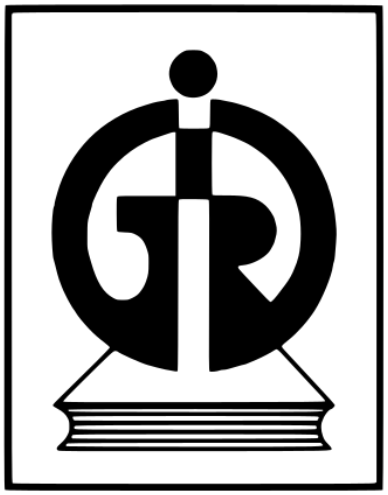

ANALYZING CYCLICAL COMPONENTS OF GDP

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Date: May 23, 2026

ABSTRACT

This research project analyses the cyclical and trend components of key macroeconomic indicators in India while conducting a comparative study of economic volatility between developed and developing countries. Through statistical analysis, the study reveals distinct patterns of volatility across these groups. One key finding is that investment volatility in the USA acts as an outlier among developed countries, increasing the overall average volatility. In contrast, developing countries exhibit significantly higher volatility compared to developed nations. Additionally, the research identifies a negative correlation between India's real investment and net exports by real GDP, providing unexpected insights into the country's economic dynamics.

1.0 Introduction

Real GDP is widely regarded as a key economic indicator for evaluating a country's overall economic performance. It measures the total value of goods and services produced, adjusted for inflation, and is often used to gauge growth and facilitate international comparisons. However, while real GDP is an essential metric, it does not capture the complexities behind short-term fluctuations, seasonal variations, and long-term economic trends. For instance, holiday-related consumer spending spikes or declines in construction activity during colder months can distort the true economic performance, making it challenging for policymakers and economists to differentiate between temporary shifts and structural changes.

To address these limitations, this project aims to provide a more detailed analysis by decomposing real GDP data into its deseasonalized form, breaking it down into two critical components: the cyclical component and the long-run trend component. The cyclical component reflects short- to medium-term fluctuations driven by business cycles, while the long-run trend component captures the fundamental growth trajectory of an economy over time.

By analyzing these components across different time periods and comparing the economic performance of various countries—specifically five developing countries (India, Chile, South Africa, Brazil, and Indonesia) and five developed countries (the USA, Germany, Japan, Canada, and South Korea).. This analysis will emphasize important variations in economic cycles and trends, offering valuable insights. Ultimately, this will deepen our understanding of global economic dynamics.

2.0 Methodology

This research article focuses on analyzing the trends and cyclical components of key economic indicators, such as Real GDP, Real consumption, Real investment, and Real net exports . The project is structured across multiple stages, incorporating data collection, processing, analysis, and documentation tools to ensure a comprehensive and accurate comparative analysis.

For India, data was collected from the first quarter of 1996 to the fourth quarter of 2019 through FRED (Federal Reserve Economic Data). Additionally, data was gathered for five developed and five developing countries, covering the period between the first quarter of 2004 and the fourth quarter of 2019, also sourced from FRED.

Once the datasets were collected, Excel was used to merge the individual datasets into one comprehensive file for each country. These merged datasets were then imported into Stata for statistical analysis. The Hodrick-Prescott filter was applied to isolate the cyclical components from the GDP series of each country. This technique smooths out short-term fluctuations, enabling clearer analysis of long-term trends.

A descriptive analysis was conducted to compute the standard deviations of the cyclical components for each country, followed by a comparative analysis of these standard deviations between the groups of developed and developing economies. The findings and analysis were thoroughly documented using LaTeX, ensuring a well-structured, professional presentation of the project.

3.0 Macroeconomic Analysis of Indian

In this section, we analyse the Macroeconomic indicators of India by decomposing it into its cyclical and trend components using the Hodrick-Prescott (HP) filter. By applying this filter, we aim to gain a clearer understanding of the underlying economic trends and the cyclical variation of macroeconomic indicators .
First, we isolate the trend component (section 1.1), which represents the long-term growth path of the economy, from the cyclical component (section 1.2), which captures the short-term deviations from this trend. This distinction is crucial for identifying the phases of economic expansion and contraction, and in formulating appropriate policy responses.
After decomposing the macroeconomic indicators data respectively , we calculate the standard deviation of the cyclical component (Table 1) to quantify the extent of economic volatility. This measure provides insights into the stability of the economy and the magnitude of economic fluctuations over time. We will be interpreting these results using the graph, and try to comment on the reasons behind them, resilience and stability of India's economic growth.

3.1 Trend Components of the India

The trend component of a macroeconomic indicator, obtained using the Hodrick-Prescott (HP) filter, is essential for analyzing the long-term trajectory of a country's economic performance over time. As illustrated in the graph depicting the trend of log(GDP) over the years, real GDP generally exhibits a consistent upward movement in the long run. This pattern is also reflected in its key components, such as the logarithm of real consumption and real investment . Therefore, while the trend component of GDP does demonstrate a consistent growth pattern, our analysis will prioritize other aspects, as this steady trajectory offers limited new insights into the dynamics of the economy

Trend component of Real GDP : One of the key indicators of a country's development is the growth of its real GDP. As an aggregate measure of economic activity, GDP provides valuable insights into the overall economic performance of a nation. In the case of India, we illustrate this relationship by plotting the log(GDP) against time in Figure 1.

While we observe some minor fluctuations in log(GDP) around 2008, primarily attributed to the subprime mortgage crisis, it is important to note that this crisis triggered a global financial downturn, impacting economies worldwide. Despite these short-term disturbances, India's long-term trend reveals a consistent upward trajectory in growth rates, underscoring its resilience in the face of external economic shocks.

