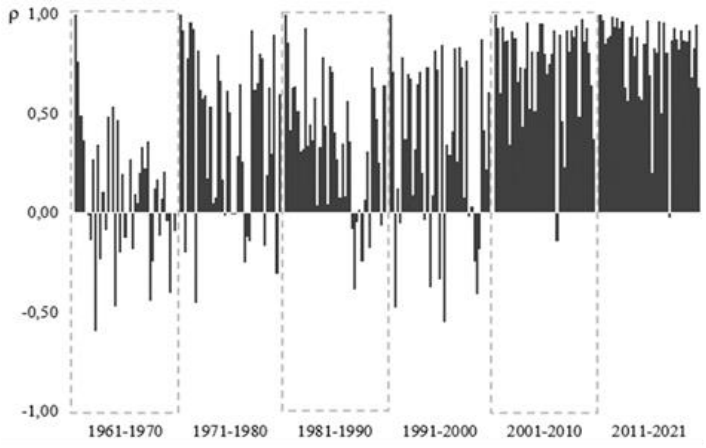

Figure 2. Evolution of the correlation of GDP for all selected countries to global GDP growth for each 10-year period
Source: *authors, (based on World Bank data)*

During global economic crises, there is a gradual "realignment" of economic development as globally interconnected economies experience mutual economic stagnation and then mutual economic boom. Since the 1990s, this development has been significantly boosted by the increasing interconnectedness of the individual economies themselves and by monetary easing, i.e., so-called unorthodox monetary policy (Modern Monetary Theory- MMT) by Mankiw (2020).

The US economy had the largest nominal GDP of the countries analysed throughout the period under review and thus had the largest impact on the global economy. For this reason, we have selected for economic crises those that occurred in the US during the period under review.

The economic crises that were added to the analyses are recorded in Table 1 according to National Bureau of Economic Research (2022).

Table 1. Economic crisis in the USA.

Recession	from	to	Number of Days of Recession
COVID-19	01.02.2020	30.04.2020	89
Great Recession	01.12.2007	30.06.2009	577
dot-com	01.03.2001	30.11.2001	274
Early 1990s recession	01.07.1990	31.03.1991	273
Energy Crisis	01.07.1981	30.11.1982	517
W-shaped Recession	01.01.1980	31.07.1980	212
Oil Crisis	01.11.1973	31.03.1975	515
Recession	01.12.1969	30.11.1970	364
Recession	01.04.1960	28.02.1961	333

Source: *National Bureau of Economic Research (2022)*

Japan started monetary easing - Quantitative Easing - in the 1990s. The Modern Monetary Policy started to be used by the US FED as well as other central banks after the onset of the US Subprime mortgage crisis in 2007. A key tool of The Modern Monetary Theory was the extensive use of quantitative easing (QE), Bernanke (2020). The balance sheets of the key central banks, the FED, the ECB and the BOJ, reached the highest levels ever measured as of 31 May 2021, at 36.6% of GDP, 66.5% of GDP and 133.2% of GDP respectively. QE made it possible to keep interest rates at low levels, stabilise the banking financial system and, through the purchase of corporate bonds, to provide crisis financing to other parts of the economy.

In Figure 3 significant rise in the correlation of percentage GDP growth occurred especially in the 1990s. In the first thirty years (1961 to 1990), the correlation of per-centage GDP growth reached

an average level of 0.37. Over the following thirty-one years (from 1991 to 2021), the correlation in percentage GDP growth averaged 0.62. Thus, over this period, the correlations of the percentage growth of GDP of the selected countries to world GDP increased by 67.6% or 0.25 points.

