Effects of Trade Openness on Life Expectancy, Infant Mortality and Adult Mortality in Nigeria

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Abstract

Despite different policies towards trade openness, Nigeria has seen relatively poor improvements in population health. Developing economies are usually centers for unhealthy goods as a result open trade. This study examines the impact of trade openness on health outcomes in Nigeria. The study used the Auto-Regressive Distributed Lag estimation technique for the effects of trade on infant mortality, adult mortality, and life expectancy. The results showed that increased trade openness, real gross domestic product, and real exchange rate decreased infant mortality in both the short-run and long-run. In contrast, increased foreign direct investment led to higher infant mortality. Additionally, increasing net exports reduced infant mortality. Trade openness, real gross domestic product, and real exchange rate improved the adult mortality rate, while changes in other variables had adverse effects on adult mortality. Furthermore, trade openness and net exports improved life expectancy, while changes in other variables reduced it. In conclusion, the study suggests that trade openness taking the country peculiarities into consideration should remain a key goal for economic purposes and for improving human health in Nigeria.

Keywords: Trade Openness, Life Expectancy, Adult Mortality, Infant Mortality

JEL Classification: F1, F4, F6, C26, I12

Introduction

The high and increasing global trade in the last fifty years has generated discourse on the nexus between open trade and health outcomes. Foreign trade has influenced the structure and the nature of the economy and the extent of the economic effects on health in developing countries, Nigeria, inclusive. The fact that trade has extensive unmediated and mediated effects on the health of the people, makes it a central health issue that cannot be disregarded (MacDonald & Horton, 2009). Trade between economies is a powerful engine for economic growth and according to the

Lancet (2009), the likely adverse consequences of trade on health necessitate more attention on the connection between trade and health. Economists posit that economic openness is critical for good health, drawing from classical and new trade theories suggesting a link between open trade and quality of living (Levine & Rothman, 2006). The link implies that improved health is a crucial aspect of both human and economic development and enables individuals to rise above the poverty line (Welander et al., 2014). However, critics of globalisation have argued that increased trade may be harmful to developing countries and highlight the unfavourable distributional consequences to developing countries like Nigeria which may worsen infant mortality, adult mortality, and life expectancy. Economic theory indicates that trade openness can directly influence economic growth through income, consumption, and investment (Frankel & Romer 1999; Harrison 1996), as well as indirectly affect wealth, inequality, poverty, and health.

Trade openness can influence individual health through two primary mechanisms. Firstly, trade with industrial nations can promote the transfer of knowledge, thereby enhancing disease treatment by granting access to high-quality medical and pharmaceutical products (Coe & Helpman, 1995). This access can lead to improved health outcomes through the exchange of innovative ideas and information, along with the implementation of effective projects, regulations, and standards (Sandholtz & Gray, 2003; Rodrik et al., 2004). Secondly, trade can enhance product quality, foster cooperation, and reduce prices (Rodrik et al., 2004). However, the empirical evidence on the effects of trade openness on health remains conflicting. Some studies, such as those by Bussmann (2009) and Bergh and Nilsson (2010), highlight the positive impacts of trade openness on health, indicating that it can lower infant mortality rates, increase life expectancy in underdeveloped countries, and contribute to societal well-being. Conversely, other research, including that of Antweiler et al. (2001), contends that trade can have detrimental effects, facilitating the spread of diseases and compromising environmental quality. The authors' suggest that excessive industrialization due to increased trade openness in developing countries might lead to pollution, uncontrolled urbanization, and reduced quality of life, thus, decreasing life expectancy. Furthermore, trade can increase corruption, which can have an adverse effect on the efficiency of health systems (Gatti, 2004).

In 1986, Nigeria adopted increased trade openness as a key component of its structural adjustment programme (SAP). Nevertheless, improvement in the health of Nigerians have not shown essential transformation compared to other regions of the world with similar policies (Sulaiman et al., 2014). This raises the ongoing question of whether external trade can effectively enhance population health. There have been limited empirical studies assessing the effects of trade openness on health outcomes. For instance, Owen and Wu (2007) conducted a panel data analysis of 219 countries from 1960 to 1995, revealing a link between increased trade openness and reductions in infant mortality rates, as well as improvements in life expectancy, particularly in developing nations. This finding was further supported by Stevens et al. (2013), who analyzed data from 1970 to 2005. These empirical studies suggest that free trade is associated with better health, especially in low-income countries. However, the relationship between trade and health is dynamic and varies significantly across countries and over time. Consequently, the results may be uncertain when considering solely a time-series perspective, which is the primary focus of the current study on Nigeria.

Literature Review

Trade policy is the government's commercial plan of action that guides a country's external trade. This policy covers issues that affect international transactions. Trade policy can fall between the extremes of free trade (no restrictions on trade) and protectionism (high restrictions to protect local producers). On the other hand, a trade agreement is a tax, tariff, and trade treaty that helps two or more countries to trade with each other. Trade agreements can be regional, bilateral, or preferential. Regional trade agreements aim to increase regional trade, which can evolve into bilateral or multilateral trade deals. Regional trade agreements can be helpful in resolving trade issues without causing difficulties in other trade agreements. Critics argue that regional trade agreements can hinder trade negotiations because they may be lopsided or unfairly beneficial to one side, especially if some of the participants are underdeveloped nations. A bilateral trade agreement is established when two countries negotiate a trade accord that provides each other with special deals and favorable terms. These agreements enable the reduction of tariffs on each other's goods and services. However, bilateral agreements have faced criticism for potentially benefiting larger nations, such as the United Kingdom, at the expense of smaller nations, which may find themselves shouldering heavier burdens. Since the 1950s, there has been a growing preference among nations for preferential trade agreements, seeking quicker benefits for the parties involved. Such agreements allow businesses to access previously restricted markets, aligning with the free trade principles advocated by many countries. Preferential trade agreements can be formed between nations with similar GDP levels, substantial economic potential, and comparable positions in relation to one another and the global economy. They can also be established within regional unions, such as NAFTA, AfCTA, the European Union, and ASEAN. Detractors of preferential trade agreements argue that these deals have heightened the reliance on tariffs for products. Additionally, smaller nations with limited resources may face challenges in meeting the product origin certification requirements.

