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G20 ECONOMIC GROWTH ANALYSIS USING VECM

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ABSTRACT

This study analyzes the effect of Gross Fixed Capital Formation (GFCF), Imports, Exports, and Government Expenditure of selected G20 member countries on Gross Domestic Product (GDP) using historical data from 1981 to 2021. The detailed analysis aims to explore the relationship between short-term and long-term causality that begins with examining and testing the degree of integration, Unit Root Test, Johansen cointegration test, and causality test. The Vector Error Correction Model (VECM) test results with a 95% confidence interval show that Gross Fixed Capital Formation causes Australia's and South Africa's long-term GDPs to have reached a balance point. In addition, Government Spending also causes the European Union's Gross Domestic Product to achieve a balance point. Imports affect the GDP of the United States, China, and South Africa towards a balance point, and exports affect the GDP of Australia, China, and South Africa. The test results using VECM also conclude that GDP, GFCF, exports, and imports affect GDP growth in the short term. However, on the contrary, on the Australian continent, only GDP, GFCF, and imports which in the previous year had an impact on Australia's GDP in the short term—concluded that differences in government policies in each country in regulating the economy could affect the causal relationship between the independent variable and GDP in the short and long term.

Keywords: VECM, Granger Causality, Economic Growth, G20

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ABSTRAK

Studi ini menganalisis pengaruh Pembentukan Modal Tetap Bruto (GFCF), Impor, Ekspor, dan Pengeluaran Pemerintah negara-negara anggota G20 terpilih terhadap Produk Domestik Bruto (PDB) menggunakan data historis dari tahun 1981 hingga 2021. Analisis rinci bertujuan untuk mengeksplorasi hubungan antara kausalitas jangka pendek dan jangka panjang yang diawali dengan pemeriksaan dan pengujian derajat integrasi, Uji Akar Unit, uji kointegrasi Johansen, dan uji kausalitas. Hasil pengujian Vector Error Correction Model (VECM) dengan interval kepercayaan 95% menunjukkan bahwa Pembentukan Modal Tetap Bruto menyebabkan PDB jangka panjang Australia dan Afrika Selatan telah mencapai titik keseimbangan. Selain itu, Belanja Pemerintah juga menyebabkan Produk Domestik Bruto Uni Eropa mencapai titik keseimbangan. Impor mempengaruhi PDB Amerika Serikat, Tiongkok, dan Afrika Selatan menuju titik keseimbangan, dan ekspor mempengaruhi PDB Australia, Tiongkok, dan Afrika Selatan. Hasil pengujian menggunakan VECM juga menyimpulkan bahwa PDB, GFCF, ekspor, dan impor berpengaruh terhadap pertumbuhan PDB dalam jangka pendek. Namun sebaliknya, di benua Australia, hanya PDB, GFCF, dan

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impor yang pada tahun sebelumnya berdampak terhadap PDB Australia dalam jangka pendek—menyimpulkan bahwa perbedaan kebijakan pemerintah di masing-masing negara dalam mengatur perekonomian dapat mempengaruhi pertumbuhan ekonomi. hubungan sebab akibat antara variabel independen dan PDB dalam jangka pendek dan jangka panjang.

Kata Kunci: *VECM, Granger causality, Pertumbuhan Ekonomi, G20*

JEL : O11, O400

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Introduction

A country's economy is the production, distribution, trade, and consumption of goods and services. Economic growth is also one of the main factors often discussed in every country. Economic growth is the expansion of the economy's production possibilities, in other words, allowing the economy to produce more goods. Economic growth can be divided into two, namely, short-term economic growth and long-term economic growth. Long-term economic growth in a country is a crucial question today that profoundly impacts state policy and welfare. More broadly, there is a perception in society that financial success depends on economic success in the long term. Long-term economic growth almost entirely depends on one thing, namely, increasing productivity because sustainable economic growth is only possible if the output produced by an average of one worker rises. This increase in productivity can be caused by technology, improved physical models, and increased human resources (Krugman & Wells, 2015).

In this study, researchers selected several variables to compare economic growth in several countries. Some of the variables we use are GDP, Gross Fixed Capital Formation (GFCF), imports, exports, and government spending. GDP is a monetary measure of the market value of all final goods and services produced and sold in a given period by a country or countries, generally "without double-counting the semi-finished goods and services used to produce them." GDP has a vital role as a measure of the size of an economy, which is helpful as a measuring scale for measuring economic performance in the previous year or as a scale for comparing economic performance with other countries. Gross Fixed Capital Formation (GFCF) is a component of GDP in terms of expenditure and is used to indicate the level of investment in the economy. Import is a good or service purchased in one country and produced in another. Export is a good and service produced in one country and sold to buyers in another. Government spending is money spent by the public sector on acquiring goods and providing services such as education, health care, social protection, and defense (Krugman & Wells, 2015).

Overall, G20 members play an essential role in contributing almost two-thirds of the world's population, 75% of global trade, and 85% of global GDP. Due to its size and strategic importance, the G20 is vital in determining the future direction of global economic growth. This research focuses on several G20 members, such as America, the European Union, China, South Africa, and Australia, as representatives of the countries with the largest economies/ richest countries on each continent. Each member has a vital role in the global economy. According to Forbes, India America is ranked first as the largest economy in the world. China, the country with the second largest economy in the world, plays an important role in the Asian economy.

Meanwhile, Australia represents the Australian continent and is ranked thirteenth in the Largest Economy (Forbes India, 2023). Apart from that, the European Union is an entity. The region, consisting of 27 member countries, significantly contributes to Europe's GDP growth.

The data utilized in this research consists of annual data spanning from 1981 to 2021. The period from 2020 to 2021 coincides with the occurrence of COVID-19, which is considered a force majeure in this study. The research is conducted without segregating periods before and after the onset of COVID-19. The selection of this research period is aimed at Observing the long-term and short-term relationships between the GDP and Gross Fixed Capital Formation (GFCF), imports, exports, and government spending.

Literature Review

Economic growth is one of the development goals in every country. One measure of economic growth is Gross Domestic Product (GDP). Several studies have shown that country development variables such as exports and Gross Fixed Capital Formation (GFCF) have a significant influence on Gross Domestic Product (GDP) in ASEAN (Andinata et al., 2018). Countries that experience rapid physical growth, increase in human resources, or rapid technological progress tend to be countries with rapid growth. One famous example is Japan in the 1950s and 1960s and China. Evidence also shows the importance of governance, property rights, political stability, and governance to foster sources of growth. Policy differences in education, savings, and investment spending can also cause differences in growth (Krugman & Wells, 2015).

Apart from exports and GFCF, with the Vector Error Correction Model (VECM) analysis, government spending also has a long-term effect on economic growth in Indonesia (Putra et al., 2017). The results of other studies also support the statement that Government Spending, Exports, and imports significantly affect Indonesia's economic growth using another analysis technique, namely the Error Correction Model (ECM) (Bonokeling et al., 2022). In addition, the diversification of the proposition regarding the ratio of imports and exports individually for each country can also cause a diversification of the effect on GDP (Carrasco & Tovar-García, 2021). Therefore, this study will analyze the variables claimed to significantly affect economic growth in several G20 countries using the Vector Error Correction Model (VECM) technique.

Time series econometric models are structural models based on existing economic theory. In 1980, Christopher Sims introduced a Vector Autoregression (VAR) model as an alternative for analyzing macroeconomics. The VAR model is designed for stationary variables that do not contain trends. Stochastic trends indicate long-run and short-run components in the time series data. In addition, the VAR model naturally does not identify cause and effect or causality between its variables. So, to identify causality, an experimental design or additional theoretical knowledge is needed. This model was then developed based on stochastic trends, so in 1981 Granger developed the concept of cointegration. Cointegration is a concept in time series analysis that refers to the long-term relationship between two or more non-stationary time series. In 1987, Engle and Granger developed the cointegration and error-correction model (ECM) concept. ECM is a statistical model used to understand short-term and long-term relationships between two or more cointegrated time series.