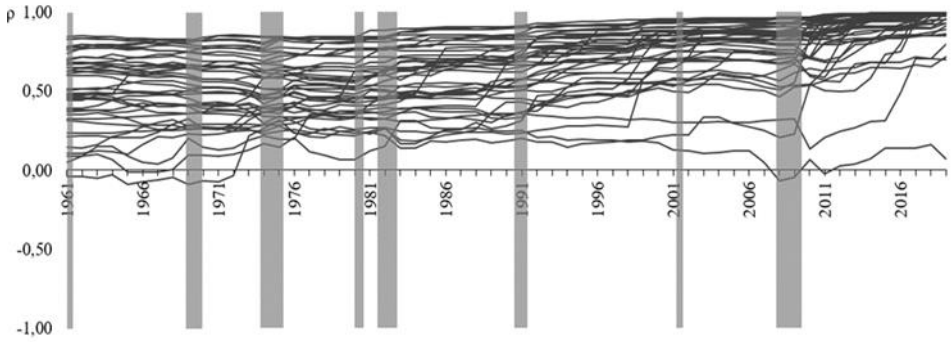

Figure 3. Evolution of the continuous correlation of GDP over time for all countries analyzed to global GDP growth, showing the beginning and end of economic crises in the US.
Source: *authors, (based on data from World Bank and National Bureau of Economic Research)*

However, after prolonged global economic crises (defined by us as 500 or more days of recession in the USA; three in total were recorded in the period ana-lysed), the GDP correlations "kicked in" and then increased significantly as follows:

1. The average correlation of countries' GDP to world GDP was 0.34 between 1961 and 1975 (i.e., until the end of the Oil Crisis recession, which lasted 515 days).
2. The average correlation was 0.42 between 1976 and 1982 (i.e., until the end of the recession - the so-called Energy Crisis, which lasted 517 days).
3. The average correlation increased further, reaching 0.47 between 1983 and 2009 (i.e., until the end of the Great Recession, which lasted 577 days).
4. In the period from 2010 to 2021, the average correlation strengthened further and reached its maximum value of 0.78.

In the following section, we focus on tracking the median correlation of GDP growth for all selected countries to global GDP growth, over three-time intervals. The median correlation over these periods increased by 0.56 points in Table 2.

Table 2. Median of correlations of GDP for all selected countries to global GDP growth for selected time periods.

For the Period	Median
1961-1982	0.28
1983-2009	0.46
2010-2021	0.84

Source: *authors, (based on World Bank data)*

The largest growth in participation in the global economy (i.e., growth in correlation with the global economy) between the 1961-1990 and 1991-2021 periods (calculated as the difference in average correlations between the selected periods) was achieved by India. Conversely in Figure 4, the largest negative growth was recorded by Nigeria. The average value for all countries was 0.25.

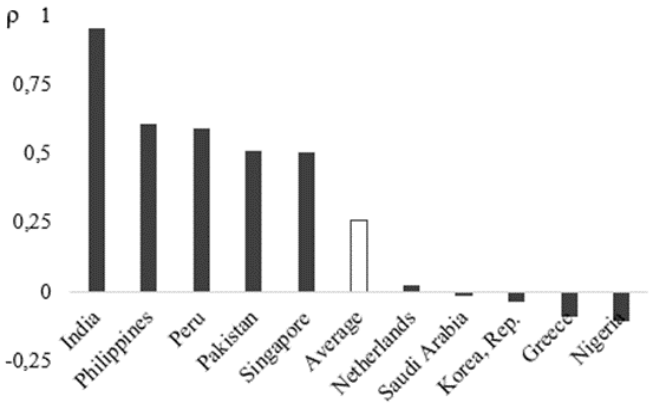

Figure 4. Difference of average GDP correlations for 10 selected countries (out of the total of 40 countries analysed) to global GDP growth (5 reached the maximum level and 5 reached the minimum level) in the time periods 1961-1990 and 1991-2021.
Source: *authors, (based on data from World Bank)*

The increasing continuous correlation of GDP of selected countries with global GDP on the one hand, and the decline in the overall cumulative percentage GDP growth on the other hand, point to a trend where the highly harmonised development of the global economy is gradually exhausting its growth potential. Deglobalization may be the answer to this trend in Figure 5.