The linkage between trade policy and health involves considering free trade and protectionism. Free trade is an external trade without barriers such as tariffs, quotas, and foreign exchange controls, allowing goods and services to flow freely between countries. This absence of governmental intervention in international exchange can lead to increased production, consumption, and international prosperity, as it enables countries to obtain goods at a cheaper price. According to Smith and Blouin (2015), increased trade enhances health by providing access to health-related goods and services from the global marketplace, as well as facilitating competitive pricing. Moreover, free trade can relieve pressure on national finances by allowing the acquisition of less expensive external goods, which in turn contributes to the availability of funds for health-related services, leading to an overall improvement in health status. In contrast, protectionism involves restricted trade, characterized by the imposition of tariffs, duties, quotas, export taxes, and subsidies by governments to limit import inflow and protect domestic products from foreign competition. Owen and Wu (2002) identified a significant connection between trade openness and health status through a fixed-effect approach analyzing data from 1960 to 1995. The study revealed a negative relationship between trade openness and infant mortality rates. The authors proposed two reasons for the positive correlation between trade openness and health outcomes. Firstly, a capable government is likely to implement effective policies that support both trade and positive health outcomes. This suggests that domestic policies promoting trade are associated with improved health results. Secondly, a positive relationship was also established between the volume of trade and health outcomes, even after controlling for the policy environment, indicating another causal link between trade and health due to knowledge spillovers. Razmi (2012) reported similar findings regarding the relationship between trade openness and human development. His analysis using a fixed effect model demonstrated a significant positive effect of trade openness on life expectancy as an indicator of human development. Additionally, trade openness was found to have a detrimental impact on infant mortality rates. The study concluded that human development can be enhanced by reducing both tariff and non-tariff barriers to external trade.

Levine and Rothman (2006) examined the impact of trade on child health across 134 developed and developing countries using a panel data analysis with a two-stage least squares regression. Their findings revealed that life expectancy was significant at the 1% level, indicating that a 20% increase in trade as a share of GDP was associated with a 2 log point increase in life expectancy, equivalent to almost an additional six months of life. These results were significant at the 1% confidence level. Additionally, the coefficient for child mortality was -0.63, suggesting that increased trade could lead to a reduction of over six months in infant mortality rates. The authors advocated for free trade while opposing trade restrictions, arguing that such policies could adversely affect the import of essential goods and services and lead to decreased investment in healthcare for poorer nations. Furthermore, Olper et al. (2014) explored the effects of trade liberalization on health outcomes in Africa, noting that the rising child mortality rate, particularly in South Africa, was linked to the widespread prevalence of HIV/AIDS. Their study analyzed 40 trade reform episodes over the last half-century and found that the impact of trade liberalization on child health varied in both direction and magnitude. In half of the cases examined, trade reforms positively influenced reductions in child mortality, while in the other half, there was a notable deterioration. This variability was attributed to the differing conditions prevalent in each country. The authors noted that trade reforms in well-established democracies tended to have a more favorable impact on child mortality, yielding more significant results. Their findings suggested that trade reform could enhance conditions in the agricultural sector, leading to a more positive effect on child mortality in nations where a significant portion of the poor are employed.

Research Methodology

This study utilized the specific factors model as proposed by Samuelson (1971), which was later modified by Stolper and Samuelson (1941). This theory posits that capital is specific to the sector in which it was initially employed, while labour is able to move freely between sectors. As a result of trade, there is an increase in real income for the factor in the growing sector—namely, the labour-intensive export sector in a labour-abundant country—contrasted with a decline in real income for the specific factor in the shrinking sector, which is the capital-intensive import-competing sector. Moreover, trade generates a nominal increase in labour income due to increase demand in the expanding sector and the mobility of labour. However, real wages may decrease in terms of the export good while increasing in relation to the import-substitute good. The overall effect on real wages depends on how labour consumption is allocated between these two goods. Winters (2000a) emphasized that the health implications of the Stolper-Samuelson (1941) theory are crucial for assessing the health impacts of trade reform in relation to the type of labour for which demand rises with trade (for instance, unskilled versus skilled labour) and the shifts in wages in connection to health outcomes. Thus, the relationship between a population's health status and trade openness is:

$$H = f(TO) \quad (1)$$

Using infant mortality, adult mortality and, life expectancy as indices of health, explicit version of equation (1) is:

$$IM_t = \beta_0 + \beta_1 TO_t + \beta_2 RGDP_t + \beta_3 NEXP_t + \beta_4 FDI_t + \beta_5 RER_t + \varepsilon_t \quad (2)$$

$$AM_t = \beta_0 + \beta_1 TO_t + \beta_2 RGDP_t + \beta_3 NEXP_t + \beta_4 FDI_t + \beta_5 RER_t + \varepsilon_t \quad (3)$$

$$LE_t = \beta_0 + \beta_1 TO_t + \beta_2 RGDP_t + \beta_3 NEXP_t + \beta_4 FDI_t + \beta_5 RER_t + \varepsilon_t \quad (4)$$

