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The Impact of Trade Openness on Sustainable Development: Study Case on G20 Group Countries

Fathya Dhiya Ulhaq[1*], Widyastutik[1], Deniey Adi Purwanto[1]

[1]Department of Economics, Faculty of Economics and Management,
IPB University, Bogor, INDONESIA

*Corresponding Author

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Abstract: The issues concerning environmental damage, poverty, and unequal income distribution have taken center stage in contemporary policies aimed at sustainable development. Amidst various policy measures, trade policies continue to hold a prominent position due to their direct and indirect connections with sustainable development. It is widely believed that trade openness can incentivize both production and consumption. However, the rapid economic integration resulting from trade openness can also have adverse effects on society, employment, and the environment. Therefore, the primary objective of this study is to examine the impact of trade openness and other relevant factors on sustainable development in the G20 countries. This research adopts a quantitative approach, utilizing secondary data. Data analysis is conducted using a Heterogeneous Dynamic Panel econometric method, covering the period from 1990 to 2019. The findings of this study reveal that in the short term, sustainable development in the G20 countries is positively and significantly influenced by capital formation and environmental quality. Conversely, in the long run, sustainable development is positively and significantly affected by trade openness. Consequently, the recommendation stemming from this research for G20 countries is to further develop trade policies that prioritize and support sustainable development goals.

Keywords: G20, heterogenous dynamic panel, sustainable development, trade openness

1. Introduction

Issues related to environmental damage, poverty, and unequal income distribution have become the focus of policies oriented toward sustainable development. Among various policies, trade policies remain a focal point for direct and indirect links with sustainable development. This is because international trade activities have the potential to expand the economic space needed to create new jobs, efficient utilization of resources and human resource skills needed for economic growth and development. Open or free trading activities are believed to influence sustainable development by incentivizing production and creating demand as well as enabling increased capital formation for a country (Fitriani et al. 2021).

Trade policies based on sustainable development have also become the focus of the the Group of 20 (G20) as a forum for international cooperation in the field of trade. In achieving inclusive and sustainable development goals through trade activities, the G20 supports the World Trade Organization (WTO)'s main policies in global governance. This strategy includes support for trade openness, including the elimination of trade barriers, trade facilitation, trade agreements, and promoting inclusive global value chains. G20 members also seek to integrate the concept of sustainable development into trade policies at all levels (WTO, 2016).

However, among the opinions that openness can provide incentives for sustainable development, rapidly advancing economic integration due to open trade can also have negative impacts on society, employment, and the environment (Sheikh et al. 2021; Ridzuan et al. 2018; Gallagher & Werksman 2002). This is because trade openness

*Corresponding author: fathyadhiya@gmail.com

allows for higher welfare costs (Sheikh et al. 2020). The identification and further studies related to the effect of trade openness on sustainable development are urgently needed so that the implemented policies can be effective.

This research analyzes the impact of trade openness on sustainable development by conducting a case study in 19 G20 member countries, namely Argentina, Australia, Brazil, Canada, China, France, Germany, India, Indonesia, Italy, Japan, Mexico, South Korea, Russia, Saudi Arabia, South Africa, Turkey, the UK, the USA, and the European Union. The G20 was chosen in this research because policies based on sustainable development in trade have become a focal point for the G20 as one of the international cooperation forums. This is reflected in one of the G20's goals, which is to ensure inclusive growth, sustainable development, and poverty alleviation through international trade activities. In pursuit of these objectives, the G20 lends support to the key policies of the World Trade Organization (WTO) in global governance. This strategy includes endorsing the removal of trade barriers, facilitating trade, trade agreements, and promoting inclusive global value chains. G20 members also strive to integrate the concept of sustainable development into trade policies at all levels (WTO, 2016). Therefore, the aim of this study is to identify the effect of trade openness and other factors on sustainable development in the G20 countries.

2. Literature Review

2.1 Theoritical Review

i. Open Economies Theory

Most of the world's economies are open economies: they export goods and services to foreign countries, import goods and services from foreign countries, and borrow and lend in the global capital markets. Therefore, international trade is a crucial aspect for analyzing economic development and formulating economic policies.