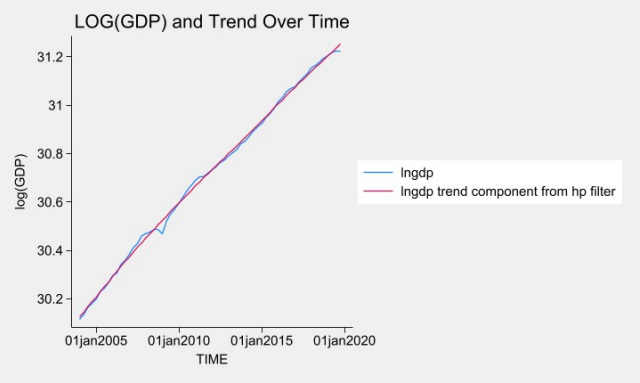


Figure 1: Log of GDP and trend over time

Trend component of consumption Expenditure : As illustrated in Figure 2, real consumption in India exhibits a growth trend over time. Notably, there was a significant spike in consumption expenditure around 2011, which can be attributed to a combination of factors, including elevated inflation during that period and the general Lok Sabha elections. It is likely that the government implemented various schemes to stimulate consumption in response to these economic conditions. Overall, the trend represented by the red line indicates a consistent increase in economic activity, reinforcing the notion of sustained growth in consumption.

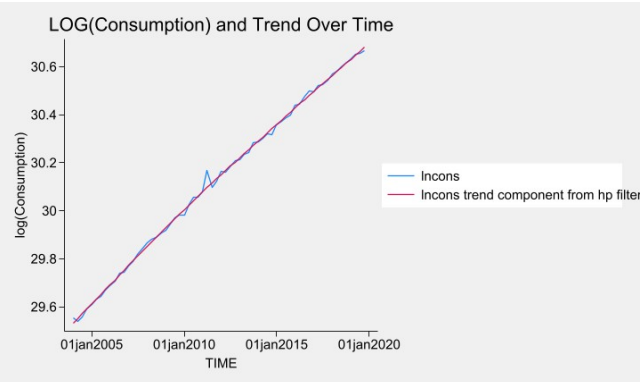


Figure 2: Log of Consumption and trend over time

Trend component of Real Investment : Investment in the country demonstrates a declining growth rate over time. Initially, the slope of the graph is steep, particularly around 1999, reflecting a surge in investment activity driven by economic reforms and liberalization policies introduced in the early 1990s. These reforms opened up various sectors to private and foreign investments, leading to increased capital inflows and a robust expansion of infrastructure.

However, as time progresses, the growth rate increases at a decreasing rate. Notably, there is a significant dip in log(investment) around 2008, coinciding with the global financial crisis, which had a profound impact on investor confidence and economic conditions worldwide. During this period, many investors became wary due to increased uncertainty, leading to reduced capital expenditures and project delays.

Despite this setback, the overall trend of log(investment) remains upward, as illustrated in Figure 3, suggesting long-term resilience and recovery in investment activity as the economy stabilizes post-crisis. This enduring trend highlights the importance of investment as a key driver of economic growth, even in the face of short-term challenges.

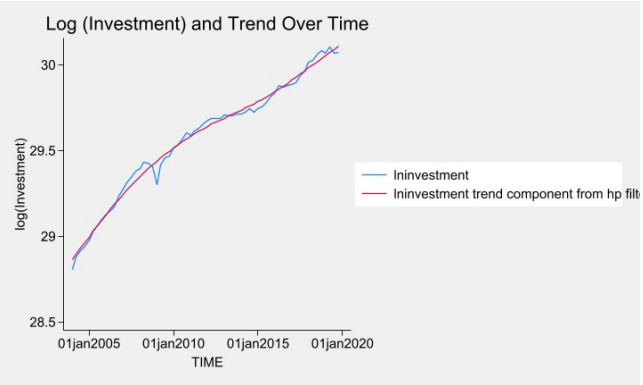


Figure 3: Log of Investment and trend over time

Trend component of ratio of Net exports to GDP : Net exports are one of the most volatile components of GDP, as shown in Figure 4. The net export-to-GDP ratio displays a somewhat cyclical pattern, with a noticeable decreasing trend up to 2011, followed by a significant upward trend from 2011 to 2017. The decline until 2011 can be attributed to several factors, including high inflation that eroded the competitiveness of Indian goods abroad, alongside increasing import costs due to inflationary pressures and rising oil prices. Additionally, domestic inflation-related protests and uncertainty likely contributed to this downward trend.

From 2011 onwards, the net export-to-GDP ratio saw a reversal, growing steadily until 2017. This increase can be linked to multiple factors, including the depreciation of the Indian rupee, which made Indian exports more

competitive globally. Additionally, global demand recovery, particularly in key export sectors like IT, textiles, and pharmaceuticals, fueled India's export growth. At the same time, government measures to curb imports, such as restrictions on gold imports, contributed to a reduction in import growth, further boosting the net export-to-GDP ratio.

This combination of economic and social factors contributes to the observed volatility in net exports, highlighting their sensitivity to both domestic conditions and external market influences.

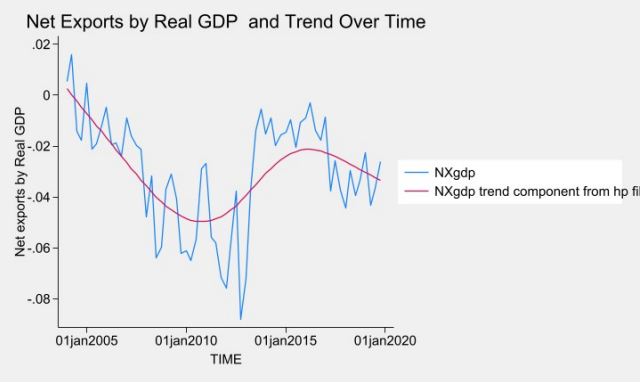


Figure 4: Net Exports by Real GDP and trend over time

3.2 Cyclical Components of the India

The cyclical components represent longer-term fluctuations that are not fixed like seasonal variations. These fluctuations correspond to the periods of growth and downturns in the economy. The proper identification of the cyclical patterns is necessary for ideal policymaking. Here we calculate the standard deviation of different cyclic component of indicators. The standard deviation of the cyclical component measures the degree of volatility of the component. The more is the standard deviation of the component, the more is the uncertainty.

Here, we have calculated the standard deviations of different components of economic indicator. In the below table no 1, the standard deviation of log of real GDP, log of private final consumption expenditure, log of real gross fixed capital formation, and log of ratio of net exports as a portion of GDP are calculated.