Then, in 1990, Johansen and Juselius developed the Vector Error Correction Model (VECM) concept, which is a combined statistical model of cointegration and ECM models that offers an easy working procedure for separating long-run components and short-run components from the data formation process. The VECM model, often referred to as a restricted form of VAR, describes a time series of changes from short-term profits to long-term equilibrium (Sinay, 2014). VECM requires a cointegration relationship between variables so that VECM can be derived from an autoregressive distributed lag term model (Jiang et al., 2023). In the case of econometrics, we are often faced with the problem of non-stationary time series analysis (Pfaff, 2008). Therefore, VECM is popularly used in econometric analysis to detect stable long-term relationships between non-stationary variables.

Data and Research Methods

Data Source

G20 is an international economic forum comprising 20 countries with the largest and fastest-growing economies. Some of them used in this study, namely, the United States, Australia, the European Union, the People's Republic of China, and South Africa, were selected as representatives of each continent with the highest GDP. The Data was used in USD units at the 2023 exchange rate.

Table 1: Descriptive Summary Data

Country	Variable	Minimum	Maximum	Mean	Standard Deviation
United State	GDP	3,207,041,000,000	23,315,080,560,000	11,332,275,383,024	5,838,736,567,879
	GFCF	748,760,000,000.00	4,939,580,000,000	2,390,483,170,732	1,185,398,967,573
	EXP	277,000,000,000	2,540,000,000,000	1,257,780,487,805	779,751,675,606
	IMP	303,184,000,000	3,401,360,000,000	1,609,102,609,756	1,006,797,159,663
	GS	507,041,000,000	3,353,730,000,000	1,701,933,463,415	841,569,431,272
Australia	GDP	176,891,907,582	1,576,380,424,746	699,963,164,221	498,010,554,403
	GFCF	47,065,044,455	439,105,000,000	180,198,635,879	127,719,034,562
	EXP	24,100,000,000	343,000,000,000	141,668,292,683	113,071,533,639
	IMP	27,658,399,626	335,599,000,000	143,524,128,194	108,018,273,040
	GS	31,504,702,194	346,275,000,000	134,183,666,070	99,771,555,386
European Union	GDP	2,603,373,084,081	17,177,419,592,825	9,855,393,645,369	4,733,040,488,209
	GFCF	577,602,000,000	3,787,270,000,000	2,138,677,731,707	991,685,293,811
	EXP	705,000,000,000	8,650,000,000,000	3,831,073,170,732	2,548,628,487,935
	IMP	731,934,000,000	8,013,850,000,000	3,623,400,609,756	2,342,731,132,520
	GS	535,128,000,000	3,782,840,000,000	2,039,586,170,732	1,015,573,291,290
People's Republic of China	GDP	195,866,382,433	17,734,062,645,371	4,210,686,920,868	5,145,990,748,429
	GFCF	53,388,698,429	7,425,980,000,000	1,751,783,170,152	2,219,090,264,264
	EXP	14,600,000,000	3,550,000,000,000	933,826,829,268	1,068,335,544,439
	IMP	12,849,964,952	3,091,260,000,000	824,101,976,552	957,231,161,725
	GS	25,820,206,821	2,823,250,000,000	669,098,979,262	844,866,399,286
South Africa	GDP	64,459,376,104	458,201,514,136	230,677,539,646	125,999,882,848
	GFCF	14,856,360,846	81,602,799,259	39,892,415,675	21,421,557,741
	EXP	17,900,000,000	779,000,000,000	233,485,365,853	239,218,170,883
	IMP	29,117,170,386	947,251,000,000	288,246,731,663	296,089,878,273
	GS	10,523,741,688	83,370,421,575	41,430,384,746	24,845,893,857

Note: GDP: Gross Domestic Product; GFCF: Gross Fixed Capital Formation; IMP: Import; EXP: Export, GS: Government Spending.

Source: World Bank (2023)

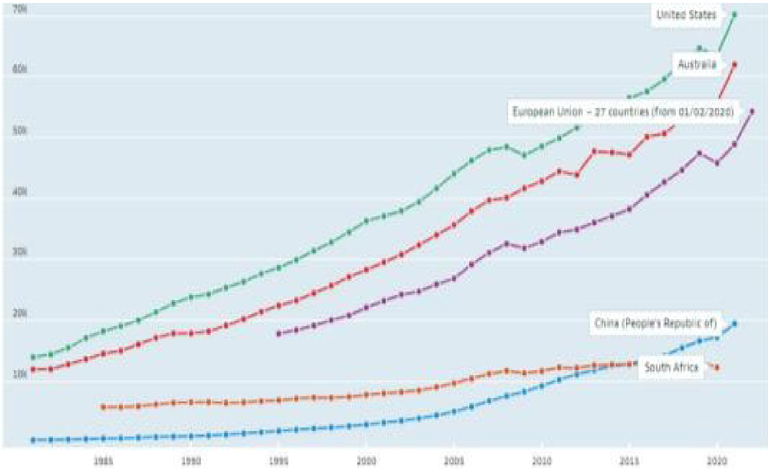

Figure 1: Annual GDP Changes from 1981 to 2021

Source: OECD (2023)

Research Methods

This research analyzed the effect of economic development from 1981 to 2021 with GDP benchmarks from gross fixed capital formation, imports, exports, and government expenditures for each country. The research data is taken from the official website of the World Bank—determination of analysis from 1981 to 2021 due to limited data on certain variables. This study uses the Vector Error Correction Model (VECM) method for time series analysis.

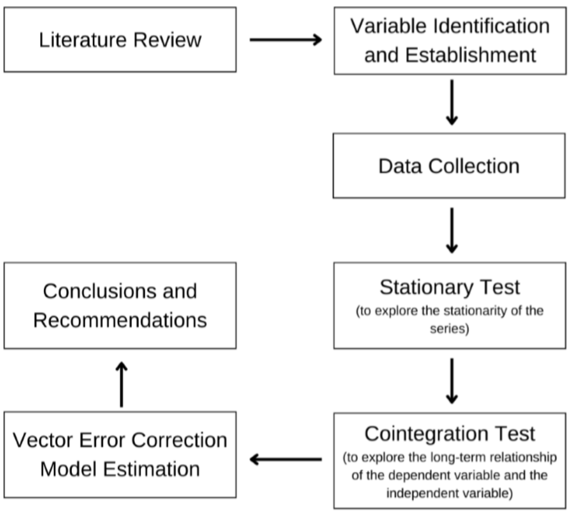

Figure 2: Research Steps With VECM

The Equation To Be Estimated

The GDP impact of gross fixed capital formation, imports, exports, and government spending can be modeled by:

$$GDP_{it} = \beta_{it} + \beta_{1i}GFCG_{it} + \beta_{2i}IMP_{it} + \beta_{3i}EXP_{it} + \beta_{4i}GS_{it} \quad (1)$$

With the aim of stationary data, data transformation is carried out using the log-differencing method used in the analysis and will be stated as follows:

$$\Delta_k \log(GDP_{it}) = \beta_{it} + \beta_{1i}\Delta_k \log(GFCG_{it}) + \beta_{2i}\Delta_k \log(IMP_{it}) + \beta_{3i}\Delta_k \log(EXP_{it}) + \beta_{4i}\Delta_k \log(GS_{it}) \quad (2)$$

With subscript i, t representing the country and the years 1981 to 2021 and $\Delta_k \log(GFCF_{it})$, $\Delta_k \log(IMP_{it})$, $\Delta_k \log(EXP_{it})$ Δ_k log(EXP_{it}), $\Delta_k \log(GS_{it})$states the log and k-th differences on the variables Gross Fixed Capital Formation (GFCF), Import (IMP), Export (EXP), and Government Spending (GS).