In an open economy, a country's expenditures in a particular year do not need to be equal to what they generate from producing goods and services. A country can spend more than it produces by borrowing from abroad, or it can spend less than it produces and lend to other countries. Additionally, in an open economy, a portion of the output is sold domestically, while another portion is exported abroad. Thus, we can categorize expenditures on output in an open economy into four components, namely:

$$Y = C + I + G + NX \quad \text{.....2.1}$$

Equation 2.1 illustrates that expenditures on domestic output are the sum of consumption (C), investment (I), government spending (G), and net exports (NX). In relation to the capital flow, we need to rewrite the national income identity equation 2.2 in the form of savings and investment as follows:

$$Y - C - G = I + NX \quad \text{.....2.2}$$

where Y - C - G represents national savings (S), I represent investment, and NX represents net exports. Therefore, from the equation above, we can conclude with the equation 2.3 bellow:

$$S - I = NX \quad \text{.....2.3}$$

Equation 2.3 indicate that a country's net exports must always be equal to the difference between its savings and investments. In terms of the trade balance, if S-I and NX are positive, it means we have a trade surplus. In this case, we are a net lender in the world capital market, exporting more goods and services than we import. If S-I and NX are negative, it means we have a trade deficit. In this case, we are a net borrower in the world capital market, importing more goods and services than we export. Meanwhile, if S-I and NX are both zero, it means we have a balanced trade because the value of imports equals the value of exports (Mankiw 2006).

ii. Trade Openness

Trade openness indicates the extent of a country's exposure to the outside world. Since the advent of Adam Smith's theory of free trade, economists have viewed free trade as an ideal concept. Theoretical models of trade assert that free trade helps avoid efficiency losses often caused by protectionism. Many economists believe that free trade can generate additional benefits that cannot be obtained when there are distortions in production and consumption (commonly known as trade barriers). While not many economists are certain that free trade is a perfect policy, in general, economists still believe that free trade is, in many respects, superior to trade with the implementation of government policies.

However, on the other side of the promising benefits of free trade, there are arguments against free trade known within the theory of the second best. Essentially, this theory suggests that the elimination of government intervention

policies (such as the concept of free trade) may be suitable and necessary for a market, provided that other markets can function properly and without any failures. If these conditions are not met, government intervention may be required to enhance overall societal welfare, even though it may distort economic incentives in a market. This is because, in practice, there are often market failures and imperfections. Therefore, various forms of trade policies that contradict the principles of free trade, such as tariff and import quota policies, are highly recommended if free trade no longer provides significant benefits or if the social losses due to market failures become greater (Krugman and Obstfeld 2004).

In broad terms, there are two different but interconnected concepts for measuring trade openness. These concepts are trade openness based on trade policies and trade openness based on trade outcomes. The measurement of trade openness based on trade policies relies on tariff data and/or trade policies between countries. On the other hand, trade openness based on trade outcomes is based on actual and real trade data (exports and imports). There are two dimensions used to measure trade openness (Ibrahim et al. 2022), that is:

1. Trade Intensity (TI)
   It is a measurement of trade openness through $\frac{export_i + Import_i}{GDP_i}$
2. World Trade Intensity (WTI)
   It is a measurement of trade openness through $\frac{export_i + Import_i}{Total\ of\ world\ trade}$

iii. Sustainable Development

The concept of savings in economics has become a crucial aspect of development and often plays a significant role in driving a country's economy. Savings play a vital role in connecting the past, present, and future economies. The amount of savings available in a country indicates the level of capital available for investment. Greater savings mean that the economy has a substantial pool of funds to capture investment opportunities, which can subsequently boost economic growth.

One approach to measuring sustainable development through savings is Adjusted Net Savings (ANS). The concept of ANS as a measurement of sustainable development was first introduced by the World Bank in 1992. ANS is Gross national savings adjusted for various changes in capital forms within a one-year period (World Bank 2023). Despite some criticisms that ANS is still weak in measuring the conditions of sustainable development, this indicator is considered capable of comprehensively explaining how much savings (investment) an economy has for future generations. Thus, ANS has been widely accepted as a tool for measuring sustainable development (Koirala & Pradhan, 2019).

The basic concept of Net Savings is the difference between total income and total consumption. Concerning sustainable well-being, Net Savings must be free from various depreciations of assets included in the calculation. According to some economists, ANS is considered capable of comprehensively explaining how much savings in the economy can be used for future generations. This is because ANS has unique characteristics, including the inclusion of human capital development (indicated by public spending on education) and the reduction of natural resource depletion along with environmental degradation due to pollution (Thiry & Cassiers, 2010).