Table 1: **Standard Deviations Economic Variables**

Variable Name	**Standard Deviation**
ln(rGDP)	0.0135535
ln(rPFCE)	0.0174226
ln(rGFCF)	0.0336798
ln(rNX/rGDP)	0.014574

Note: The table presents the standard deviations of the cyclical components of various economic variables calculated using the Hodrick-Prescott filter.

Cyclical component of log of real GDP : The cyclical component of the log real GDP exhibits a clear V-shaped curve around the 2008 to 2010 period, which directly reflects the sharp downturn caused by the global financial crisis followed by a strong recovery. The initial steep decline is a result of the subprime mortgage crisis, which led to a global economic contraction. India, like many countries, saw a drop in exports, weakened investor confidence, and a slowdown in growth during this time.

However, the recovery phase of the V-shaped curve reflects the quick rebound in economic activity, driven by several factors. Governments and central banks, including India's, implemented large-scale fiscal and monetary interventions, such as stimulus packages and interest rate cuts, to stabilize the economy. Additionally, the global recovery, particularly in key markets, boosted demand for Indian exports, helping the economy bounce back. India's relatively strong banking system and limited exposure to the toxic assets that triggered the crisis further contributed to a faster recovery.

The magnitude of the cyclical component post-crisis is smaller, indicating that the economy has stabilized with less severe fluctuations. This suggests a narrower gap between the peaks and troughs of the business cycle, signaling lower volatility in the aftermath of the crisis. The corresponding figure for the cyclical component of the log of GDP is depicted in Figure 5.

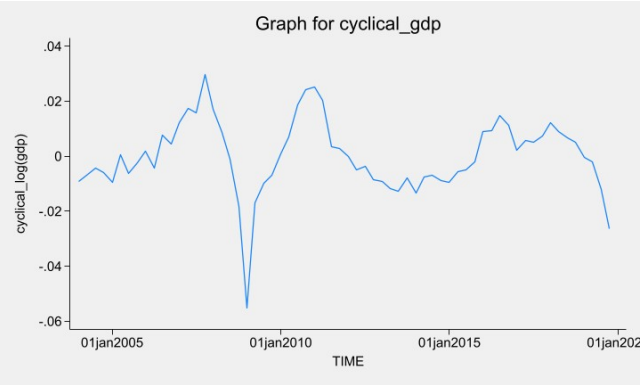


Figure 5: Cyclical Component of GDP

Cyclical component of log of real consumption : The cyclical component of the log of real consumption, as illustrated in Figure 6, captures the fluctuations in consumption patterns over time. A sharp rise in the cyclical component is noticeable following the 2008 financial crisis, largely driven by multiple factors. First, a rebound in agricultural production during this period led to increased rural income, supporting higher consumption levels. Additionally, government stimulus measures, such as rural employment schemes and increased public spending, fueled overall economic activity, contributing to stronger-than-expected growth. The economy was still benefitting from post-crisis recovery momentum, with sectors like manufacturing and services also picking up, leading to higher consumption demand across both urban and rural areas.

However, by 2014, the cyclical component shows a significant dip, indicating a slowdown in consumption. This decline can be attributed to several key factors. First, there was a broader economic deceleration in India, driven by weaker industrial output and sluggish global demand, which impacted household incomes. With income growth stagnating, particularly in rural areas, purchasing power declined, reducing consumer spending. High inflation, especially in essential items like food, exacerbated the situation, as rising prices eroded real incomes. This was particularly evident in rural areas, where a larger portion of income is spent on food and necessities, making rural consumption more vulnerable to inflationary pressures. The inflationary spike in food prices during this period was driven by supply-side constraints, including poor agricultural performance in certain regions and rising input costs, which further squeezed consumption.

In addition, external factors such as volatile global commodity prices and unfavorable weather conditions (e.g., weak monsoon seasons) impacted agricultural output, limiting income growth in rural regions. These conditions, coupled with inflation-related constraints, significantly reduced demand, leading to the observed dip in the cyclical component of real consumption in 2014.

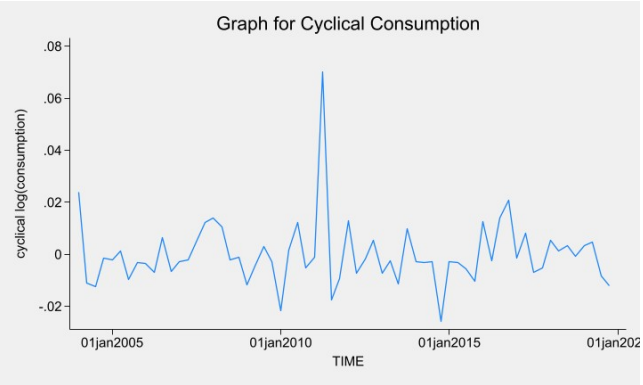


Figure 6: Cyclical Component of Consumption

Cyclical component of log of real investment : The real investment in the economy, as illustrated in Figure 7, experienced a significant decline in 2008, largely driven by the repercussions of the subprime mortgage crisis in the United States. This global financial crisis not only destabilized financial markets but also led to a loss of confidence among investors worldwide, including in India. As a result, many businesses postponed or scaled back their investment plans, leading to a sharp contraction in capital formation.

During this period, the log of real investment plunged into negative territory, indicating that actual investment levels were far below expectations. The trend estimated by the HP filter suggested a higher anticipated growth trajectory for investment, highlighting the extent of the economic setback. This negative cyclical component signifies that the economy was underperforming relative to its potential, as businesses faced challenges such as tightened credit conditions, reduced consumer demand, and increased uncertainty regarding economic stability.

Additionally, the decline in investment was exacerbated by several factors. The slowdown in global demand adversely affected Indian exports, which in turn impacted production and profitability for many sectors. Companies became increasingly cautious, opting to conserve cash rather than invest in new projects or expand operations. Furthermore, the crisis led to increased volatility in commodity prices and a slowdown in infrastructure projects, further dampening investor sentiment.

The subsequent negative effects on employment and income growth created a cycle of reduced consumption, which further strained businesses and delayed recovery. Consequently, the contraction in real investment during this period reflects a broader economic malaise, emphasizing the interconnectedness of global financial systems and their impact on domestic economies.