Unit Root Test

The unit root test is a stationary test on sequential data. Econometric modeling of sequential data is required to use stationary data to prevent the data from having autocorrelation or heteroscedasticity. Equation (3) is a unit root test model (Kusumaningtyas et al., 2022):

$$\Delta(x_{it}) = a_1 + \delta\Delta(x_{i,t-1}) + \sum_{j=1}^{m_i} \alpha_{ij} x_{i,t-j} + e_{it} \quad (3)$$

Where a_1 is the intercept of the time trend, Δx_{it} is the first difference of the variable x from i country, and t year, m_i is the length of the lag order based on i country. The null hypothesis of the unit root test, assuming $\delta_i = \delta$ homogeneous, is

$$H_0: \delta = 0, for\ all\ i\ is\ a\ non-stationary\ series$$

$$H_a: \delta < 0\ for\ all\ i\ is\ a\ stationary\ series$$

Integration Test

Integration degree test model (Kusumaningtyas et al., 2022): The integration degree test is needed if the unit root test model has not produced stationary data. To what degree of integration implements the data will be stationary?

$$\Delta(x_{it}) = b_1 + b_2\Gamma + \delta\Delta(x_{i,t-1}) + \sum_{j=1}^{m_i} \alpha_{ij} x_{i,t-j} + e_{it} \quad (4)$$

Based on comparing the t-statistic values from equations (3) and (4) in the Durbin-Watson table. If the value in both equations equals one, then the variable $\Delta(x_{it})$ is said to be stationary at degree one, or denoted I (1).

Cointegration Test

Tests can be carried out using the Johansen cointegration test method to see if there is a causality relationship, and the cointegration vector estimation is based on the maximum likelihood procedure. The cointegration test in the VECM model was carried out to see the long-term relationship between the observation variables with non-stationary data. For the p-cointegration order of the autoregression vector (VAR) model, the error correction model without considering the deterministic component can be expressed in equation (5) (Kleiber & Zeileis, 2008):

$$\Delta y_{i,t} = \Pi y_{i,t-1} + \sum_{j=1}^{p-1} \beta_i \Delta y_{it-j} + \varepsilon_{it} \quad (5)$$

Where Y_t=(GDP, gross fixed capital formation, imports, exports, and government spending), p is the optimal amount of lag, i, t is the estimated parameter, and it is the error. In time series analysis, choosing the optimal lag is the key to success in building a model. The optimal lag can be selected using the Akaike Information Criteria (AIC) method with the smallest AIC value (DelSole & Tippett, 2021). The lag for the United States model is 5 with an AIC of -141.1799, while the lag for the Australian, European Union, People's Republic of China, and South Africa models is 4 with AIC values of -36.4586, 44.47813, -30.56246, and - 32.15593.

Granger Causality Test

Granger causality test aims to explain the causal relationship between variables. The results of a significant causality test can provide information regarding the future evolution of the dependent Y on the independent variable X. In the Granger causality assumption test, it is assumed that the time series data are stationary.

$$\Delta\log(GDP) = \beta_{1i} + \sum_{p}\beta_{11ip}\Delta\log(GFCF)_{it-p} + \sum_{p}\beta_{12ip}\Delta\log(IMP)_{it-p} \\ \sum_{p}\beta_{13ip}\Delta\log(EXP)_{it-p} + \sum_{p}\beta_{14ip}\Delta\log(GS)_{it-p} + \sum_{r}\theta_{ir}ECT_{it-r} + \varepsilon_{1it} \quad (6)$$

$$\Delta\log(GFCF) = \beta_{2i} + \sum_{p}\beta_{21ip}\Delta\log(GDP)_{it-p} + \sum_{p}\beta_{22ip}\Delta\log(IMP)_{it-p} \\ \sum_{p}\beta_{23ip}\Delta\log(EXP)_{it-p} + \sum_{p}\beta_{24ip}\Delta\log(GS)_{it-p} + \sum_{r}\theta_{ir}ECT_{it-r} + \varepsilon_{2it} \quad (7)$$

$$\Delta\log(IMP) = \beta_{3i} + \sum_{p}\beta_{31ip}\Delta\log(GDP)_{it-p} + \sum_{p}\beta_{32ip}\Delta\log(GFCF)_{it-p} \\ \sum_{p}\beta_{33ip}\Delta\log(EXP)_{it-p} + \sum_{p}\beta_{34ip}\Delta\log(GS)_{it-p} + \sum_{r}\theta_{ir}ECT_{it-r} + \varepsilon_{3it} \quad (8)$$

$$\Delta\log(EXP) = \beta_{4i} + \sum_{p}\beta_{41ip}\Delta\log(GDP)_{it-p} + \sum_{p}\beta_{42ip}\Delta\log(GFCF)_{it-p} \\ \sum_{p}\beta_{43ip}\Delta\log(IMP)_{it-p} + \sum_{p}\beta_{44ip}\Delta\log(GS)_{it-p} + \sum_{r}\theta_{ir}ECT_{it-r} + \varepsilon_{4it} \quad (9)$$

$$\Delta\log(GS) = \beta_{5i} + \sum_{p}\beta_{51ip}\Delta\log(GDP)_{it-p} + \sum_{p}\beta_{52ip}\Delta\log(GFCF)_{it-p} \\ \sum_{p}\beta_{53ip}\Delta\log(EXP)_{it-p} + \sum_{p}\beta_{54ip}\Delta\log(IMP)_{it-p} + \sum_{r}\theta_{ir}ECT_{it-r} + \varepsilon_{5it} \quad (10)$$

In the long term, Gross Fixed Capital Formation tends to have a significant relationship, For example, in Australia (ECT3) and South Africa (ECT3 and ECT4). However, the relationship between GDP and Gross fixed capital spending can be insignificant in the long term and is different from the theory. Such differences, such as in the United States (Ireland & Schuh, 2008), are caused by changes in investment preferences, such as investment in technology that is not accounted for in Gross Fixed Capital Spending and some of the most significant contributors to China's rapid economic growth, namely investment in innovation. In contrast, capital construction and fixed investment innovations do not significantly contribute to China's economic growth (Ding & Knight, 2010).

Government spending of the European Union tends to cause the European Union's GDP to return to the long-term balance point shown in the significant ECT1, ECT2, and ECT3 values with t-statistic values. This is in line with Keynesian theory. However, the government spending variables of the United States, Australia, China, and South Africa do not.

Finding and Discussion

Model development begins with examining the stationarity of the time series variables as a condition for entering the cointegration and causality testing stages. Unit root test testing is applied to see data stationarity. The results of the unit root test for each variable are attached in Table 2. The results of interpreting the data for each variable for five countries cannot reject the null hypothesis of non-stationarity. This shows that with 95% confidence, the data for each variable for five countries are not stationary. We have obtained stationary data by testing the degree of integration and data transformation for each variable.

Table 2: ADF unit root test for stationarity

Country		GDP	GFCF	IMP	EXP	GS
United State	p-value levels	0.9864	0.933	0.4868	0.5656	0.7748
	p-value log-third difference	0.01***	0.01***	0.01***	0.01***	0.01***
Australia	p-value levels	0.5539	0.5526	0.6343	0.5628	0.7511
	p-value log-second difference	0.02434**	0.01***	0.01***	0.01324**	0.03075**
European Union	p-value levels	0.3122	0.1355	0.5275	0.5671	0.2502
	p-value second difference	0.01***	0.01***	0.01***	0.01***	0.01***
People's Republic of China	p-value levels	0.99	0.99	0.9466	0.9518	0.99
	p-value log-third difference	0.01***	0.01***	0.01***	0.01***	0.01***
South Africa	p-value levels	0.433	0.4501	0.8826	0.8983	0.4352
	p-value log-third difference	0.01***	0.01***	0.01***	0.01***	0.01***

Note: GDP: Gross Domestic Product; GFCF: Gross Fixed Capital Formation; IMP: Import; EXP: Export, GS: Government Spending; ** indicates Statistically Significant at 5%; and *** indicates Statistically Significant at 1%.