The value of ANS indicates the availability of an economy's savings to meet the needs of future generations, meaning that the economy in that country can be considered sustainable. Conversely, if the ANS value shows a negative figure, the economic conditions in that country cannot be considered sustainable. This is because the country has not successfully transformed its natural capital wealth into physical and human capital, which is crucial for raising future per capita income. Their national savings and investments in education are insufficient to accommodate the reduction in physical capital and the depletion of natural resources caused by consumption.

iv. Empirical Review

Previous research has indeed demonstrated that trade openness can have negative impacts on sustainable development. First, Sheikh et al. (2021) found similar facts in their other research that in the long term, realizing trade, capital formation, and energy consumption hurt sustainable development, while economic growth and population growth have a positive effect on sustainable development. Next, the research of Sheikh et al. (2020) found the fact that trade can reduce Green Gross Domestic Product (GGDP) and increase the gap between Gross Domestic Product (GDP) and GGDP in India. This is contrary to previous research and trade theory which states that free trade can maximize productivity in the use of resources around the world, including environmental resources. The findings of Sheikh et al. (2020) study is in line with the opinion of environmentalists that trade discovery is strongly associated with higher welfare costs. Furthermore, Ridzuan et al. (2018) also found the same result that trade openness had negative impacts on sustainable development.

However, this does not rule out the possibility that trade discovery can stimulate sustainable development in the long term. Ogede & Tiamiyu (2022) in their research found the fact that trade has a positive impact on sustainable

development in Nigeria in the long term. Although indeed when the production process increases which is reflected in the increase in the formation of fixed capital, causing trade and *carbon dioxide* (CO2) emissions to hurt sustainable development, this is only seen in the short term. According to Jadaun et al. (2021), although there may be some negative environmental impacts from trade, these can be minimized with appropriate environmental policies. Overall, supposedly free trade reduces vulnerability to global change by not exploiting resources. With the inclusion of trade, sustainable development will be achieved globally because it can prevent migration globally and prevent responses to shortages of natural resources. In addition, the existence of hidden trade also allows for increased technology transfer.

3. Research Methods

3.1. Data

This research was conducted using secondary data with a period spanning 1990-2019 of 20 members of the G20. The selection of that period was based on data availability. We used percentage of adjusted net savings to gross national income (GNI) to measure sustainable development variable, percentage of net export to gross domestic product (GDP) to measure trade openness variable, gross capital formation to measure domestic capital variable, total population to measure population variable, and CO2 emission to measure environmental quality variable. All of data obtained from the World Development Indicator (WDI).

3.2. Data Analysis Method

This research was conducted using an econometric approach through the heterogeneous dynamic panel method introduced by Pesaran et al. (1999). This method is carried out to anticipate problems that often occur in panel data, namely stationarity and heterogeneity problems. This estimation technique considers the characteristics of each short-term and long-term parameters whether they are considered the same for all units, are considered different which are then estimated with the average, or even both. These considerations make this method has three modeling alternatives, namely PLS (Pooled Least Square) when all short-term and long-term parameters are homogeneous for all individual cross sections.

In general, there are three stages of this research analysis. First, the stationarity and cointegration pre-estimation test. The stationarity test conducted in this study utilizes the *multipurt* command in STATA from Eberhardt (2011) which displays the results of the first-generation stationarity test from Maddala & Wu (1999) and the second-generation stationarity test from Pesaran (2007). Meanwhile, cointegration testing in this study was carried out by utilizing the *xtwest* command in STATA. This feature is a cointegration test for panel data based on the Error Correction Model (ECM) from Westerlund (2007).

The second stage in the analysis procedure is model estimation and selection of the best model from the three empirical models considered in this study. The selection of heterogeneous dynamic panel model estimates is based on the Hausman test. The null hypothesis of the Hausman test is the difference in the unsystematic coefficients or in other words the Mean Group model is not the best estimate. After selecting the best estimation of the heterogeneous dynamic panel model, then choosing the best empirical model for further discussion. The selection of the model is based on the AIC (Akaike Information Criterion) and BIC (Bayesian Information Criterion) score criteria. The model with the best AIC and BIC values will be considered as the selected model.