In equations (2), (3) and (4), IM_t is infant mortality at time t, AM_t is adult mortality at time t, LE_t is average life expectancy at time t, TO is trade Openness defined as (exports+imports)/GDP, RGDP is a real gross domestic product, NEXP is net export defined as (export–import). FDI is foreign direct investment inflow, RER is the exchange rate. β_0 is the intercept, β_1-β_5, are the estimated parameters and ε_t is the stochastic error term. The a priori expectations are:

$$\frac{\delta IM}{\delta TO} < 0,\ \frac{\delta IM}{\delta RGDP} < 0,\ \frac{\delta IM}{\delta NEXP} < 0, \frac{\delta IM}{\delta FDI} < 0, \frac{\delta IM}{\delta EX} < 0$$

$$\frac{\delta AM}{\delta TO} < 0, \frac{\delta AM}{\delta RGDP} < 0, \frac{\delta AM}{\delta NEXP} < 0, \frac{\delta AM}{\delta FDI} < 0, \frac{\delta AM}{\delta ER} < 0$$

$$\frac{\delta LE}{\delta TO} > 0, \frac{\delta LE}{\delta RGDP} > 0, \frac{\delta LE}{\delta NEXP} > 0, \frac{\delta LE}{\delta FDI} > 0, \frac{\delta LE}{\delta ER} > 0$$

Estimation Techniques

The analysis was conducted using time series data covering a period of 36 years (1986-2022). A unit root test was performed to assess stationarity in order to determine the appropriate estimation method. The Augmented Dickey-Fuller (ADF) test was applied for this purpose, employing the general ADF equation for unit root appraisal:

$$\Delta Y_t = \beta_1 + \beta_{2t} + \rho Y_{t-1} + \Sigma\delta\Delta Y_{t-1} + \mu_t \quad (5)$$

Y_t represents the level of the variable being analyzed, t signifies the time trend, β_1 indicates the constant term, and μ_t is the error term, which is assumed to be normally distributed with a mean of zero and constant variance. The optimal lag length for the model is determined using the Akaike Information Criterion (AIC). Unit root tests reveal varying integration orders among the variables, leading to the application of the Auto-Regressive Distributed Lag (ARDL) estimation technique. The representation of the ARDL model is as follows:

$$\Delta IM_t = \beta_0 + \Sigma^n_{i=1} \beta_1 \Delta TO_{t-1} + \Sigma^n_{i=1} \beta_2 \Delta RGDP_{t-1} + \Sigma^n_{i=1} \beta_3 \Delta NEXP_{t-1} + + \Sigma^n_{i=1} \beta_4 \Delta FDI_{t-1} + \Sigma^n_{i=1} \beta_5 \Delta RER_{t-1} + \Sigma^n_{i=1} \beta_6 \Delta IM_{t-1} + \beta_7 \Delta TO_{t-1} + \beta_8 \Delta RGDP_{t-1} + \beta_9 \Delta NEXP_{t-1} + \beta_{10} \Delta FDI_{t-1} + \beta_{11} \Delta RER_{t-1} + \mu_t \quad (6)$$

$$\Delta AM_t = \beta_0 + \Sigma^n_{i=1} \beta_1 \Delta TO_{t-1} + \Sigma^n_{i=1} \beta_2 \Delta RGDP_{t-1} + \Sigma^n_{i=1} \beta_3 \Delta NEXP_{t-1} + + \Sigma^n_{i=1} \beta_4 \Delta FDI_{t-1} + \Sigma^n_{i=1} \beta_5 \Delta RER_{t-1} + \Sigma^n_{i=1} \beta_6 \Delta AM_{t-1} + \beta_7 \Delta TO_{t-1} + \beta_8 \Delta RGDP_{t-1} + \beta_9 \Delta NEXP_{t-1} + \beta_{10} \Delta FDI_{t-1} + \beta_{11} \Delta RER_{t-1} + \mu_t \quad (7)$$

$$\Delta LE_t = \beta_0 + \Sigma^n_{i=1} \beta_1 \Delta TO_{t-1} + \Sigma^n_{i=1} \beta_2 \Delta RGDP_{t-1} + \Sigma^n_{i=1} \beta_3 \Delta NEXP_{t-1} + + \Sigma^n_{i=1} \beta_4 \Delta FDI_{t-1} + \Sigma^n_{i=1} \beta_5 \Delta RER_{t-1} + \Sigma^n_{i=1} \beta_6 \Delta LE_{t-1} + \beta_7 \Delta TO_{t-1} + \beta_8 \Delta RGDP_{t-1} + \beta_9 \Delta NEXP_{t-1} + \beta_{10} \Delta FDI_{t-1} + \beta_{11} \Delta RER_{t-1} + \mu_t \quad (8)$$

The error correction model (ECM) is a crucial tool in time series analysis for addressing co-integration issues. It illustrates how quickly a system adjusts from short-run equilibrium to long-run equilibrium. Once co-integration is established in a time series dataset, we construct an ECM to explore the dynamic relationship between the short-run and long-run periods. The ECM framework demonstrates the rate of adjustment after a deviation from long-run equilibrium. For effective error correction, the ECM coefficient must be negative and statistically significant. A higher coefficient indicates a quicker return to long-run equilibrium. The ECM can be expressed thus:

$$\Delta Y_t = \alpha_0 + b_1 \Delta X_t - \text{л}\hat{u}_{t-1} + Y_t \quad (9)$$

The Granger-Causality test establish the causal relationship between health and trade openness. The theoretical dictates is that the probability value must falls between 0 and 0.05, for an existence of a causal relationship.

Source of Data and Measurement of Variables

The data utilized for this study was sourced from the World Development Indicators (World Bank, 2023) and covers the period from 1986 to 2022. The variables examined include trade openness, real GDP, net exports, foreign direct investment, real exchange rates, life expectancy, infant mortality, and adult mortality. Table I presents these variables along with their respective measurements.