In summary, the negative cyclical component of real investment during the 2008 crisis underscores a crucial moment in the Indian economy, where external shocks significantly impeded growth prospects, leading to a

period of stagnation and uncertainty that would take time to overcome.

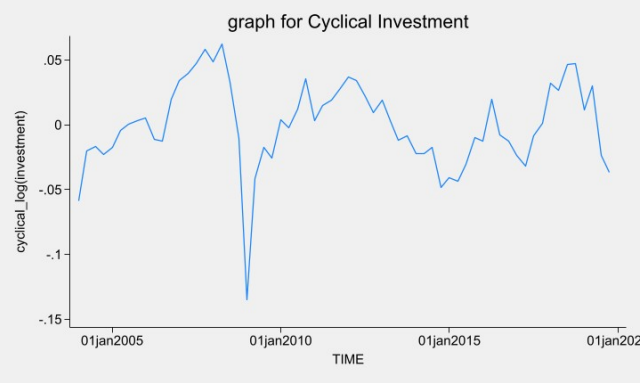


Figure 7: Cyclical Component of Investment

Cyclical component of log of ratio of net exports to GDP : The cyclical component of nation of net exports to GDP is one of the most volatile indicator among all the indicator. The net exports show a clearer business cycle.Between 2012 and 2014, this ratio experienced a significant decline, driven by several interrelated factors.

During this period, India faced a widening trade deficit as imports surged—particularly of essential commodities like crude oil and gold—while export growth stagnated. Weak global demand, especially in traditional export markets, exacerbated this imbalance, following the slow recovery from the 2008 financial crisis. High inflation rates in food and energy sectors eroded domestic purchasing power, making Indian goods less competitive in international markets.

The depreciation of the Indian rupee further complicated the situation. While a weaker currency was expected to boost exports by making them cheaper for foreign buyers, it simultaneously increased import costs, negatively impacting the overall trade balance.

Structural challenges within the manufacturing sector, including inefficiencies, high production costs, and inadequate infrastructure, hindered the ability to produce competitive goods for export. Additionally, uncertainties in the policy and regulatory environment created challenges for exporters, further contributing to the decline in net exports.

However, in 2014, the situation began to improve. The Indian government implemented various policy measures aimed at enhancing export competitiveness, including the "Make in India" initiative, which sought to encourage domestic manufacturing and attract foreign investment. The favourable global economic climate, coupled with

rising demand for Indian goods in markets like the United States and Europe, contributed to a gradual recovery in export growth.

As a result, by late 2014, there was a noticeable up tick in net exports relative to GDP, indicating a shift towards a more balanced trade scenario. This change was essential for stabilizing the economy and fostering sustainable growth.

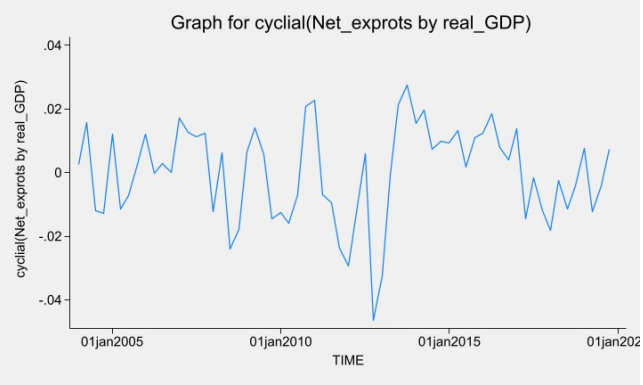


Figure 8: Cyclical Component of Net Exports by Real GDP

3.3 Correlation between indicators of India

Correlation analysis between different economic indicators is a powerful tool for understanding their relationships and how they influence one another. A positive correlation indicates that two indicators move in the same direction, while a negative correlation suggests an inverse relationship. In the case of investment and consumption, there is a positive correlation, meaning that as investment increases, consumption tends to rise as well. However, since the correlation is not close to 1, the relationship is not perfectly proportional, but the broader trend indicates they are positively related.

On the other hand, the correlation between net exports and investment is negative, which is somewhat unexpected. Typically, one would expect that increased investment in the economy would lead to a rise in net exports by improving production capacity and international competitiveness. However, the negative correlation suggests otherwise. There are several potential reasons for this. First, much of India's investment may be directed towards sectors that cater primarily to domestic consumption, such as real estate, infrastructure, and services, which do not contribute directly to exports. Additionally, investment often leads to higher imports of capital goods, technology, and raw materials, which can increase the trade deficit as imports rise faster than

exports. Another possible factor is currency appreciation driven by foreign investment inflows, which makes Indian goods more expensive in global markets, reducing exports while increasing imports. Furthermore, investments in non-exporting sectors or the delayed impact of investment on export-oriented industries might also explain this outcome.

Structural challenges in India's export sector, such as high logistics costs and regulatory barriers, may further limit the positive effects of investment on exports. This suggests that investment, while beneficial to the domestic economy, is not yet translating into stronger export performance. Table 2 below provides a detailed overview of the correlation between all key economic indicators, highlighting the complex relationships at play.

Table 2: **Correlation Matrix of Cyclical Economic Indicators**

Variable Name	**GDP**	**Consumption**	**Investment**	**Net Exports**
GDP	1			
Consumption	0.03455	1		
Investment	0.0765	0.1514	1	
Net Exports	-0.0245	-0.1114	-0.2572	1

Note: The table presents the correlation coefficients between the cyclical components of GDP, Consumption, Investment, and Net Exports, calculated using the Hodrick-Prescott filter.

4.0 Cyclical Trends in Developed Economics

This section examines the cyclical trends in GDP for selected developed economies, including the United States, Canada, Germany, Japan, and South Korea. Utilizing the Hodrick-Prescott (HP) filter, we extract the cyclical components of GDP to provide a clear representation of economic fluctuations over the period from Q1 2004 to Q4 2019.