Furthermore, with stationary data, the Johansen Cointegration test was carried out to obtain the Durbin-Watson cointegrating regression test (CRDW) value (table 3).

The rank cointegration and lag results are used to analyze the Granger causality test by constructing a vector error correction model (VECM) based on maximum likelihood (ML). Based on the Johansen cointegration test, the CRDW values in Table 4 show that it is significant for the United States, Australia, the People's Republic of China, and South Africa at r<=4. At the same time, for the European Union, it is significant at r<=3.

Based on the results of the VECM that has been built, the gross fixed capital formation model of the United States is identified as a granger cause of the GDP of the United States. Statistically, the growth of 1 GFCF unit causes GDP growth of 1.4487 units in the next period. One unit of GFCF also causes GDP growth of 1.1108, 0.5736, and 1.5344 for the next 2, 4, and 5 periods. The results of the short-term Granger causality test using VECM for the five models are presented in Table 4.

In the long term, gross fixed gapital formation tends to have a significant relationship, For example, in Australia (ECT3) and South Africa (ECT3 and ECT4). However, the relationship between GDP and gross fixed capital spending can be insignificant in the long term and is different from the theory. Such differences, such as in the United States (Ireland & Schuh, 2008), are caused by changes in investment preferences, such as investment in technology that is not accounted for in gross fixed capital spending and some of the most significant contributors to China's rapid economic growth, namely investment in innovation. In contrast, capital construction and fixed investment innovations do not significantly contribute to China's economic growth (Ding & Knight, 2010).

Government spending of the European Union tends to cause the European Union's GDP to return to the long-term balance point shown in the significant ECT1, ECT2, and ECT3 values with t-statistic values. This is in line with Keynesian theory. However, the government spending variables of the United States, Australia, China, and South Africa do not significantly affect GDP in the long term. Several things, such as the low effectiveness of public spending, dependence on the private sector, inconsistent economic policies, and the inflation rate, can cause this.

Table 3: Johansen Cointegration Test

Country	Cointegrating Rank	Trace Test	
		test	5%
United State	r=0	187.92**	76.07
	r<=1	113.49**	53.12
	r<=2	61.43**	34.91
	r<=3	36.19**	19.96
	r<=4	13.60**	9.24
Australia	r=0	147.85**	76.07
	r<=1	96.23**	53.12
	r<=2	48.78**	34.91
	r<=3	26.59**	19.96
	r<=4	12.07**	9.24
European Union	r=0	149.50**	76.07
	r<=1	81.50**	53.12
	r<=2	48.89**	34.91
	r<=3	22.78**	19.96
	r<=4	4.05	9.24
People’s Republic of China	r=0	217.68**	76.07
	r<=1	108.21**	53.12
	r<=2	64.77**	34.91
	r<=3	30.77**	19.96
	r<=4	14.24**	9.24
South Africa	r=0	209.20**	76.07
	r<=1	140.69**	53.12
	r<=2	86.03**	34.91
	r<=3	45.88**	19.96
	r<=4	20.37**	9.24

Note: ** indicates Statistically Significant at 5%.

We find that US government spending has a negative impact on economic growth. This statement contradicts other research articles, which state that there is a stable positive relationship between government spending and economic growth through causality test techniques (Kamasa & Asante, 2015). However, other studies also found a negative effect of government spending on economic growth during the COVID-19 pandemic. It can be noted that repeated periods of crisis can thwart the developing economy from a sustainable path so a prolonged economic downturn will hamper economic growth (Pratibha & Krishna, 2022). Government spending that has adverse consequences and the federal budget to finance activities that have the potential to produce negative effects will weigh on economic conditions. Australia’s deficit spending also negatively impacts GDP long-term (Gemmell et al., 2015). The same thing also happened to China and South Africa.

Exports from the US, China, and South Africa tend to cause GDP to return to the long-term equilibrium point shown in the ECT values presented in Table 4. Meanwhile, exports to Australia and the European Union do not cause GDP to return to the long-term equilibrium point. The GDP of Australia, China, and the European Union is very dependent on export commodities, so this explains that there is a positive relationship between exports and GDP. However, trade openness significantly negatively affects GDP due to several factors, such as the depreciation of the exchange rate, large volumes of imported materials, and a negative trade balance position. In recent years, the influence of the COVID-19 pandemic has also hampered exports as a whole, causing a significant economic downturn (Mamun & Kabir, 2023). Therefore, China's exports tend to cause GDP to return to a long-term equilibrium point. Imports in the long term tend to help GDP return to a balance point in Australia (ECT3), China (ECT4), and South Africa (ECT 3 and ECT 4), but on the contrary, in the European Union and the United States, imports in the long term do not tend to help correct GDP back to the equilibrium point. Economic growth and imports may not affect GDP in the long term. This can be caused by differences in trade policies, such as in the case of the United States, which adheres to a relatively open trade policy so that imports have a minimal impact on GDP in the long term (Guan & Hong, 2012).

Conclusion

This study investigates the relationship between Gross Domestic Product (GDP), Gross Fixed Capital Formation (GFCF), Import (IMP), Export (EXP), and Government Spending (GS) empirically in the context of representative G20 member countries from five continents by analyzing series data time for the period 1981-2021. Based on the results of our research, it was found that in the United States, GDP in the long term has a significant relationship to historical data GDP and Export in the past as well as in the short-term relationship GDP is influenced by historical data such as import, GFCF, GS, and GDP.

Our findings identify government spending directly affecting growth in GDP, GFCF, and imports for the Australian model. Increases in imports, exports, and government spending in previous periods directly affected China's GDP growth. In addition, GDP growth and government spending in the last period directly impacted the growth of China's government spending. Growth in GDP, imports, exports, and government spending in the previous period was identified as having a direct effect on China's export and import growth.

Our findings identify that exports and imports directly affect GDP growth in South Africa. Growth in GDP, GFCF, exports, and imports in the previous period was identified as directly influencing the growth of exports and imports. In addition, our findings also identify that export growth in the last period directly affected the growth of South Africa's government spending. The research results also show that exports and imports do not directly affect the European Union's GFCF. Import growth in the previous period was also identified as not directly affecting the European Union's import growth. The results show differences in the causal variables, which are statistically significant to the response variables, namely GDP in each country, which differences in government policies can cause.

The research modeling was conducted without separating data on force majeure events, namely before and after COVID-19. This was due to the limited availability of data after COVID-19. Therefore, future research could use more data and separate the modeling by force majeure events. This would allow for the observation of changes in GDP that occur due to force majeure. Additionally, future research is expected to increase the population variable. This is important because social welfare can be measured by comparing GDP and population (Bonokeling, et al., 2022). Through improvements in social welfare that can be identified by higher increases in GDP compared to increases in population, the variable of improvements in social welfare becomes an important variable to observe.