Table 1: Measurement of Variables

Variables	Description	Measurement	Source
IM	Infant Mortality	Per 1,000 live births	WDI 2023
AM	Adult Mortality	Per 1,000 adults	WDI 2023
LE	Life Expectancy	Life Expectancy	WDI 2023
TO	Trade Openness	(Export + Import) as % of GDP	WDI 2023
RGDP	Real Gross Domestic Product	Annual %	WDI 2023
NEXP	Net Export	% of GDP	WDI 2023
FDI	Foreign Direct Investment Inflow	% of GDP	WDI 2023
RER	Real Exchange Rate	Real Exchange Rate	WDI 2023

Source: World Bank, 2023

Results and Discussion

Table 2 presents the descriptive statistics for the variables included in the study. The mean values for infant mortality (IM), adult mortality (AM), life expectancy (LE), trade openness (TO), real gross domestic product (RGDP), net exports (NEXP), foreign direct investment inflows (FDI), and real exchange rate (RER) are 102.1, -1.4, 0.3, 35.2, 4.4, 6.6, 1.7, and 110.1, respectively. The maximum values recorded are 124.4, 2.6, 0.6, 53.3, 15.3, 23.1, 5.8, and 272.9. In contrast, the minimum values are 74.2, -4.8, -0.1, 9.1, -2.0, -5.6, 0.2, and 49.7. The standard deviations from the sample means are 18.6, 3.0, 0.2, 10.3, 3.9, 6.2, 1.3, and 55.5.

Table 2: Descriptive Statistics of the Variable Used

Variables	IM	AM	LE	TO	RGDP	NEXP	FDI	RER
Mean	102.05	-1.37	0.26	35.23	4.38	6.61	1.69	110.05
Maximum	124.40	2.62	0.56	53.28	15.32	23.05	5.79	272.92
Minimum	74.20	-4.81	-0.06	9.14	-2.04	-5.58	0.19	49.74
Std. Dev.	18.59	3.02	0.23	10.31	3.88	6.209	1.26	55.47
Skewness	-0.07	0.20	-0.20	-0.43	0.49	0.44	1.64	1.81
Kurtosis	1.38	1.28	1.35	2.93	3.38	3.39	5.61	5.45
Jarque-Bera	3.74	4.28	3.96	1.06	1.59	1.29	24.97	26.96
Probability	0.15	0.12	0.14	0.59	0.45	0.52	0.00	0.00
Sum	3469.60	-45.23	8.59	1197.9	148.9	224.70	57.58	3741.84
Obs	36	36	36	36	36	36	36	36

Source: Authors' Computation, 2024

Unit Root Test Results

Table 3 presents the results of the Augmented Dickey-Fuller (ADF) unit root test, which assesses the order of integration. The test indicates that IM, AM, and LE are stationary at the first difference I(1). In contrast, TO, RGDP, NEXP, FDI, and RER are stationary at the level, categorizing them as I(0) variables.

Table 3: Unit Root Test Result

Variables	Level ADF Test Statistic	First Difference ADF Test Statistic	Decision
IM	-2.33	-7.98**	1(1)
AM	-1.27	-5.51**	1(1)
LE	-3.80**	-3.98	1(0)
TO	-4.68**	-7.73	1(0)
RGDP	-3.88**	-10.16	1(0)
NEXP	-3.83**	-8.51	1(0)
FDI	-3.93**	-7.42	1(0)
RER	-3.44**	-6.09	1(0)

Source: Author's Computation, 2024

Long Run Bound Test

The results of the unit root test indicate that the ARDL technique is appropriate for estimation purposes. A long-run bound test was performed to determine whether a long-term relationship exists between trade, life expectancy, infant mortality, and adult mortality. As presented in Table 4, the findings confirm a long-run relationship, as the F-statistic exceeds the Pesaran critical value at the 5% significance level.

Table 4: Bounds Test Estimation between Trade, Infant Mortality, Adult Mortality and Life Expectancy

Trade and Infant Mortality		
Panel A		
Test Statistic	**Values**	**K**
F-Statistic	6.689079	5
Panel B	**Pesaran *et. al.* (2001) critical values**	
Critical Value Bound	I(0)	I(1)
(at 5% Significance Level)	2.39	3.38
Trade and Adult Mortality		
Panel A		
Test Statistic	**Values**	**K**
F-Statistic	7.304153	5
Panel B	**Pesaran *et. al.* (2001) critical values**	
Critical Value Bound	I(0)	I(1)
(at 5% Significance Level)	2.39	3.38
Trade and Life Expectancy		
Panel A		
F-Statistic	2.406514	5
Panel B	**Pesaran *et al.* (2001) critical values**	
Critical Value Bound	I(0)	I(1)
(at 5% Significance Level)	2.39	3.38

Source: Authors Computation

Effects of Trade on Life Expectancy, Infant Mortality and Adult Mortality in Nigeria

The ARDL method was utilized to assess both the long-run and short-run effects of trade on infant mortality, adult mortality, and life expectancy. This approach allowed for the identification of the optimal lag structure using the Akaike Information Criteria (AIC), resulting in a selected lag of 2. The results of the ARDL analysis for both long-run and short-run periods are presented in Table 5. The findings reveal that trade openness (TO) exhibits an inverse relationship with infant mortality in the short run; specifically, a 1% increase in trade openness is associated with a 36% decrease in the infant mortality rate. Real gross domestic product (RGDP), when considered without any lag and with a one-year lag, displayed a non-significant inverse effect on infant mortality in the short term. However, RGDP became inversely and statistically significant at a lag of 2, indicating that an increase in RGDP contributes to a decrease in infant mortality. Net exports (NEXP), examined both without a lag and with a one-year lag, showed a negative and non-significant effect on infant mortality. The coefficient for foreign direct investment inflow (FDI) was positive yet also non-significant in the short run. The real exchange rate (RER) indicated a non-significant indirect relationship with infant mortality, whereby a 1% increase in the real exchange rate resulted in a 0.06% decrease in the infant mortality rate. In the short-run model, the coefficient of determination (R^2) and the adjusted R^2 were 0.55 and 0.29, respectively, suggesting that the model explains approximately 55% of the variation in the infant mortality rate. The overall regression F-test was significant at the 10% level. Furthermore, the Durbin-Watson statistic for the short run was 2.6, signifying the absence of autocorrelation. The Breusch-Godfrey Serial Correlation LM test further confirmed the lack of serial correlation at a 5% significance level.