3.3. Model Specification

The modeling specifications in this study refer to the studies of Belloumi & Alshehry (2020), Sheikh et al. (2021), and Ogede & Tiamiyu (2022). The selection of several variables was also carried out to suit the object of research and consideration of data availability. The model specifications in this study are:

$$ANS_{it} = \alpha_0 + \beta_1 LnGCF_{it} + \beta_2 LnPOP_{it} + \beta_3 OPN_{it} + \beta_4 LnENV_{it} + \varepsilon_{it} \quad \text{.....3.1}$$

where ANS symbolizes sustainable development, which is described by Adjusted Net Savings. GCF represents Gross Capital Formation or gross capital formation in country i in year t. GCF is an important component as an important factor determining growth. GCF covers the procurement, manufacture and purchase of new capital goods from within the country and abroad. GCF is very important for the economy because it can help stimulate economic growth, increase national income, create jobs, and improve a country's standard of living (World Bank 2023). Thus, the GCF is expected to have a positive impact on development. The variable of population (POP) represents the number of inhabitants. An increase in population, whether due to immigration or more births than deaths, can impact natural resources and social infrastructure. This can put pressure on the sustainability of a country. On the other hand, a reduced population can impact the government's commitment to maintaining services and infrastructure (World Bank 2023). Then, trade openness symbolized by the variable of trade openness (OPN) is believed to influence sustainable development by giving incentives to production and creating demand. On the other hand, trade allows for increased

technological progress, which in turn helps reduce negative effects. In analyzing the relationship between trade openness and sustainable development also needs to include environmental aspects that can have an impact on the sustainability of a country's development (Shirazi et al. 2020). Therefore, the variable of environmental quality (ENV) variable is taken into account in the modeling.

It is assumed that the long-term equation from equation 3.1 is as follows:

$$ANS_{it} = \theta_{0t} + \theta_{1t}GCF_{it} + \theta_{2t}POP_{it} + \theta_{3t}OPN_{it} + \theta_{4t}ENV_{it} + \mu_i + \varepsilon_{it} \quad \text{.....3.2}$$

where i = 1, 2, ..., n denotes the number of countries studied; t = 1, 2, ..., n denotes the time period; and shows the parameter coefficients. GCF, POP, and OPN variables in natural logarithmic form. If the variable is I (1) and cointegrated, then the error term I (0) for all i. The specifications for the ARDL (1,1,1) dynamic panel are:

$$ANS_{it} = \delta_{10i}GCF_{it} + \delta_{11i}GCF_{it-1} + \delta_{20i}POP_{it} + \delta_{21i}POP_{it-1} + \theta_{3t}OPN_{it} + \theta_{4t}ENV_{it} + \lambda_i ANS_{it-1} + \mu_i + \varepsilon_{it} \quad \text{.....3.3}$$

and reparameterization of the error correction equation, namely:

$$\Delta ANS_{it} = \phi_i(ANS_{it-1} - \theta_{0i} - \theta_{1i}GCF_{it} - \theta_{2i}POP_{it} - \theta_{3i}POP_{it} - \theta_{4i}ENV_{it}) + \delta_{11i}\Delta GCF_{it} + \delta_{21i}\Delta POP_{it} + \delta_{31i}\Delta OPN_{it} + \delta_{41i}\Delta ENV_{it} + \varepsilon_{it} \quad \text{.....3.4}$$

Where $\phi_i = -(1-\lambda_i)\theta_{0i} = \frac{\mu_i}{1-\lambda_i}\ \theta_{1i} = \frac{\delta_{10i}+\delta_{11i}}{1-\lambda_i}\ \theta_{2i} = \frac{\delta_{20i}+\delta_{21i}}{1-\lambda_i}\ \theta_{3i} = \frac{\delta_{30i}+\delta_{31i}}{1-\lambda_i}\ \theta_{4i} = \frac{\delta_{40i}+\delta_{41i}}{1-\lambda_i}$

With including θ_{0i}, estimation of the mean positive or negative cointegration relationship becomes possible. The value of ϕ_i is expected to be negative if the variable shows a return to long-run equilibrium. In heterogenous dynamic panel context, the Pooled Least Square (PLS) allows pooled short-term parameter (δ) and long-term parameter (θ), the Mean Group (MG) model allows heterogenous short-term parameter (δ) and long-term parameter (θ), and the Pooled Mean Group (PMG) model allows heterogenous short-term parameter (δ) while pooled long-term parameter (θ).