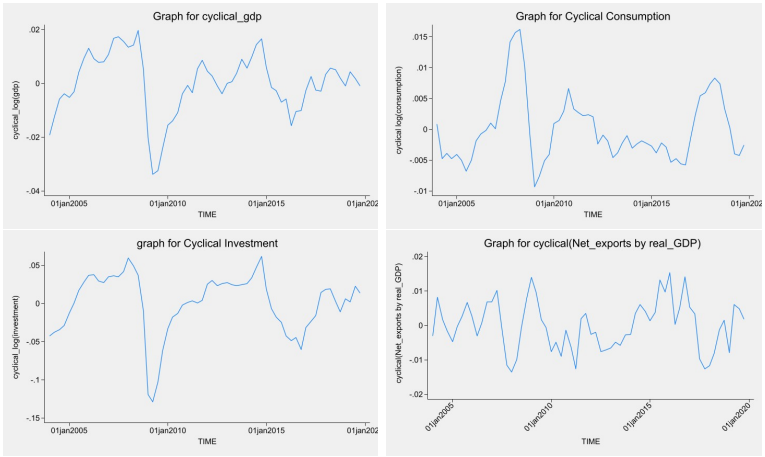
Accompanying the visual graphs, a table detailing the standard deviations of these cyclical components is presented to illustrate the volatility associated with each economy. Together, these visualizations and metrics enhance our understanding of the economic dynamics in developed countries and serve as a basis for further comparative analysis with developing economies.

CANADA

Figure 9: Standard Deviations Economic Variables

Variable Name	Standard Deviation
ln(rGDP)	0.0113839
ln(rPFCE)	0.0054612
ln(rGFCF)	0.0394958
ln(rNX/rGDP)	0.0071149

Note: The table presents the standard deviations of the cyclical components of various economic variables calculated using the Hodrick-Prescott filter for Canada .

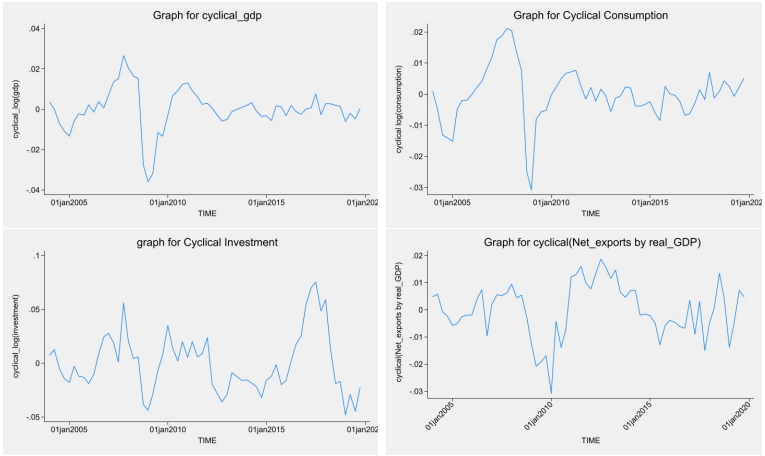


SOUTH KOREA

Figure 10: Standard Deviations Economic Variables

Variable Name	Standard Deviation
ln(rGDP)	0.0103992
ln(rPFCE)	0.0088737
ln(rGFCF)	0.0275811
ln(rNX/rGDP)	0.0099299

Note: The table presents the standard deviations of the cyclical components of various economic variables calculated using the Hodrick-Prescott filter for South Korea .

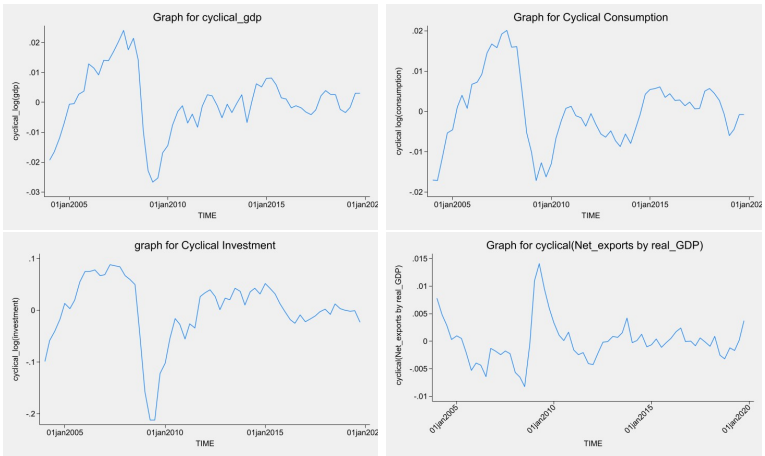


USA

Figure 11: Standard Deviations Economic Variables

Variable Name	Standard Deviation
ln(rGDP)	0.0105381
ln(rPFCE)	0.0086995
ln(rGFCF)	0.0629371
ln(rNX/rGDP)	0.0038767

Note: The table presents the standard deviations of the cyclical components of various economic variables calculated using the Hodrick-Prescott filter for USA.



Germany

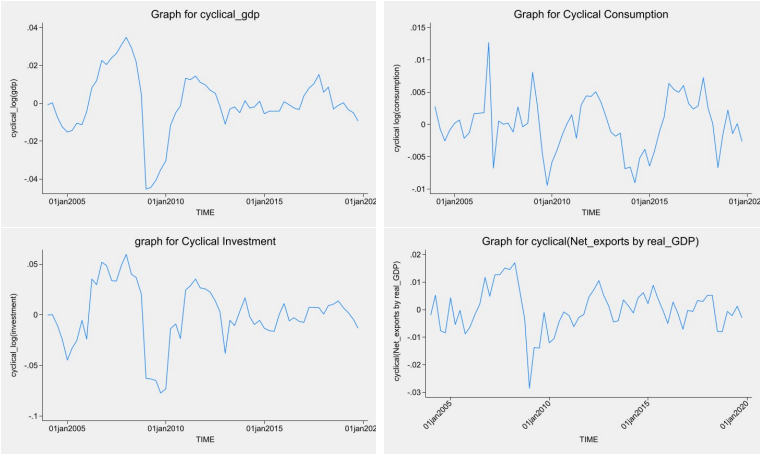


Figure 12: Standard Deviations Economic Variables

Variable Name	Standard Deviation
ln(rGDP)	0.016232
ln(rPFCE)	0.0042468
ln(rGFCF)	0.0299523
ln(rNX/rGDP)	0.007835

Note: The table presents the standard deviations of the cyclical components of various economic variables calculated using the Hodrick-Prescott filter for Germany .