In the long-run analysis, trade openness (TO) exhibits a significant inverse relationship with infant mortality at a 5% significance level, suggesting that a 1% increase in trade openness is associated with a 48% decrease in infant mortality. The coefficient of real GDP (RGDP), considering a one-year and two-year lag, shows a negative correlation with infant mortality. Both net exports (NEXP) and the real exchange rate (RER) present a negative but non-significant relationship with infant mortality in the long run. However, with a two-year lag, RER reveals a significant positive impact on infant mortality at a 10% significance level. The coefficient of determination (R^2) and the adjusted R^2 are 0.82 and 0.69, respectively, indicating that approximately 69% of the variation in infant mortality is explained by the long-run model. Additionally, both the Durbin-Watson statistic and the Breusch-Godfrey Serial Correlation LM test confirm the absence of auto-correlation and serial correlation in the long run.

The impact of trade openness (TO) on the adult mortality rate (AM) was analyzed while holding other variables constant. In the short run, the adult mortality rate decreased by 0.15% when trade openness was considered without lag, and both immediate and one-year lag effects were found to be positive but non-significant. The real gross domestic product (RGDP), without accounting for any lag, also showed a positive but non-significant effect on adult mortality in the short run. However, when considering one-year and two-year lags, RGDP demonstrated a significant negative effect on the adult mortality rate. The coefficient for net exports (NEXP) with a two-year lag had a significant positive effect, indicating that a 1% increase in net exports would lead to a 0.07% increase in the adult mortality rate. Foreign direct investment inflow (FDI) and the real exchange rate (RER) had non-significant positive effects on adult mortality in the short run. The coefficients of determination, R^2 and adjusted R^2, were found to be 0.58 and 0.34, respectively, indicating that approximately 34% of the variation in the adult mortality rate could be explained by trade openness in the short run. The F-test was significant at the 5% level in the short-run model. The Durbin-Watson statistic for both short-run and long-run analyses was 1.9, showing no evidence of autocorrelation, which was further confirmed by the Breusch-Godfrey Serial Correlation LM test. In the long run, while holding other variables constant, the adult mortality rate was estimated to decrease by about 7.9%, but this effect was not significant. Trade openness showed a positive non-significant effect on adult mortality in the long run. The RGDP without lag, as well as with one-year and two-year lags, had a consistently negative effect on the adult mortality rate, suggesting that an increase in RGDP would reduce adult mortality. The coefficients for net exports (NEXP), both without lag and with one-year and two-year lags, demonstrated a positive effect on adult mortality. FDI had a significant positive effect on the adult mortality rate in the long run at a 10% significance level. The coefficient for the real exchange rate (RER) showed a negative non-significant effect on adult mortality; however, with one-year and two-year lags, a 1% increase in the real exchange rate would raise the adult mortality rate.

Table 5: Short-run and Long-run ARDL Estimate

Variables	Trade and Infant Mortality		Trade and Adult Mortality		Trade and Life Expectancy	
	Short-run D(IM)	**Long-run** IM	**Short-run** D(AM)	**Long-run** AM	**Short-run** D(LE)	**Long-run** LE
	Coefficient	**Coefficient**	**Coefficient**	**Coefficient**	**Coefficient**	**Coefficient**
D(IM(-1))	-0.36 (0.22)	-0.03 (0.18)				
D(AM(-1))			0.02 (0.168)			
D(LE(-1))					1.02 (0.17)*	
D(LE(-2))					-0.25 (0.18)	
IM(-2)		0.77(0.19)*				
AM(-1)				0.35(0.21)		
AM(-2)				0.32(0.18)***		
LE(-1)						1.31(0.11)*
LE(-2)						0.49(0.11)*
D(TO)	0.12 (0.16)	-0.48(0.17)**	0.18(1.188)		0.01(0.01)	
D(TO(-1))			1.92(1.14)		0.01(0.01)***	
TO				0.46(1.01)		0.01(0.03)**
TO(-1)		-0.23(0.14)				0.01(0.04)
TO(-2)		-0.19(0.10)**				-0.03(0.03)
D(RGDP)	-0.02 (0.01)		0.01(0.07)		-0.01(0.03)**	
D(RGDP(-1))	-0.01(0.01)		-0.23(0.08)*		0.01(0.04)	
D(RGDP(-2))	-0.02(0.01)**		-0.20(0.06)*		-0.04(0.02)	
RGDP		0.01(0.01)		-0.02(0.07)		-0.01(0.02)*
RGDP(-1)		-0.01(0.01)		-0.27(0.07)*		0.07(0.02)*
RGDP(-2)		-0.02(0.01)**		-0.16(0.08)***		
D(NEXP)	-0.01 (0.01)		0.01(0.04)		-0.01(0.02)**	
D(NEXP(-1))	-0.04 (0.01)		-0.02(0.04)		0.01(0.03)	
D(NEXP(-2))	0.01 (0.01)		0.08(0.03)**		-0.03(0.07)**	
NEXP		-0.01(0.01)***		0.02(0.04)		0.06(0.01)*
NEXP(-1)				0.06(0.04)		0.03(0.02)***
NEXP(-2)				0.10(0.04)**		0.04(0.01)**
D(FDI)	0.01 (0.02)		0.26(0.17)		0.03(0.05)	
D(FDI(-1))					0.09(0.02)	
FDI		0.01(0.03)		0.46(0.23)***		0.08(0.07)
FDI(-1)						0.09(0.07)**
D(RER)	-0.07(0.10)		0.32(0.75)		0.03(0.03)	
D(RER(-1))	-0.19 (0.12)				-0.01(0.04)**	
D(RER(-2))					0.01(0.01)***	
RER		-0.11(0.11)		-0.45(0.82)		0.02(0.03)
RER(-1)		-0.17(0.13)		0.60(1.05)		-0.92(0.03)**
RER(-2)		0.17(0.09)***		1.08(0.81)		0.01(0.03)*
C	0.01(0.03)	-1.10(0.61)***	-0.15(0.22)	-7.93(5.39)	-0.03(0.01)	-0.07(0.02)*