4. Result and Discussion

The first stage is to do pre-estimation testing. The first pre-estimation test is to test stationarity to see whether there is a unit root in the variable or not. Stationarity testing was carried out by combining the Fisher test approach (Maddala & Wu, 1999) and the CIPS test − i.e. Pesaran Panel Unit Root test) − approach (Pesaran, 2007). Table 1 shows the results of the stationarity test. We can conclude the result by looking at the p-value whether it is above or below the 5% significance level. From table 1, we can see that each variable, except for the new population, reaches a stationary condition at first difference with the Fisher and CIPS tests. Meanwhile, the total population seems to be stationary at the level.

Table 1 - Stationarity test result

Variable	lag	Fisher's test (Maddala and Wu, 1999)				CIPS test (Pesaran, 2007)			
		Levels		First differences		Levels		First differences	
		Chi_sq	P-values	Chi_sq	P-values	Zt-bar	P-values	Zt-bar	P-values
Sustainable development	0	51.131	0.112	429.6	0.000	-0.16	0.436	-12.44	0.000
	1	55.684	0.051	303.2	0.000	-0.542	0.294	-7.882	0.000
Domestic capital	0	25.348	0.966	371.2	0.000	-2.403	0.008	-12.93	0.000
	1	28.373	0.916	253.4	0.000	-1.837	0.033	-9.375	0.000
Population	0	225.88	0.000	60.3	0.000	-7.683	0.000	0.874	0.800
	1	70.414	0.002	47.6	0.191	4.117	1.000	-1.148	0.100
environmental quality	0	37.055	0.604	414.8	0.000	0.533	0.703	-12.6	0.000
	1	36.605	0.624	172.4	0.000	0.356	0.639	-6.055	0.000
Trade openness 1	0	62.487	0.013	421.9	0.000	-3.311	0.000	-14.06	0.000
	1	75.370	0.001	278.8	0.000	-5.008	0.000	-11.17	0.000
Trade openness 2	0	31.482	0.830	481.6	0.000	0.181	0.572	-11.84	0.000
	1	31.734	0.821	297.0	0.000	-0.123	0.451	-6.523	0.000

Trade openness 3	0	46.113	0.234	523.1	0.000	-0.952	0.171	-12.12	0.000
	1	48.071	0.178	303.2	0.000	-0.720	0.236	-7.018	0.000

Note: Fisher's test assumes that the cross sections are dependent, while CIPS test assumes that the cross sections are independent.

The next pre-estimation test is the cointegration test to determine whether the impact on both sustainable development and conventional development can be estimated in the long term so as not to produce biased estimates. By using the Westerlund cointegration test approach on panel data, the results in table 2 show that there is cointegration between sustainable development variables with at least one explanatory variable. We can conclude the result by looking at the p-value of Gt statistic that showed 0.013 is below of significant level 5%. Thus, modeling to analyze the impact on sustainable development is further carried out by considering alternative models based on Error Correction Model (ECM).

Table 2 - Cointegration test result

Westerlund Panel Cointegration Test: Sustainable development				
Statistics	*Value*	*Z-values*	*P-values*	*Robust p-value*
Gt	-2,186	1,051	0.854	0.013
Ga	-2,332	6,179	1,000	0967
Pt	-5,065	3,721	1,000	0.613
Pa	-1,623	4,282	1,000	0837

Notes:
Gt, Ga → H0: no cointegration in at least one-unit cross section
Pt, Pa → H0: no cointegration for all cross-section units

Table 3 showed the result of three alternatives estimation model. Based on the results of the Hausman test show that p-value rejected null hypothesis of the Hausman test that is the difference in the unsystematic coefficients or in other words the Mean Group model is not the best estimate. Therefore, the Pooled Mean Group (PMG) model is the best of the three empirical models. Furthermore, it is shown by Akaike Information Criterion (AIC) and Bayesian Information Criterion (BIC) that the values of model 1 have the lowest value of the others model. Then, the best empirical model chosen for further analysis is model 1 with the net export indicator as trade openness.