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Country	Dependent Variable	Independent Variable							
		ECT_1	ECT_2	ECT_3	ECT_4	$\Delta_3 \log(GDP)_{t-1}$	$\Delta_3 \log(GDP)_{t-2}$	$\Delta_3 \log(GDP)_{t-3}$	$\Delta_3 \log(GDP)_{t-4}$
United State	$\Delta 3 \log(GDP)$	5.4718 (0.7301)*	1.4665 (0.1769)*	-0.2642 (0.2102)	0.3048 (0.0448)*	-10.9227 (0.8032)**	-10.6422 (0.7164)**	-8.3429 (0.5773)**	-5.9138 (0.4466)**
	$\Delta 3 \log(GFCF)$	16.6167 (6.3285)	-3.4950 (1.5335)	-3.7424 (1.8219)	-0.6685 (0.3881)	-20.6160 (6.9613).	-19.9765 (6.2090).	-15.7831 (5.0036).	-11.6756 (3.8710).
	$\Delta_3 \log(GS)$	5.2708 (4.2484)	1.0412 (1.0295)	0.1795 (1.2231)	0.7902 (0.2606).	-5.6871 (4.6733)	-3.3313 (4.1682)	-0.8947 (3.3590)	0.2297 (2.5986)
	$\Delta_3 \log(EXP)$	21.4484 (4.5895)*	7.5356 (1.1122)*	2.8771 (1.3213)	0.4869 (0.2815)	-33.2029 (5.0485)*	-28.0746 (4.5029)*	-18.7471 (3.6287)*	-15.6519 (2.8073)*
	$\Delta_3 \log(IMP)$	50.7044 (18.0033)	-1.6941 (4.3626)	-4.1886 (5.183)	0.7547 (1.1042)	-60.6372 (19.8036).	-51.5896 (17.6634).	-36.5933 (14.2343)	-26.8993 (11.0121)
		$\Delta_3 \log(GDP)_{t-5}$	$\Delta_3 \log(GFCF)_{t-1}$	$\Delta_3 \log(GFCF)_{t-2}$	$\Delta_3 \log(GFCF)_{t-3}$	$\Delta_3 \log(GFCF)_{t-4}$	$\Delta_3 \log(GFCF)_{t-5}$	$\Delta_3 \log(GS)_{t-1}$	$\Delta_3 \log(GFCF)_{t-2}$
	$\Delta 3 \log(GDP)$	-4.9122 (0.2569)**	1.4487 (0.2009)*	1.1108 (0.1569)*	-0.3593 (0.1100).	0.5736 (0.0986)*	1.5344 (0.0952)**	2.2342 (0.2083)**	2.7575 (0.2007)**
	$\Delta 3 \log(GFCF)$	-8.1854 (2.2264).	5.0843 (1.7415)	5.0151 (1.3602).	2.6514 (0.9531)	2.9986 (0.8546).	3.3004 (0.8253).	4.9928 (1.8051)	6.3908 (1.7399).
	$\Delta_3 \log(GS)$	-0.3850 (1.4946)	0.4144 (1.1691)	-0.2492 (0.9131)	-0.9784 (0.6399)	-0.7983 (0.5737)	-0.2684 (0.5541)	-0.4168 (1.2118)	-0.8892 (1.1680)
	$\Delta_3 \log(EXP)$	-16.2193 (1.6146)**	1.4647 (1.2630)	-2.3350 (0.9864)	-7.1802 (0.6912)**	-0.8333 (0.6198)	5.9299 (0.5986)*	2.0509 (1.3091)	2.1959 (1.2618)
	$\Delta_3 \log(IMP)$	-21.2464 (6.3336).	10.5862 (4.9542)	6.9230 (3.8694)	-0.0286 (2.7115)	3.3143 (2.4313)	7.6215 (2.3480).	8.5441 (5.1351)	9.1923 (4.9497)

Country	Dependent Variable	Independent Variable							
		$\Delta_3 \log(GS)_{t-3}$	$\Delta_3 \log(GS)_{t-4}$	$\Delta_3 \log(GS)_{t-5}$	$\Delta_3 \log(EXP)_{t-1}$	$\Delta_3 \log(EXP)_{t-2}$	$\Delta_3 \log(EXP)_{t-3}$	$\Delta_3 \log(EXP)_{t-4}$	$\Delta_3 \log(EXP)_{t-5}$
	$\Delta 3 \log(GDP)$	1.6549	0.7527	-0.8379	-0.2230	0.0478	-0.2720	0.8903	0.3193
		(0.1451)**	(0.0948)*	(0.0609)**	(0.0471)*	(0.0474)	(0.0557)*	(0.0699)**	(0.0476)*
	$\Delta 3 \log(GFCF)$	4.2842	2.0009	0.2872	0.9525	1.1356	0.8001	1.9163	1.0308
		(1.2577).	(0.8219)	(0.5280)	(0.4080)	(0.4111)	(0.4826)	(0.6056).	(0.4130)
	$\Delta_3 \log(GS)$	-1.2642	-0.5335	-1.1827	-0.5255	-0.3647	-0.7798	-0.3906	-0.4557
		(0.8443)	(0.5518)	(0.3544)	(0.2739)	(0.2760)	(0.3240)	(0.4066)	(0.2772)
	$\Delta_3 \log(EXP)$	0.4160	-3.3667	-6.6192	-1.6018	-1.4483	-1.8203	3.1702	1.6040
		(0.9121)	(0.5961)*	(0.3829)**	(0.2959)*	(0.2982)*	(0.3500)*	(0.4392)*	(0.2995)*
	$\Delta_3 \log(IMP)$	5.7508	-0.321	-4.5374	-0.2078	-0.0216	-1.1002	3.3971	1.8006
		(3.5779)	6(2.3382)	(1.5020).	(1.1606)	(1.1696)	(1.3729)	(1.7229)	(1.1748)
United State		$\Delta_3 \log(IMP)_{t-1}$	$\Delta_3 \log(IMP)_{t-2}$	$\Delta_3 \log(IMP)_{t-3}$	$\Delta_3 \log(IMP)_{t-4}$	$\Delta_3 \log(IMP)_{t-5}$	Intercept		
	$\Delta 3 \log(GDP)$	4.1057	3.6181	3.5300	1.4875	0.5300	0.0051		
		(0.1857)**	(0.1773)**	(0.1477)**	(0.0601)**	(0.0289)**	(0.0005)*		
	$\Delta 3 \log(GFCF)$	5.6001	4.5168	3.8831	1.2911	-0.0035	0.0064		
		(1.6091).	(1.5369).	(1.2798).	(0.5207)	(0.2507)	(0.0045)		
	$\Delta_3 \log(GS)$	1.2039	0.8657	1.0856	0.6924	0.6096	0.0037		
		(1.0802)	(1.0317)	(0.8591)	(0.3495)	(0.1683).	(0.0030)		
	$\Delta_3 \log(EXP)$	18.2719	17.4470	16.0818	7.1954	1.7834	18.2719		
		(1.1670)**	(1.1146)**	(0.9281)**	(0.3776)**	(0.1818)*	(1.1670)**		
	$\Delta_3 \log(IMP)$	17.9033	15.9090	14.7556	6.5328	1.4659	17.9033		
		(4.5777).	(4.3721).	(3.6408).	(1.4812)*	(0.7132)	(4.5777).		