**, **, ***Significant at 1%, 5% and 10% level; *Standard Errors are in parenthesis*

Source: Author's Computation

Table 6: Post-Diagnostic Results

Measure	Trade and Infant Mortality		Trade and Adult Mortality		Trade and Life Expectancy	
	Short-run D(IM)	**Long-run** IM	**Short-run** D(AM)	**Short-run** D(IM)	**Long-run** IM	**Short-run** D(AM)
F-statistic	2.14	6.459	2.44	17.49	4.19	24.67
Prob(F-stat.)	0.07	0.000	0.04	0.00	0.00	0.00
R-squared	0.55	0.82	0.58	0.93	0.81	0.96
Adj R^2	0.29	0.69	0.35	0.87	0.62	0.92
D.W Stat	2.56	2.86	1.93	1.91	2.61	2.40
B.G. corr. LM	0.06	0.35	0.02	3.91	2.61	0.91
Prob (Fstat.)	0.94	0.71	0.98	0.04	0.11	0.42

B.G. corr. LM: Breusch-Godfrey Serial Correlation LM; D.W. Stat: Drubin-Watson Statistics

In the long run, the coefficients of determination, R^2 and adjusted R^2, were 0.92 and 0.87, respectively, indicating that approximately 87% of the variation in adult mortality rate could be explained by trade openness. The F-test was significant at the 5% level in the long-run model, and the Durbin-Watson statistic was 1.91, further supporting the absence of autocorrelation. The Breusch-Godfrey Serial Correlation LM test also confirmed no serial correlation in this model.

The relationship between trade openness (TO) and life expectancy reveals some intriguing findings. In the short run, life expectancy decreases by 0.03% when other variables are held constant. The coefficient for trade openness (TO) without a lag, as well as with a one-year lag, positively influences life expectancy in the short term. Conversely, the real gross domestic product rate (RGDP) shows a negative effect on life expectancy without a lag and with a two-year lag, while it positively impacts life expectancy with a one-year lag. Moreover, net exports (NEXP) without a lag significantly reduce life expectancy in the short run, but when subjected to a one-year lag, their effect, while positive, is not statistically significant. Foreign direct investment inflows (FDI), both without a lag and with a year lag, positively impact life expectancy in the short run. The real exchange rate (RER) also exhibited a positive effect on life expectancy in the short term, although this effect was not statistically significant. The coefficient of determination, R^2, as well as the adjusted R^2, are noted at 0.80 and 0.61, respectively, indicating that approximately 61% of the variation in life expectancy can be attributed to trade openness. The F-test demonstrates significance at the 5% level, confirming the overall validity of the model. Furthermore, the Durbin-Watson statistic is around 2.6, suggesting no issues with auto-correlation, and the Breusch-Godfrey Serial Correlation LM test indicates an absence of serial correlation within the model.

In the long run, trade openness (TO) exerts a positive and statistically significant effect on life expectancy. At one-year and two-year lags, trade openness continues to positively influence life expectancy. The coefficient for the real gross domestic product rate (RGDP) without lag demonstrates a negative yet statistically significant impact on life expectancy at a 1% significance level. However, RGDP—when assessed without a lag and with a one-year lag—significantly and positively affects life expectancy. Similarly, the coefficient for net exports (NEXP) without lag, as well as with one-year and two-year lags, shows a significant positive impact on life expectancy. Moreover, foreign direct investment inflow (FDI) with a one-year lag significantly and positively influences the life expectancy rate. The coefficient for the real exchange rate (RER) indicates a positive, non-significant effect on life expectancy with a one-year lag but shows a positive and significant effect with a two-year lag. The coefficient of determination (R^2) and the adjusted R^2 are calculated at 0.95 and 0.91 respectively in the long run, suggesting that approximately 91% of the variations in life expectancy are accounted for by trade openness. The overall F-test in the long-run model is significant at the 5% level, while the Durbin-Watson statistic approximates 2.40. The Breusch-Godfrey Serial Correlation LM test indicates an absence of serial correlation in the model. These results align with existing literature, including findings by Owen and Wu (2007), Ramzi (2012), and Levine and Rothman (2006), which suggest that trade openness enhances population health. Conversely, Olayiwola, Adedokun, and Oloruntuyi (2019) concluded that improvements in population health can lead to increased foreign direct investment inflow. Figures 1, 2, and 3 illustrate the cumulative sum of the recursive stability test for the model's variables. These figures show that the ARDL estimation models in Table 5 are stable, indicating statistically significant results.