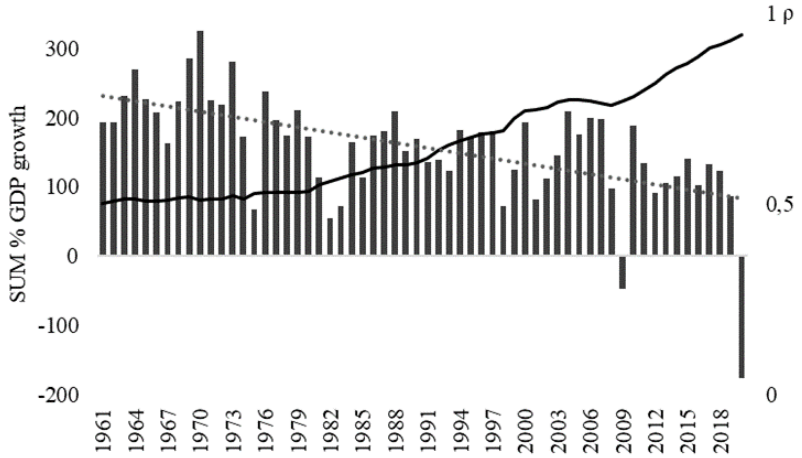

Figure 5. Evolution of the correlation of GDP of selected countries with global GDP, calculated continuously (right Y-axis) and total cumulative percentage GDP growth (representing sum of all percentual GDP growth numbers for selected countries for given year), showing the slope of the linear regression line (left Y-axis) for the time period 1961-2021
Source: *authors, (based on data from World Bank)*

From the calculated correlations it is clear that over the last 61 years there has been a significant alignment of economic development on a global basis, or a harmonization of the percentage GDP growth of individual major as well as minor global economies with the global percentage GDP growth. Globalization, together with deep economic crises and the subsequent economic recovery, has thus significantly aligned the eco-nomic development of countries over the course of the last 61 years.

A political analysis of the distribution of countries into political, economic and geographical clusters as defined by the World Bank confirms that (a) participation in the global economy increases

the wealth of countries, (b) the overall average correlation has increased significantly over time in Table 3.

Table 3. Average correlations of GDP of selected country groupings to global GDP growth for specified time periods.

For the period	High income	Middle income	East Asia & Pacific	Upper middle income	Latin America & Carribean	Africa Eastern and Southern	Lower middle income	Sub-Saharan Africa	Heavily indepted poor countries	Africa Western and Central	Average
1961-1970	0.91	0.47	0.78	0.56	0.22	0.35	0.14	0.15	0.37	0.05	0.40
1971-1980	1.00	0.54	0.78	0.38	0.52	-0.15	0.39	0.13	0.00	0.24	0.38
1981-1990	0.99	0.66	0.80	0.63	0.56	0.36	-0.15	0.75	0.02	0.59	0.52
1991-2000	0.97	0.87	0.18	0.82	0.14	0.79	0.61	0.80	0.62	0.55	0.64
2001-2010	0.98	0.90	0.90	0.90	0.91	0.91	0.78	0.82	0.80	-0.03	0.79
2011-2021	1.00	0.96	0.96	0.93	0.89	0.89	0.93	0.81	0.79	0.58	0.88
Average	0.97	0.73	0.73	0.70	0.52	0.52	0.45	0.58	0.43	0.33	

Source: *authors, (based on World Bank data)*

The average correlation of the GDP of the selected clusters with world GDP was 0.40 in the period 1961-1970, but in the period 2011-2021 it was already 0.88, a difference of 0.48 points, or a growth of 118%.

The poorest cluster of countries, Africa West and Central (28 countries in total), had a correlation of only -0.03 to 0.59 between 1961 and 2021, or 0.33 on average. The GDP of this political grouping reached 835.8 billion in 2021. This is only 1.41% of the GDP of the countries included in the High-income economic cluster (79 countries in total), which reached a total GDP of 59.4 trillion USD in 2021. (The World GDP reached 96.1 trillion USD in 2021).