Country	Dependent Variable	Independent Variable							
		ECT_1	ECT_2	ECT_3	ECT_4	$\Delta_2 \log(GDP)_{t-1}$	$\Delta_2 \log(GDP)_{t-2}$	$\Delta_2 \log(GDP)_{t-3}$	$\Delta_2 \log(GDP)_{t-4}$
Australia	$\Delta 3 \log(GDP)$	-7.7620	1.4144	12.5273	-1.1560	5.3697	5.7779	6.5651	2.8887
		(7.0886)	(2.5546)	(5.5138)*	(3.2035)	(6.4122)	(5.3765)	(4.0290)	(2.1970)
	$\Delta 3 \log(GFCF)$	-10.6514	1.1200	15.8204	-0.9317	8.7239	8.2728	7.3347	2.2311
		(6.5531)	(2.3616)	(5.0973)*	(2.9615)	(5.9279)	(4.9704)	(3.7247).	(2.0311)
	$\Delta_3 \log(GS)$	-2.3632	1.1511	7.3713	-0.1955	1.1601	2.5579	4.4442	1.9531
		(6.7186)	(2.4212)	(5.2260)	(3.0363)	(6.0775)	(5.0959)	(3.8187)	(2.0824)
	$\Delta_3 \log(EXP)$	-7.5480	-0.4423	12.9853	-6.0607	6.0392	6.570	5.3777	1.9480
		(7.9109)	(2.8509)	(6.1535).	(3.5752)	(7.1561)	6(6.0003)	(4.4964)	(2.4519)
	$\Delta_3 \log(IMP)$	-3.7571	1.3976	10.2272	-2.2817	2.3053	3.4575	3.7041	1.0862
		(5.3717)	(1.9359)	(4.1784)*	(2.4276)	(4.8592)	(4.0743)	(3.0532)	(1.6649)
		$\Delta_2 \log(GFCF)_{t-1}$	$\Delta_2 \log(GFCF)_{t-2}$	$\Delta_2 \log(GFCF)_{t-3}$	$\Delta_2 \log(GFCF)_{t-4}$	$\Delta_2 \log(GS)_{t-1}$	$\Delta_2 \log(GS)_{t-2}$	$\Delta_2 \log(GS)_{t-3}$	$\Delta_2 \log(GS)_{t-4}$
	$\Delta 3 \log(GDP)$	-0.0828	1.2506	-0.4979	-0.3440	-9.7810	-9.2452	-7.7018	-3.2231
		(2.4919)	(2.2413)	(1.7685)	(1.0154)	(4.9862).	(3.7727)*	(2.9453)*	(1.7907)
	$\Delta 3 \log(GFCF)$	-1.0442	0.6330	-0.3702	0.0856	-12.0887	-10.9393	-8.1910	-2.6242
		(2.3037)	(2.0720)	(1.6350)	(0.9387)	(4.6096)*	(3.4877)*	(2.7228)*	(1.6554)
	$\Delta_3 \log(GS)$	0.2523	1.5554	-0.0937	-0.1299	-6.1275	-6.6914	-6.2503	-2.6089
		(2.3618)	(2.1243)	(1.6762)	(0.9624)	(4.7259)	(3.5758).	(2.7915).	(1.6972)
	$\Delta_3 \log(EXP)$	1.0876	1.2766	-0.5453	-0.6684	-9.3900	-8.4866	-5.9148	-1.7129
		(2.7810)	(2.5013)	(1.9737)	(1.1332)	(5.5647)	(4.2103).	(3.2869)	(1.9984)
	$\Delta_3 \log(IMP)$	0.3782	1.6919	0.2399	0.0624	-7.3862	-7.6536	-5.7344	-1.5478
		(1.8884)	(1.6984)	(1.3402)	(0.7695)	(3.7786).	(2.8589)*	(2.2319)*	(1.3570)

Country	Dependent Variable	Independent Variable							
		$\Delta_2 \log(EXP)_{t-1}$	$\Delta_2 \log(EXP)_{t-2}$	$\Delta_2 \log(EXP)_{t-3}$	$\Delta_2 \log(EXP)_{t-4}$	$\Delta_2 \log(IMP)_{t-1}$	$\Delta_2 \log(IMP)_{t-2}$	$\Delta_2 \log(IMP)_{t-3}$	$\Delta_2 \log(IMP)_{t-4}$
	$\Delta 3 \log(GDP)$	1.7953	1.7804	0.7978	0.1909	1.9565	-0.2674	0.1843	-0.1519
		(2.8946)	(2.1572)	(1.3610)	(0.6807)	(5.5537)	(4.1519)	(2.6194)	(1.1607)
	$\Delta 3 \log(GFCF)$	1.6980	2.0384	1.2673	0.7879	2.4562	-0.2552	-0.4453	-0.8344
		(2.6759)	(1.9943)	(1.2582)	(0.6293)	(5.1342)	(3.8382)	(2.4216)	(1.0730)
	$\Delta_3 \log(GS)$	1.1094	1.3037	0.6385	0.0927	3.0725	0.6474	0.6285	0.0083
		(2.7435)	(2.0446)	(1.2900)	(0.6452)	(5.2638)	(3.9352)	(2.4827)	(1.1001)
	$\Delta_3 \log(EXP)$	4.5057	3.0468	1.5071	0.3018	-3.5204	-3.2827	-0.9543	-0.3435
		(3.2304)	(2.4075)	(1.5189)	(0.7597)	(6.1979)	(4.6335)	(2.9233)	(1.2953)
	$\Delta_3 \log(IMP)$	3.1502	2.8748	1.6172	0.5049	0.7841	-1.1886	-0.6884	-0.7913
		(2.1935)	(1.6347)	(1.0314)	(0.5159)	(4.2086)	(3.1463)	(1.9850)	(0.8796)
Australia									
		Intercept							
	$\Delta 3 \log(GDP)$	0.0304							
		(0.0239)							
	$\Delta 3 \log(GFCF)$	0.0385							
		(0.0221)							
	$\Delta_3 \log(GS)$	0.0264							
		(0.0227)							
	$\Delta_3 \log(EXP)$	0.0223							
		(0.0267)							
	$\Delta_3 \log(IMP)$	0.0261							
		(0.0181)							

Country	Dependent Variable	Independent Variable							
		ECT_1	ECT_2	ECT_3	ECT_4	$\Delta_3 \log(GDP)_{t-1}$	$\Delta_3 \log(GDP)_{t-2}$	$\Delta_3 \log(GDP)_{t-3}$	$\Delta_3 \log(GDP)_{t-4}$
People's of Republic China	$\Delta 3 \log(GDP)$	-3.2697	2.7905	1.2750	-2.1713	1.2626	0.7000	-0.4057	-0.2085
		(1.6328)	(1.0956)*	(1.1365)	(1.0769)	(1.3649)	(1.1721)	(0.7541)	(0.5167)
	$\Delta 3 \log(GFCF)$	1.1411	-0.8578	2.5885	-3.2177	-1.6789	-1.7764	-1.0837	-1.2565
		(3.2095)	(2.1536)	(2.2339)	(2.1167)	(2.6828)	(2.3038)	(1.4822)	(1.0157)
	$\Delta_3 \log(GS)$	2.4089	1.1873	1.1705	-1.5060	-2.0167	-1.7726	-1.9521	-1.0941
		(1.6987)	(1.1398)	(1.1823)	(1.1203)	(1.4199)	(1.2194)	(0.7845)*	(0.5376)
	$\Delta_3 \log(EXP)$	0.8007	0.6639	5.9950	-11.6048	-3.0941	-2.0097	-5.2220	-0.0923
		(3.4392)	(2.3077)	(2.3937)*	(2.2682)***	(2.8748)	(2.4687)	(1.5883)*	(1.0883)
	$\Delta_3 \log(IMP)$	-1.0095	2.8064	2.4431	-9.4479	-1.5754	-2.3279	-4.2834	-0.4200
		(3.6884)	(2.4749)	(2.5672)	(2.4326)**	(3.0831)	(2.6476)	(1.7034)*	(1.1672)
		$\Delta_3 \log(GFCF)_{t-1}$	$\Delta_3 \log(GFCF)_{t-2}$	$\Delta_3 \log(GFCF)_{t-3}$	$\Delta_3 \log(GFCF)_{t-4}$	$\Delta_3 \log(GS)_{t-1}$	$\Delta_3 \log(GFCF)_{t-2}$	$\Delta_3 \log(GS)_{t-3}$	$\Delta_3 \log(GS)_{t-4}$
	$\Delta 3 \log(GDP)$	-1.8279	-1.3910	-1.1612	-0.3880	0.7617	1.2341	1.7522	0.7936
		(0.9610)	(0.7262)	(0.5129)	(0.4020)	(1.1908)	(0.9044)	(0.6409)*	(0.5074)
	$\Delta 3 \log(GFCF)$	0.1786	-0.0786	-0.4496	-0.6019	0.7616	1.0294	1.5312	1.3798
		(1.8889)	(1.4274)	(1.0082)	(0.7901)	(2.3405)	(1.7777)	(1.2597)	(0.9974)
	$\Delta_3 \log(GS)$	-0.7570	-0.6571	-0.9451	-0.5292	2.6567	2.4639	2.3091	0.9829
		(0.9997)	(0.7555)	(0.5336)	(0.4182)	(1.2388)	(0.9409)*	(0.6667)**	(0.5279)
	$\Delta_3 \log(EXP)$	0.8650	1.2870	0.7746	1.6100	2.1541	3.2166	4.8664	0.7113
		(2.0240)	(1.5295)	(1.0803)	(0.8467)	(2.5081)	(1.9050)	(1.3499)**	(1.0688)
	$\Delta_3 \log(IMP)$	-0.3354	0.4832	0.5973	1.1538	1.0763	2.6746	4.0881	1.1758
		(2.1707)	(1.6403)	(1.1586)	(0.9080)	(2.6898)	(2.0430)	(1.4477)*	(1.1462)