Figure 1: Plot of Cumulative Sum of Recursive Residuals of the model

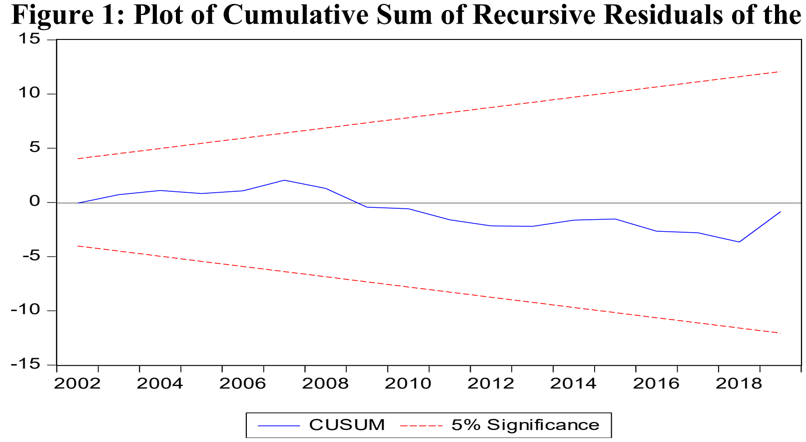


Figure 2: Plot of Cumulative Sum of Recursive Residuals of the model

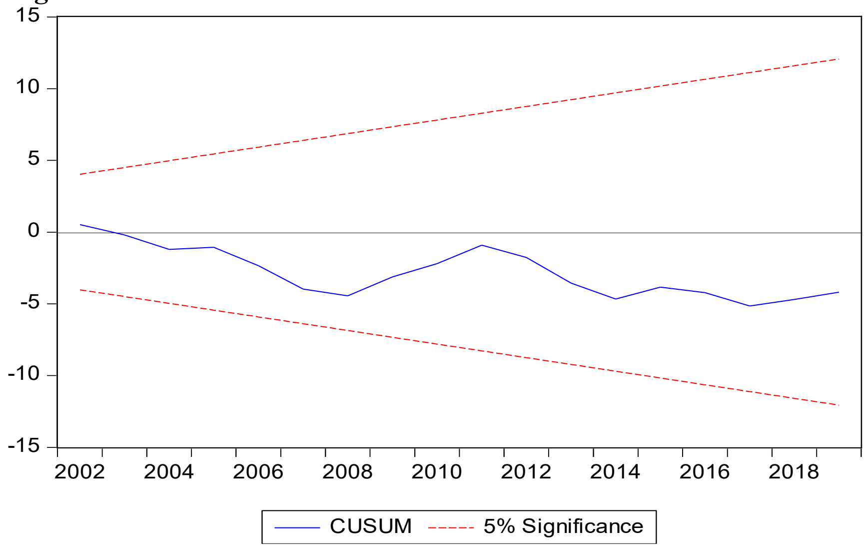


Figure 3: Plot of Cumulative Sum of Recursive Residuals of the model

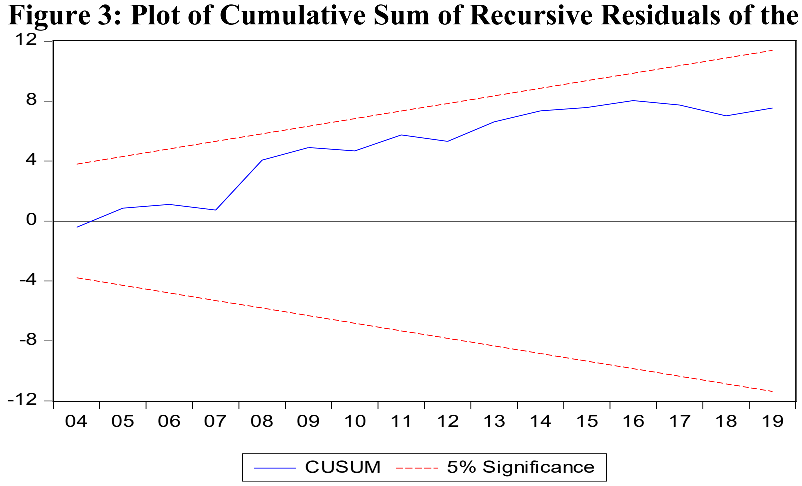


Table 7 presents the results of the error correction model (ECM). The results indicate that the ECM term is negative, which suggests a feedback mechanism in the short-run. This implies that when short-run variables deviate from equilibrium, they will return to equilibrium in the long-run. The coefficients of the ECT(-1) were -1.357, -0.988, and -0.23, respectively, indicating that the speed of adjustment is approximately 135.7%, 98.8%, and 23%. The feedback mechanisms between trade and infant mortality, as well as trade and adult mortality, are rapid, with the model returning to long-run equilibrium in less than a year should a deviation occur.

Conversely, around 77% of any deviation in the trade and life expectancy model will only be corrected in subsequent years, demonstrating a commendable adjustment speed.

Table 7: Result of the Restricted ECM Estimate

Variables Method: ARDL	Dep Var.: IM Coefficient	Dep. Var.: AM Coefficient	Dep. Var: LE Coefficient
D(RGDP, 2)	0.02 (0.05)	0.01(0.04)	-0.09 (0.00)
D(RGDP(-1), 2)	-0.02 (0.01)	0.20 (0.05)	0.04 (0.02)
D(TO, 2)		0.18 (0.68)	0.01 (0.03)
D(LE(-1), 2)			0.25 (0.11)
D(NEXP, 2)	-0.01 (0.02)	0.01 (0.03)	-0.05 (0.01)
D(NEXP(-1), 2)	-0.01 (0.01)	-0.07 (0.02)	0.05 (0.01)
D(RER, 2)	-0.07 (0.07)		0.03 (0.02)
D(RER(-1), 2)			-0.07 (0.02)
D(FDI, 2)			0.03 (0.04)
ECT(-1)*	-1.36 (0.17)	-0.98 (0.12)	-0.23 (0.05)
F-statistic	2.14	2.45	4.19
Prob(F-statistic)	0.071	0.04	0.00
R-squared	0.83	0.79	0.86
Adjusted R-squared	0.79	0.75	0.80
Durbin-Watson stat	1.56	1.93	2.61
B.G. corr. LM	0.06	0.02	2.61
Prob(F-statistic)	0.94	0.98	0.11

**Standard Errors are in parenthesis; *, **, ***Significant at 1%, 5% and 10% level*
Source: Author's Computation

Figures 4, 5, and 6 support the findings, showing the stability of the ECT model through the cumulative sum of recursive data.