Table 3 - Estimation result

Variable	Model 1			Model 2			Model 3		
	PLS	MG	**PMG**	PLS	MG	PMG	PLS	MG	PMG
long runs									
Domestic capital	-0.32	5.87	**-0.27**	-1.92	-8.24	-0.85	-3.32	-6.91	-2.26**
	(1.80)	(15.51)	**(0.82)**	(2.02)	(7.38)	(0.96)	(2.16)	(5.08)	(0.87)
Population	11.97	-99.4**	**2.71**	10.86	-133.99**	5.41	12.2	-111.75***	8.07*
	(10.81)	(46.14)	**(4.78)**	(12.16)	(35.92)	(4.45)	(12.31)	(42.99)	(4.26)
environmental	-5.61	21.33	**-0.49**	-3.63	25.61	-3.88*	-2.52	24.71	-0.72
quality	(4.32)	(13.63)	**(1.59)**	(4.71)	(21.62)	(1.98)	(4.87)	(15.42)	(1.97)
Trade openness 1	0.64***	0.97*	**0.95****	-	-	-	-	-	-
	(0.19)	(0.52)	**(0.13)**						
Trade openness 2			**-**	0.24**	0.44***	0.10**	-	-	-
				(0.11)	(0.15)	(0.05)			
Trade openness 3				-	-	-	0.34**	0.33***	-0.03
							(0.15)	(0.12)	(0.04)
Short runs									
ECT	-0.16***	-0.48***	**-0.24****	-0.15***	-0.44***	-0.25***	-0.15***	-0.46***	-0.03***
	(0.02)	(0.05)	**(0.03)**	(0.02)	(0.06)	(0.04)	(0.02)	(0.06)	(0.04)
Capital formation	1.95***	4.34**	**3.39****	3.03***	4.42**	4.24**	2.52***	4.08**	3.66**
	(0.62)	(1.81)	**(1.45)**	(0.66)	(1.97)	(1.76)	(0.64)	(1.82)	(1.61)
Population	-43.21	-105.93	**-25.91**	-36.28	-347.78*	-67.68	-36.69	-408.00*	-78.35
	(34.29)	(101.39)	**(60.18)**	(35.43)	(206.05)	(50.43)	(35.94)	(218.97)	(53.33)
environmental	7.77***	0.33	**7.18****	5.05*	-2.81	2.73	4.74	-2.04	4.38
quality	(2.87)	(4.46)	**(3.36)**	(2.99)	(5.43)	(3.88)	(3.07)	(5.28)	(4.09)

Trade openness 1	0.23*** (0.04)	0.03 (0.08)	**0.001 (0.11)**	-	-	-	-	-	-
Trade openness 2	-	-	-	0.11*** (0.03)	0.11** (0.05)	0.18*** (0.05)	-	-	-
Trade openness 3	-	-	-	-	-	-	0.08** (0.04)	0.00 (0.04)	0.07* (0.04)
Constant	-21.11 (26.8)	725.11* (417.33)	**-7.17*** (1.01)**	-15.32 (28.8)	872.47 (247.71)	-5.09*** (1.11)	-15.76 (28.68)	813.12*** (312.79)	-19.26*** (2.89)
Observation	580	580	580	580	580	580	580	580	580
Hausman MG-PLS test	0.402				0.206			0.306	
Hausman MG-PMG test	0.446				0.392			0.398	
AIC	-	1732	1935	-	1780	1986.6	-	1822	2017
BIC	-	1776	1979	-	1823	2030.2	-	1865	2061

Note: *p<0.1, **p<0.05, ***p<0.01, values in brackets indicate standard error
The results of the hausman test are based on the probability of the Chi-square statistic

4.1. Short-Term Impact

In the short term, the variable that has the greatest potential influence on sustainable development is a population of 25.91% and has a negative effect, although it was not proven statistically significant in this study. This could be because the behavior of the population in the G20 group of countries in the short term has not been oriented towards sustainable development, so that a large increase in population will result in strong pressure on the availability of natural resources and sustainable development in the G20 group of countries (Akhirul et al. 2020).

The next variable that has a major influence and is proven to be significant on sustainable development in the G20 countries is the quality of the environment as measured by CO2 emissions. The positive coefficient is equal to 7.18 means that an increase in CO2 emissions by 1% will increase sustainable development by 7.18%. This shows that in the short term, the G20 group of countries is aggressively taking action to reduce CO2 emissions so that with high CO2 emissions, sustainable development achievements will be even higher due to policies based on CO2 reduction. For example, Indonesia is pushing their steam power plant (PLTU) to make efforts to reduce emissions, apply carbon taxes, and replace PLTU units that are no longer efficient and have high emissions into renewable energy generators (EBT) (Ministry of Energy and Mineral Resources RI 2022).

In addition to environmental quality, a variable that is also proven to significantly influence sustainable development is capital formation as measured by Gross Capital Formation. Capital formation is proven to have a positive and significant effect where an increase in capital formation by 1% can have an impact on increasing sustainable development by 3.39%. This is in line with the theory of economic development which states that capital formation will always make a positive contribution to economic development. Capital formation occurs when most of the income is saved and then reinvested with the aim of increasing output in the future. Thus, increasing the physical capital stock in a country allows for an increase in output in the future. The results of this study are in line with those of Puspasari (2019), Brkić (2020), Kusuma (2020), Mohd et al. (2021), and Ziberi et al. (2022).