Country	Dependent Variable	Independent Variable							
		$\Delta_3 \log(EXP)_{t-1}$	$\Delta_3 \log(EXP)_{t-2}$	$\Delta_3 \log(EXP)_{t-3}$	$\Delta_3 \log(EXP)_{t-4}$	$\Delta_3 \log(IMP)_{t-1}$	$\Delta_3 \log(IMP)_{t-2}$	$\Delta_3 \log(IMP)_{t-3}$	$\Delta_3 \log(IMP)_{t-4}$
	$\Delta 3 \log(GDP)$	2.1775	1.4284	0.6686	0.3341	-1.5820	-1.4612	-0.9439	-0.5272
		(0.9077)*	(0.6281)	(0.4292)	(0.2241)	(0.9571)	(0.6673)	(0.3796)*	(0.1882)*
	$\Delta 3 \log(GFCF)$	2.8801	2.1028	0.8451	0.2656	-2.3704	-1.9607	-1.1173	-0.4644
		(1.7842)	(1.2346)	(0.8436)	(0.4404)	(1.8813)	(1.3117)	(0.7462)	(0.3700)
	$\Delta_3 \log(GS)$	1.3784	0.7343	0.1032	0.0146	-1.1531	-0.9182	-0.3925	-0.0715
		(0.9443)	(0.6534)	(0.4465)	(0.2331)	(0.9957)	(0.6942)	(0.3949)	(0.1958)
	$\Delta_3 \log(EXP)$	10.2584	7.0500	4.4098	2.2492	-7.1298	-6.0015	-3.8325	-2.2591
		(1.9119)***	(1.3229)***	(0.9040)**	(0.4719)**	(2.0159)**	(1.4055)**	(0.7996)**	(0.3964)***
	$\Delta_3 \log(IMP)$	9.5937	7.1696	4.6287	2.1838	-5.3247	-5.0349	-3.5175	-2.0782
		(2.0504)**	(1.4188)***	(0.9695)**	(0.5061)**	(2.1620)*	(1.5074)*	(0.8575)**	(0.4252)**
People's of Republic China									
		Intercept							
	$\Delta 3 \log(GDP)$	-0.0015							
		(0.0077)							
	$\Delta 3 \log(GFCF)$	-0.0010							
		(0.0152)							
	$\Delta_3 \log(GS)$	-0.0025							
		(0.0080)							
	$\Delta_3 \log(EXP)$	-0.0057							
		(0.0163)							
	$\Delta_3 \log(IMP)$	-0.0044							
		(0.0175)							

Country	Dependent Variable	Independent Variable							
		ECT_1	ECT_2	ECT_3	ECT_4	$\Delta_3 \log(GDP)_{t-1}$	$\Delta_3 \log(GDP)_{t-2}$	$\Delta_3 \log(GDP)_{t-3}$	$\Delta_3 \log(GDP)_{t-4}$
	$\Delta 3 \log(GDP)$	-12.5949	2.2180	2.5035	-13.0120	7.5690	1.9710	-0.8496	-0.8978
		(11.3137)	(3.4185)	(2.1903)	(4.6772)*	(9.1945)	(6.3932)	(3.4116)	(1.2126)
	$\Delta 3 \log(GFCF)$	2.0035	-3.5261	7.5526	-20.0682	-2.9027	-5.3193	-3.5828	-0.9486
		(13.8772)	(4.1931)	(2.6865)*	(5.7369)**	(11.2778)	(7.8417)	(4.1846)	(1.4873)
	$\Delta_3 \log(GS)$	-12.2582	2.8495	0.4645	-7.8582	8.5778	3.3462	0.0363	-0.8110
		(11.0181)	(3.3292)	(2.1330)	(4.5549)	(8.9542)	(6.2261)	(3.3224)	(1.1809)
	$\Delta_3 \log(EXP)$	11.2942	-1.3788	4.9084	-21.1563	-10.5622	-9.3878	-5.7196	-1.8545
		(7.3110)	(2.2091)	(1.4154)**	(3.0224)***	(5.9415)	(4.1313)	(2.2046)*	(0.7836)*
	$\Delta_3 \log(IMP)$	20.5239	-2.0552	5.1785	-25.4046	-18.5424	-15.8985	-8.9506	-2.3840
		(10.0961)	(3.0506)	(1.9546)*	(4.1738)***	(8.2050)	(5.7051)*	(3.0444)*	(1.0821)
South Afrika									
		$\Delta_3 \log(GFCF)_{t-1}$	$\Delta_3 \log(GFCF)_{t-2}$	$\Delta_3 \log(GFCF)_{t-3}$	$\Delta_3 \log(GFCF)_{t-4}$	$\Delta_3 \log(GS)_{t-1}$	$\Delta_3 \log(GFCF)_{t-2}$	$\Delta_3 \log(GS)_{t-3}$	$\Delta_3 \log(GS)_{t-4}$
	$\Delta 3 \log(GDP)$	-2.2105	-0.2568	0.5418	0.7603	-7.4858	-4.4378	-1.6687	-0.4800
		(2.7857)	(2.0466)	(1.2130)	(0.4795)	(6.9363)	(5.1007)	(2.7978)	(0.9562)
	$\Delta 3 \log(GFCF)$	1.4858	2.6531	2.3066	1.2839	-2.3696	-0.8810	-1.0097	-0.9834
		(3.4169)	(2.5103)	(1.4878)	(0.5881)	(8.5079)	(6.2564)	(3.4317)	(1.1728)
	$\Delta_3 \log(GS)$	-2.7842	-0.9524	-0.1604	0.4228	-6.4213	-4.0850	-1.3064	-0.1247
		(2.7129)	(1.9931)	(1.1813)	(0.4669)	(6.7550)	(4.9674)	(2.7247)	(0.9312)
	$\Delta_3 \log(EXP)$	1.1208	1.8356	1.5257	0.8599	3.6586	3.1151	1.6355	0.1834
		(1.8001)	(1.3225)	(0.7838)	(0.3098)*	(4.4823)	(3.2961)	(1.8079)	(0.6179)
	$\Delta_3 \log(IMP)$	1.7211	2.7570	2.1354	1.0603	9.3099	7.6530	3.8056	0.5207
		(2.4859)	(1.8263)	(1.0824)	(0.4279)*	(6.1898)	(4.5518)	(2.4967)	(0.8533)