The calculated correlations of the percentage GDP growth of the selected 40 countries with the global percentage GDP growth over the last 61 years have shown that the interconnectedness of major economies has reached an advanced level. The high correlation has been fostered over time both by globalisation itself and by major economic recessions. The involvement of individual countries in the global economy has been shown to increase the economic wealth of countries and vice versa. At the same time, we have highlighted the risks of globalization and the gradually depleting sources of economic growth for countries heavily involved in the global economy.

The article provides a comprehensive analysis of the correlation of GDP growth for selected countries with global GDP growth over a period of 61 years, from 1961 to 2021. While the research contributes valuable insights into the evolving nature of global economic interdependence, there are certain limitations and potential avenues for future research.

Limits of the research:

- Focus on Correlation: The study primarily relies on correlation analysis to understand the relationship between individual countries' GDP growth and global GDP growth. Correlation, while informative, does not imply causation. The study could benefit from further exploring causal mechanisms and underlying factors driving the observed correlations.
- Limited Scope of Economic Crises: The analysis centers on economic crises in the United States, and the inclusion of only the U.S. economic crises might not fully capture the global economic landscape. Future research could expand the scope to include crises in other major economies, providing a more comprehensive understanding of the global economic dynamics during challenging periods.
- Simplification of Correlation Metrics: The article focuses on average and median correlation values, which may oversimplify the complex relationships between GDP growth at the national and global levels. Further exploration of variations and outliers in correlation values could provide a more nuanced perspective.

Link to future research developments:

- Causation and Mechanisms: Future research could delve deeper into the causal relationships between economic crises and the observed changes in GDP correlations. Identifying specific mechanisms through which global economic events influence national economies would enhance the understanding of the dynamics at play.
- Regional and sectoral analysis: The study currently aggregates data for selected countries without exploring potential regional or sectoral variations. Future research could

investigate how different regions or economic sectors contribute to or deviate from the observed trends, providing a more detailed and nuanced analysis.

- Impact of Short-Term Shocks: The article acknowledges the impact of the COVID-19 pandemic but suggests that correlations cannot be reliably calculated for short periods. Future research could employ sophisticated methodologies to analyze the short-term impact of global shocks on GDP correlations, offering insights into the resilience or vulnerability of economies to sudden disruptions.
- Deglobalization Trends: The article briefly touches on the trend towards deglobalization, citing factors such as tariffs and geopolitical events. A more in-depth investigation into the drivers and implications of deglobalization, particularly in the post-COVID-19 era, could be a fruitful avenue for future research.
- Cross-disciplinary Perspectives: Integrating insights from political science, sociology, or other disciplines could enrich the analysis. Exploring how geopolitical events, social dynamics, or policy decisions influence the observed economic correlations would provide a more holistic understanding of the interconnectedness of global economies.

Conclusion

It can be concluded that the higher the correlation of GDP growth of the selected countries with global GDP growth, the higher the effect of economic booms as well as recessions will be multiplied. If most of the world's economies have a high correlation of GDP to world GDP in the long term, then identical economic changes will affect a larger number of countries, multiplying the resulting risk.

This analysis has so far failed to include the impact of the admittedly extremely short but extremely sudden and fully global recession caused by COVID 19 (correlations cannot be reliably calculated for short periods). The economies of virtually all developed countries have synchronously stopped and then reopened in “post-Covid" euphoria. This event will be the subject of our next research. However, we can hypothesize that the COVID-induced economic shock further deepened the correlations of countries' GDP with global GDP, as has been the case in previous major economic crises in the past.

At the same time, however, there are also contradictory developments at work here. The trend towards deglobalisation has multiplied in the wake of the COVID 19 crisis. The trend may continue because COVID 19 is still evolving as a disease and has the potential to continue to constrain economic activity. Also, various forms of tariffs and tariffs at global level, the restriction of trade between the US and China and the war in Ukraine are factors that strongly support the deglobalisation trend. The above will also be the subject of our further research in this area.

In conclusion, while the article provides valuable insights, addressing the identified limitations and exploring the suggested avenues for future research would contribute to a more comprehensive and nuanced understanding of the evolving dynamics of global economic interdependence.

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