Japan

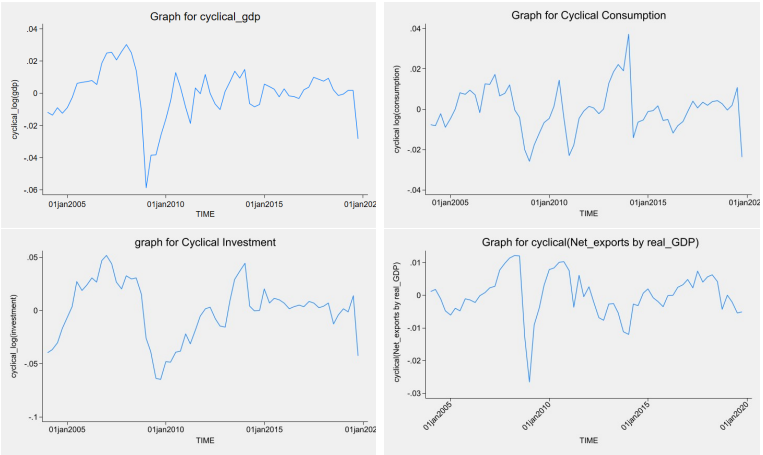


Figure 13: Standard Deviations Economic Variables

Variable Name	Standard Deviation
ln(rGDP)	0.0157315
ln(rPFCE)	0.0113525
ln(rGFCF)	0.0271262
ln(rNX/rGDP)	0.0067635

Note: The table presents the standard deviations of the cyclical components of various economic variables calculated using the Hodrick-Prescott filter for Japan .

4.1 Cyclical Trends in Developing Economics

This section provides an overview of the cyclical trends in GDP for selected developing economies, including Brazil, India, Mexico, Chile, and South Africa. By applying the Hodrick-Prescott (HP) filter, we isolate the cyclical components of GDP, which allows for a clear visualization of economic fluctuations over the period from Q1 2004 to Q4 2019.

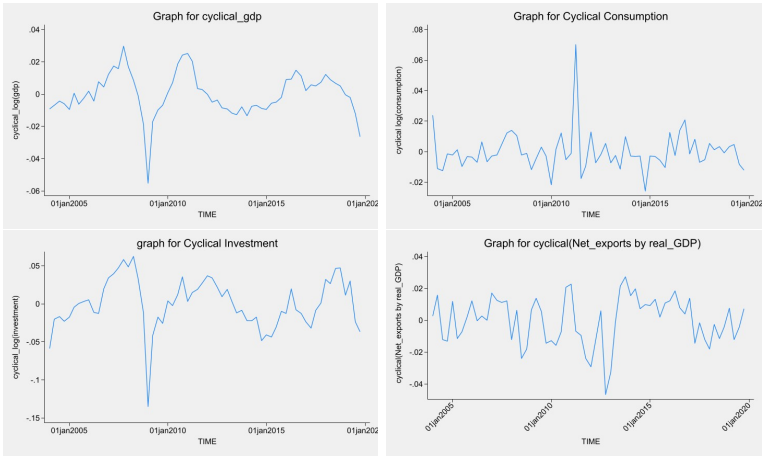
Additionally, for every country, the table presenting the standard deviations of these cyclical components is included to quantify the volatility of each economy. Together, the graphs and the table offer insights into the economic behaviours of developing countries, laying the groundwork for subsequent comparative analysis with developed economies.

INDIA

Figure 14: Standard Deviations Economic Variables

Variable Name	Standard Deviation
ln(rGDP)	0.0132593
ln(rPFCE)	0.0128258
ln(rGFCF)	0.0329771
ln(rNX/rGDP)	0.0148885

Note: The table presents the standard deviations of the cyclical components of various economic variables calculated using the Hodrick-Prescott filter for India .

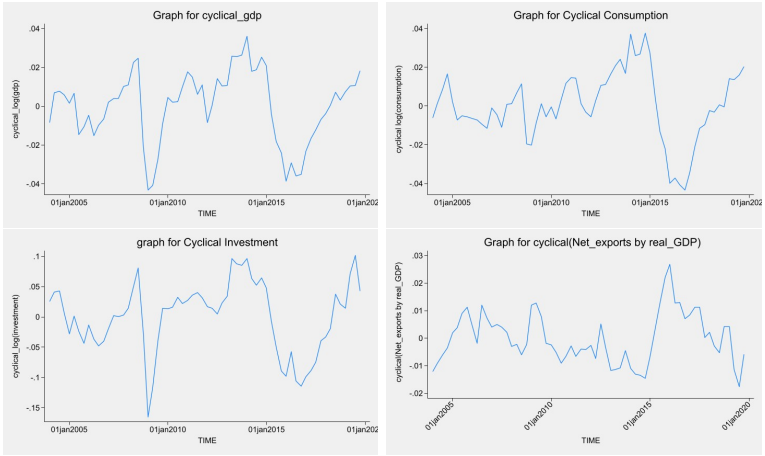


BRAZIL

Figure 15: Standard Deviations Economic Variables

Variable Name	Standard Deviation
ln(rGDP)	0.0182563
ln(rPFCE)	0.0176395
ln(rGFCF)	0.058321
ln(rNX/rGDP)	0.0091898

Note: The table presents the standard deviations of the cyclical components of various economic variables calculated using the Hodrick-Prescott filter for Brazil .