Country	Dependent Variable	Independent Variable							
		$\Delta_3 \log(EXP)_{t-1}$	$\Delta_3 \log(EXP)_{t-2}$	$\Delta_3 \log(EXP)_{t-3}$	$\Delta_3 \log(EXP)_{t-4}$	$\Delta_3 \log(IMP)_{t-1}$	$\Delta_3 \log(IMP)_{t-2}$	$\Delta_3 \log(IMP)_{t-3}$	$\Delta_3 \log(IMP)_{t-4}$
	$\Delta 3 \log(GDP)$	14.6683	14.1695	9.8028	3.4492	-3.7387	-4.4379	-3.3886	-1.1141
		(4.6084)*	(4.3636)*	(3.3119)*	(1.1784)*	(1.7938)	(1.5706)*	(1.1710)*	(0.5519)
	$\Delta 3 \log(GFCF)$	20.6187	17.7968	11.1889	3.9398	-8.1539	-7.9636	-5.6307	-2.3605
		(5.6525)**	(5.3523)*	(4.0624)*	(1.4454)*	(2.2003)**	(1.9265)**	(1.4363)**	(0.6770)**
	$\Delta_3 \log(GS)$	10.0260	10.6438	8.1404	3.0079	-1.9014	-2.7777	-2.5008	-0.6434
		(4.4880)	(4.2496)*	(3.2254)*	(1.1476)*	(1.7469)	(1.5296)	(1.1404)	(0.5375)
	$\Delta_3 \log(EXP)$	18.4917	14.5741	8.6571	2.8765	-5.1934	-5.0816	-3.5232	-1.3513
		(2.9780)***	(2.8198)***	(2.1402)**	(0.7615)**	(1.1592)**	(1.0149)**	(0.7567)**	(0.3567)**
	$\Delta_3 \log(IMP)$	24.4059	19.3099	10.9156	3.6453	-7.3048	-7.3191	-5.0751	-2.2769
		(4.1124)***	(3.8940)**	(2.9555)**	(1.0516)**	(1.6008)**	(1.4016)***	(1.0449)**	(0.4925)**
South Afrika									
		Intercept							
	$\Delta 3 \log(GDP)$	-0.0101							
		(0.0248)							
	$\Delta 3 \log(GFCF)$	-0.0128							
		(0.0305)							
	$\Delta_3 \log(GS)$	-0.0090							
		(0.0242)							
	$\Delta_3 \log(EXP)$	-0.0009							
		(0.0160)							
	$\Delta_3 \log(IMP)$	0.0017							
		(0.0222)							

Country	Dependent Variable	Independent Variable							
		ECT_1	ECT_2	ECT_3	$\Delta_2 \log(GDP)_{t-1}$	$\Delta_2 \log(GDP)_{t-2}$	$\Delta_2 \log(GDP)_{t-3}$	$\Delta_2 \log(GDP)_{t-4}$	$\Delta_2 \log(GFCF)_{t-1}$
European Union	$\Delta 3 \log(GDP)$	-46.3757	97.2459	-82.5375	35.1326	32.6989	33.4745	21.7582	-73.9786
		(19.8223)*	(36.5692)*	(28.5801)*	(17.4268)	(17.4599)	(12.6467)*	(6.2822)**	(31.3695)*
	$\Delta 3 \log(GFCF)$	-2.9461	9.3987	-11.4427	0.6663	1.6140	5.0287	4.6266	-5.5393
		(5.7015)	(10.5184)	(8.2205)	(5.0125)	(5.0220)	(3.6376)	(1.8070)*	(9.0228)
	$\Delta_3 \log(GS)$	-13.9084	27.7137	-21.9447	11.9519	10.1249	7.8061	4.2425	-22.8633
		(3.3741)**	(6.2248)**	(4.8649)**	(2.9664)**	(2.9720)**	(2.1527)**	(1.0694)**	(5.3397)**
	$\Delta_3 \log(EXP)$	-0.3878	6.2069	-10.1137	-3.5525	0.0320	8.5401	8.4793	2.2891
		(8.5991)	(15.8640)	(12.3983)	(7.5599)	(7.5742)	(5.4862)	(2.7253)*	(13.6083)
	$\Delta_3 \log(IMP)$	3.2622	1.0997	-8.2234	-6.8396	-2.8120	6.6582	7.6300	6.7593
		(9.0912)	(16.7719)	(13.1078)	(7.9925)	(8.0077)	(5.8002)	(2.8813)*	(14.3871)
		$\Delta_2 \log(GFCF)_{t-2}$	$\Delta_2 \log(GFCF)_{t-3}$	$\Delta_2 \log(GFCF)_{t-4}$	$\Delta_2 \log(GS)_{t-1}$	$\Delta_2 \log(GS)_{t-2}$	$\Delta_2 \log(GS)_{t-3}$	$\Delta_2 \log(GS)_{t-4}$	$\Delta_2 \log(EXP)_{t-1}$
	$\Delta 3 \log(GDP)$	-70.4918	-65.0580	-30.4176	-82.3076	-79.7146	-89.1260	-65.7666	-68.9632
		(30.8742)*	(20.8434)*	(9.1478)**	(46.9161)	(47.6309)	(35.4750)*	(18.9711)**	(26.6581)*
	$\Delta 3 \log(GFCF)$	-7.6079	-12.2959	-6.9848	2.1210	-0.9706	-11.5662	-13.5264	-7.5277
		(8.8803)	(5.9952)	(2.6312)*	(13.4944)	(13.7000)	(10.2036)	(5.4566)*	(7.6677)
	$\Delta_3 \log(GS)$	-19.6593	-14.2379	-5.9775	-30.2019	-26.2834	-21.6483	-12.9070	-19.7307
		(5.2554)**	(3.5479)**	(1.5571)**	(7.9860)**	(8.1077)**	(6.0385)**	(3.2292)**	(4.5377)**
	$\Delta_3 \log(EXP)$	-5.9077	-19.0262	-11.9030	12.3387	3.8523	-20.4410	-25.3248	-3.0334
		(13.3935)	(9.0420)	(3.9684)*	(20.3526)	(20.6626)	(15.3893)	(8.2298)*	(11.5645)
	$\Delta_3 \log(IMP)$	-1.9724	-16.8901	-11.0006	21.4717	11.9581	-14.7077	-22.7721	0.9395
		(14.1600)	(9.5595)	(4.1955)*	(21.5173)	(21.8451)	(16.2700)	(8.7008)*	(12.2263)

Country	Dependent Variable	Independent Variable							
		$\Delta_2 \log(EXP)_{t-2}$	$\Delta_2 \log(EXP)_{t-3}$	$\Delta_2 \log(EXP)_{t-4}$	$\Delta_2 \log(IMP)_{t-1}$	$\Delta_2 \log(IMP)_{t-2}$	$\Delta_2 \log(IMP)_{t-3}$	$\Delta_2 \log(IMP)_{t-4}$	Intercept
European Union	$\Delta 3 \log(GDP)$	-49.6234	-40.8229	-17.5642	65.7598	47.8767	37.5578	13.4419	-150.3286
		(22.8086)	(15.1984)*	(7.1898)*	(25.2839)*	(21.1601)*	(13.1775)*	(6.1324)	(138.7312)
	$\Delta 3 \log(GFCF)$	-5.5653	-7.5373	-3.9924	7.9157	5.9968	7.1806	3.0305	-21.8562
		(6.5604)	(4.3715)	(2.0680)	(7.2724)	(6.0863)	(3.7902)	(1.7639)	(39.9031)
	$\Delta_3 \log(GS)$	-13.7379	-8.8587	-3.2361	18.5067	13.1077	8.3314	2.6724	-36.9257
		(3.8825)**	(2.5871)**	(1.2238)*	(4.3038)**	(3.6019)**	(2.2431)**	(1.0439)*	(23.6147)
	$\Delta_3 \log(EXP)$	-5.6673	-15.2724	-8.8125	3.8805	5.8897	13.5643	6.5571	-10.8176
		(9.8945)	(6.5932)*	(3.1190)*	(10.9684)	(9.1794)	(5.7165)*	(2.6603)*	(60.1827)
	$\Delta_3 \log(IMP)$	-2.7253	-13.6300	-8.0329	0.8915	3.6768	12.4890	6.0630	-3.0669
		(10.4608)	(6.9705)	(3.2975)*	(11.5961)	(9.7048)	(6.0436)	(2.8125)	(63.6268)

Note: The intercept and slope of each parameter are presented without parentheses, while the t-statistic is presented with parentheses. * Rejection of H0 at 10% significance level. ** Rejection of H0 at 5% significance level. *** Rejection of H0 at 1% significance level.