Figure 4: Plot of Cumulative Sum of Recursive Residuals of the Restricted Error Correction Model

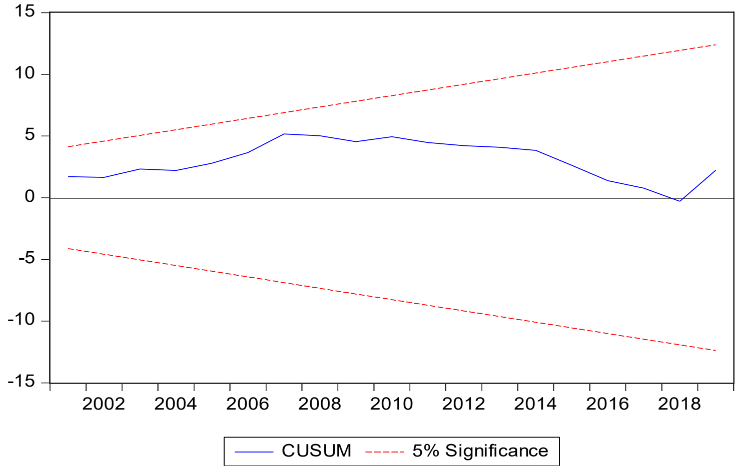


Figure 5: Plot of Cumulative Sum of Recursive Residuals of the Restricted Error Correction Model

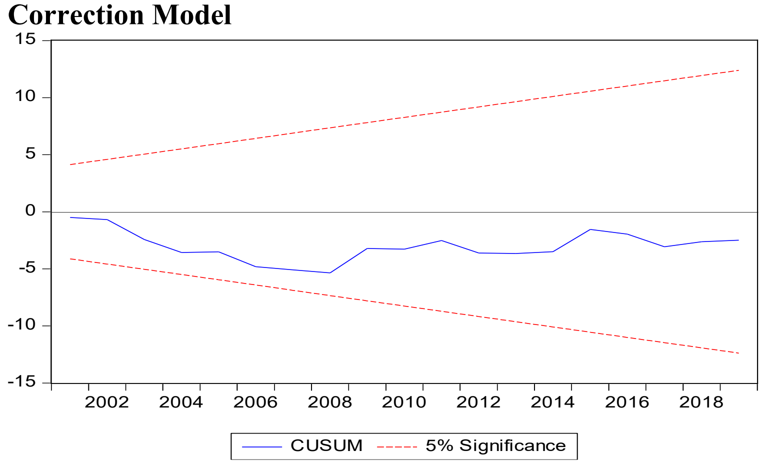
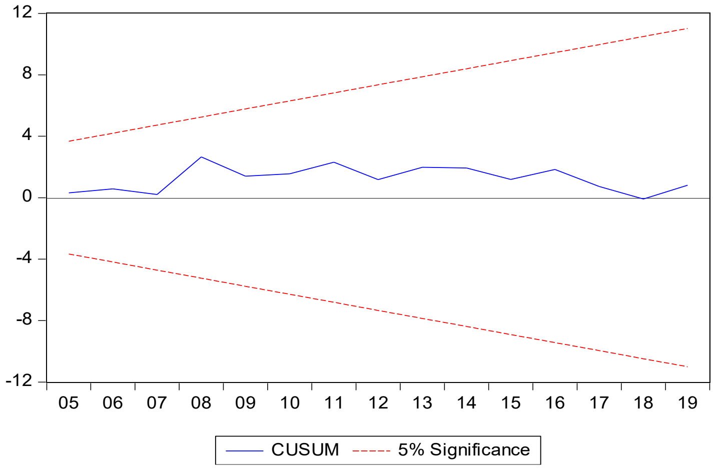


Figure 6: Plot of Cumulative Sum of Recursive Residuals of the Restricted Error Correction Model



Conclusion

This study examined the impact of trade openness on infant mortality, adult mortality, and life expectancy in Nigeria. The findings indicate that growth in trade openness, real gross domestic product, and the real exchange rate all contribute to a decrease in infant mortality in both the short-run and the long-run. Conversely, an increase in foreign direct investment is associated with a rise in infant mortality. Additionally, a positive change in net exports also leads to a reduction in infant mortality. The study confirmed a long-term relationship between trade and infant mortality in Nigeria. Regarding adult mortality, only real GDP and the real exchange rate positively affect the adult mortality rate in both the short-run and the long-run. Changes in other variables adversely impact the adult mortality rate. Furthermore, while trade openness and net exports improve life expectancy in the short-run, they have a negative effect in the long-run. The analysis also confirmed a long-run relationship between trade and life expectancy in Nigeria. The Restricted Error Correction Model indicated that it would take more than two years for the system to return to equilibrium following any shock that causes disequilibrium. Therefore, increasing trade openness, tailored to the country's specific conditions, should remain a crucial objective—not only for economic advancement but also for enhancing human welfare and health in Nigeria.

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