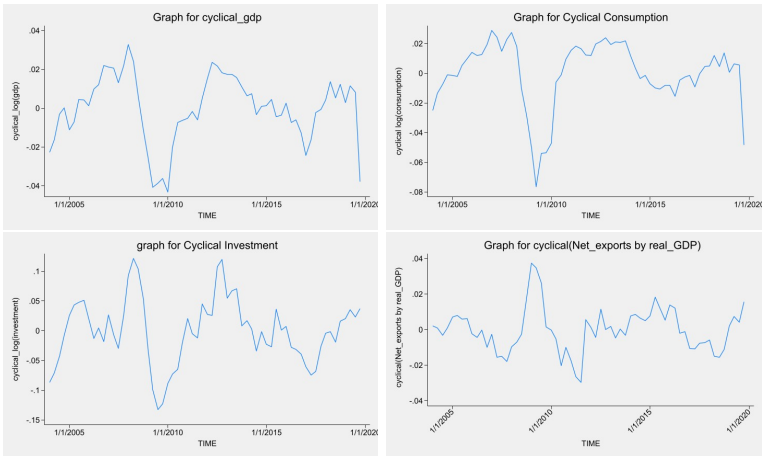


CHILE

Figure 16: Standard Deviations Economic Variables

Variable Name	Standard Deviation
ln(rGDP)	0.0171283
ln(rPFCE)	0.0220171
ln(rGFCF)	0.0552019
ln(rNX/rGDP)	0.0125774

Note: The table presents the standard deviations of the cyclical components of various economic variables calculated using the Hodrick-Prescott filter for Chile .



SOUTH AFRICA

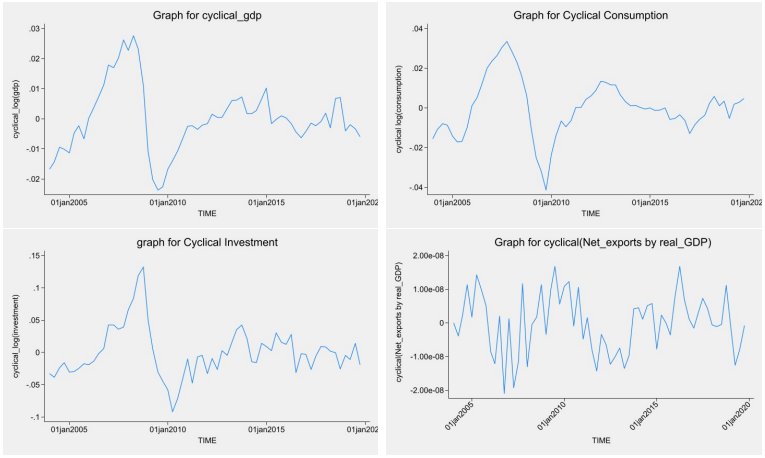


Figure 17: Standard Deviations Economic Variables

Variable Name	Standard Deviation
ln(rGDP)	0.0109382
ln(rPFCE)	0.014165
ln(rGFCF)	0.0387417
ln(rNX/rGDP)	0.000000000875

Note: The table presents the standard deviations of the cyclical components of various economic variables calculated using the Hodrick-Prescott filter for South Africa .

MEXICO

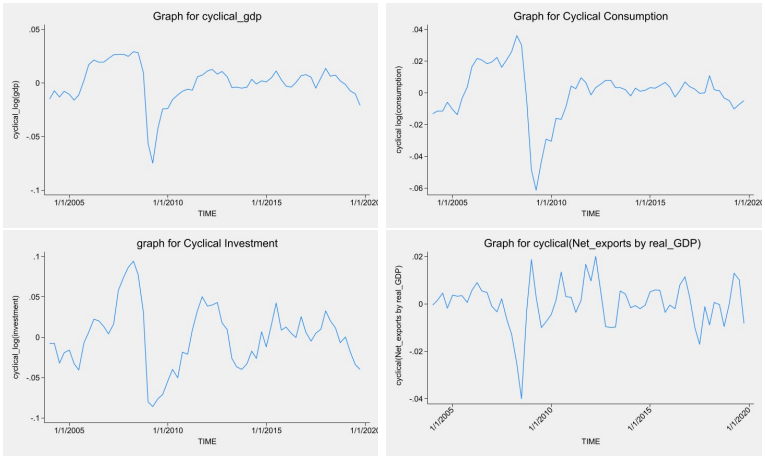


Figure 18: Standard Deviations Economic Variables

Variable Name	Standard Deviation
ln(rGDP)	0.0185447
ln(rPFCE)	0.0169417
ln(rGFCF)	0.0385041
ln(rNX/rGDP)	0.0095792

Note: The table presents the standard deviations of the cyclical components of various economic variables calculated using the Hodrick-Prescott filter for Mexico .

4.2 Comparative analysis

In this section, we present a comparative analysis of the standard deviations and associated volatility between two sets of countries: developed economies (United States, Canada, South Korea, Germany, Japan) and developing economies (Brazil, Chile, India, Mexico, South Africa). By examining the cyclical components of

these economies, we aim to highlight the differences in economic stability and fluctuations over time. Standard deviation is one of the key metric for understanding the degree of variability in economic performance within each group, while volatility analysis provides insight into the consistency or unpredictability of their respective economic cycles. This comparison spans the period from Q1 2004 to Q4 2019, offering a comprehensive view of how developed and developing economies respond to global and regional economic conditions.

4.2.1 Real GDP

The table compares the economic stability of developing and developed countries using two metrics: Standard Deviation and Mean Values(sd) of Real Gross Domestic Product . Here's a breakdown:

Table 3: Standard Deviations and Mean Values of Real GDP by Country

Group	**Country Name**	**Standard Deviation**	**Mean Value of sd**
Developing	Brazil	0.0182563	
	India	0.0132593	
	Mexico	0.0185447	0.01562536
	Chile	0.0171283	
	South Africa	0.0109382	
Developed	Canada	0.0113839	
	Germany	0.016232	
	Japan	0.0157315	0.01285694
	South Korea	0.0103992	
	US	0.0105381	

Note: The table presents the standard deviations and mean values of Real GDP calculated for various countries.

Developing Economies: The standard deviations for the developing countries range from 0.0109382 (South Africa) to 0.0185447 (Mexico), reflecting varying levels of economic volatility. Mexico exhibits the highest standard deviation (0.0185447), suggesting it experienced the greatest fluctuations in its economic cycles. South Africa, with the lowest standard deviation (0.0109382), indicates relatively more stable economic performance within this group. The mean standard deviation for the developing countries is 0.0156253, implying an average level of moderate volatility across these economies.