Trade openness is the variable that has the least influence and is not proven to be significant in the short term, although it has the potential to have a positive effect on sustainable development. This means that trade openness has the potential to be a stimulus for sustainable development in the G20 countries even though the effect is not large, but G20 trading activities are not oriented towards sustainable development so this variable is not proven to be significant. This is evident from OECD (2023) which reports that only five G20 member countries have focused on exports of green goods (exports of environmentally based goods). These countries include China, Germany, US, Japan, and Italy.

4.2. Long-Term Impact

Even though trade openness does not seem to have a significant effect on sustainable development, in the long run trade openness is proven to have a positive and significant effect. An increase in trade openness in the long term of 1% will have a positive impact on sustainable development of 0.95%. These results are in line with research from Ogede & Tiamiyu (2022), Zamani & Tayebi (2022), and Shirazi et al. (2020) which found a positive effect of trade openness on sustainable development. The results of this study mean that in the long run the trading activities of the G20 countries are more oriented towards sustainable development conditions.

On the capital formation side, although it has proven to have a positive and significant effect in the short term, it has not proven to be significant in the long term and even has the potential to have a negative effect. This shows that even though the G20 group of countries has carried out expansive capital formation towards sustainable development in

the short term, this has not been accommodated for sustainable development in the long term. The same thing happens to the environmental quality variable where an increase in CO2 emissions will potentially lead to a decrease in sustainable development. This shows that the initiative to reduce CO2 emissions from the G20 group of countries in the long term is not optimal. This relates to policy commitments related to sustainable development where according to a report from Sachs et al. (2023), there are still many G20 countries that do not have a commitment to net zero emission conditions including Brazil, India, Indonesia, Mexico and South Africa. The negative effect of CO2 emissions on sustainable development has been proven from research by Raza (2022), Wei & Huang (2022), and Kang et al. (2020).

Meanwhile, on the population, although it is not proven to have a significant influence on sustainable development, the potential influence is positive, which means that in the long run the G20 country group has begun to be oriented towards sustainable development both in terms of consumption and production, but its utilization has not yet maximum so that this potential cannot be proven to have a significant effect. According to Filipenco (2023), the positive influence of population on sustainable development is related to the greater availability of human capital which can increase economic expansion and promote sustainable development.

5. Conclusion

The primary objective of this study is to examine the impact of trade openness and other relevant factors on sustainable development in the G20 countries. Then, the results of this study showed that in the short term the variables that had a significant effect on sustainable development were only capital formation and environmental quality where the effect is positive. Trade openness was not proven to have a significant effect, even though it had a potential positive influence. Trade openness was proven to have a positive and significant effect on sustainable development in the long term. This means that the trading activities of the G20 countries in the long term are more oriented towards sustainable development conditions as shown in the initiation of the G20 Priority Agenda for 2030. The other factors, capital formation, population size, and environmental quality, were not proven to have a significant effect on sustainable development in the long term. The findings of the effect of CO2 emissions have the potential to have a negative impact in the long-term but was proven to be positive and significant in the short-term indicating that the initiative to reduce CO2 emissions from the G20 group of countries in the long term is not optimal.

This study found that trade openness did not prove to have an effect on sustainable development, even though it had the potential for a positive impact, mainly because there were not many trade activities in the G20 group of countries that were based on green goods. Consequently, the advice that can be given to the G20 countries is to further develop a trade policy focused on goods that can support sustainable development. The difference in the effect of capital formation in the long term was not proven to be significant and even had the potential for a negative impact, indicating that capital formation supporting sustainable development in the short term had not been sustained over the long term. Therefore, the government should take a more active role in promoting capital formation that supports sustainable development in the long term. Additionally, the governments of G20 countries should enhance their commitment to sustainable development programs, particularly those related to environmental issues, based on the results concerning the influence of environmental quality variables.

This research had limitations, especially in the estimation results, as it only looked at the impact of trade openness on sustainable development at an aggregate level due to data limitations. Therefore, for future research, it was suggested to conduct a more in-depth analysis of the relationship between trade openness and sustainable development, with a greater focus on the specific determinants of sustainable development itself.

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