Developed Economies: The standard deviations for the developed countries range from 0.0103992 (South Korea) to 0.016232 (Germany). Germany shows the highest standard deviation (0.016232) among developed nations, indicating the greatest degree of economic variability within this group. South Korea, with the lowest standard deviation (0.0103992), shows the least volatility, suggesting more stable economic performance. The mean standard deviation for the developed countries is 0.01285694, indicating lower average volatility compared to the developing group. The developing group exhibits a higher average standard deviation (0.0156253) compared to the developed group (0.01285694), highlighting that developing countries tend to experience more economic volatility.

4.2.2 Real Consumption (PFCE)

Developing Economies: The standard deviations for the developing countries range from 0.0128258 (India) to 0.0220171 (Chile), indicating varying levels of consumption volatility. Chile shows the highest standard deviation (0.0220171), which suggests it experienced the greatest fluctuations in its real Private Final Consumption Expenditure (PFCE) among the developing nations. India, with the lowest standard deviation (0.0128258), reflects more stable consumption trends in this group. The average standard deviation for developing countries is approximately 0.0163178, suggesting moderate consumption volatility overall in these economies.

- **Volatility**: The volatility values range from 0.0967306 (India) to 1.294994 (South Africa). South Africa, with the highest volatility (1.294994), likely experienced significant consumption swings during periods of economic instability, such as fluctuating commodity prices and political uncertainty. India's much lower volatility (0.0967306) can be attributed to relatively stable growth patterns during this period.

Reasons: - **2008 Financial Crisis**: Developing countries like Brazil, Mexico, and South Africa were impacted by the global recession indirectly, through reduced export demand and slower growth. The higher standard deviations and volatilities reflect the greater exposure to global economic conditions. - **Commodity Price Volatility**: Countries like Chile, Brazil, and South Africa, which rely heavily on commodities, faced large fluctuations in consumption, especially during the commodity price crash of 2014-2016. - **Policy and

Political Instability**: Developing countries also faced significant political changes during this period, leading to fluctuating consumer confidence and spending patterns. Brazil and South Africa, for example, were both affected by political crises, contributing to their high volatility.

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Developed Economies: The standard deviations for the developed countries range from 0.0042468 (Germany) to 0.0113525 (Japan), showing lower consumption volatility overall. Japan has the highest standard deviation (0.0113525), indicating it experienced the greatest degree of consumption variability in this group, possibly due to prolonged periods of economic stagnation. Germany, with the lowest standard deviation (0.0042468), reflects a more stable consumption pattern during this period. The average standard deviation for developed economies is approximately 0.0072267, demonstrating lower volatility compared to developing economies.

- **Volatility**: Volatility in developed countries ranges from 0.261631 (Germany) to 0.853306 (South Korea). South Korea's relatively high volatility (0.853306) may reflect external pressures, such as global trade conditions, while Germany's low volatility (0.261631) suggests a more stable consumption environment, likely bolstered by sound economic policies.

Reasons: - **Financial Crisis Recovery**: Developed economies like the U.S. and Germany, though affected by the 2008 crisis, implemented effective stimulus packages and recovery measures, which helped stabilize consumption by 2010-2015. This explains their relatively low volatilities. - **Robust Social Safety Nets**: The presence of strong social welfare systems in countries like Canada and Germany helped maintain consumption levels during economic downturns, keeping volatility low. - **Technological and Structural Resilience**: Developed countries, with more diversified economies and advanced technological infrastructure, were better able to withstand global economic shocks, resulting in lower consumption volatility.

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In summary, the developing countries exhibit higher standard deviations and volatilities compared to developed countries. This reflects the greater economic vulnerability of developing nations to external shocks, commodity price swings, and political instability during the time period (2004-2019). Developed nations, with more stable economic structures and policies, demonstrate lower volatility in their real PFCE.

Table 4: Standard Deviations, Volatilities, and Mean Values of Real PFCE by Country

Group	**Country Name**	**Standard Deviation**	**Volatility**	**Mean Value of Volatility**
Developing	Brazil	0.0176395	0.966214	
	India	0.0128258	0.0967306	
	Mexico	0.0169417	0.91356	1.085499
	Chile	0.0220171	1.285422	
	South Africa	0.0141649	1.294994	
Developed	Canada	0.0054612	0.47973	0.628367
	Germany	0.0042468	0.261631	
	Japan	0.0113525	0.721641	
	South Korea	0.0088737	0.853306	
	US	0.0086995	0.825528	

Note: The table presents the standard deviations, volatilities, and mean values of Real PFCE calculated for various countries.

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4.2.3 Real Investment (GFCF)

Table 5: Standard Deviations, Volatilities, and Mean Values of Real GFCF by Country

Group	Country Name	Standard Deviation	Volatility	Mean Value
Developing	Brazil	0.058321	3.194568	2.90453313
	India	0.0329771	2.487092	
	Mexico	0.0385041	2.076286	
	Chile	0.0552019	3.222848	
	South Africa	0.0387417	3.541872	
Developed	Canada	0.0394958	3.46944	3.13272
	Germany	0.0299523	1.845262	
	Japan	0.0271262	1.724324	
	South Korea	0.0275811	2.652233	
	US	0.0629371	5.972338	

Note: The table presents the standard deviations, volatilities, and mean values of Real GFCF calculated for various countries.

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4.2.4 Real Exports (NX)

Table 6: Standard Deviations, Volatilities, and Mean Values of Real NX by Country

Group	Country Name	Standard Deviation	Volatility	Mean Value
Developing	Brazil	0.0091898		0.009247
	India	0.0148885	1.1144825	
	Mexioc	0.0095792	1.8202238	
	Chile	0.0125774	0.54367876	
	South Africa	0.00000000875	0.77670997	
Developed	Canada	0.0071149	0.52248347	0.007104
	Germany	0.007835	0.46782911	
	Japan	0.0067635	0.42249668	
	South Korea	0.0099299	0.45686466	
	US	0.0038767	0.26592126	

Note: The table presents the standard deviations volatilities, and mean values of Real NX calculated for various countries.

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Conclusion