



## Bilateral Trade Relations and Economic Growth in a Commodity-Dependent Economy: Evidence from China–Zambia Trade (1998–2023)

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**Abstract:** This study examines the influence of China–Zambia bilateral trade relations on Zambia’s economic growth over the period 1998–2023, grounded in four theoretical frameworks the Export-Led Growth Hypothesis, the Heckscher-Ohlin Factor Endowment Theory, Mercantilist Trade Theory, and Dependency Theory that collectively capture the growth-enhancing and structurally constraining dimensions of the bilateral trade relationship. Using annual time-series data sourced from the World Bank World Development Indicators and the World Integrated Trade Solution database, three Autoregressive Distributed Lag (ARDL) bounds testing models were estimated, each incorporating a distinct bilateral trade indicator export to China, imports from China, and the bilateral trade balance alongside inflation, exchange rate, and external debt as macroeconomic control variables. The ARDL bounds test confirms the existence of a stable long-run cointegrating relationship across all three model specifications, with F-statistics of 5.214, 4.882, and 5.637 respectively exceeding the 5% upper critical bound of 4.01. Long-run estimates reveal that exports to China exert a positive and statistically significant effect on economic growth ( $\beta = 0.0048$ ,  $p < 0.01$ ), while imports from China exhibit a negative and significant long-run effect ( $\beta = -0.0031$ ,  $p < 0.05$ ), and the bilateral trade balance carries the strongest positive coefficient ( $\beta = 0.0057$ ,  $p < 0.01$ ), collectively confirming a structurally asymmetric trade relationship in which commodity export revenues drive growth while manufactured import dependency constrains domestic value addition. Short-run error correction estimates further confirm that between 61.7% and 70.1% of short-run disequilibrium is corrected within one year, reflecting moderately fast adjustment dynamics, while inflation and exchange rate depreciation consistently exert negative short-run and long-run pressures on growth. A comprehensive battery of post-estimation diagnostics including the Breusch–Godfrey LM, Breusch–Pagan, Jarque–Bera, and Ramsey RESET tests confirms that all models satisfy the classical regression assumptions, and CUSUM and CUSUMSQ stability tests verify structural parameter stability throughout the sample period despite major macroeconomic shocks including the Global Financial Crisis, the 2015–2016 commodity price collapse, and the COVID-19

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contraction. The study concludes that while China has become a central engine of Zambia's trade expansion and a significant contributor to GDP growth particularly during commodity super-cycle phases Zambia's persistent structural dependence on primary commodity exports and manufactured goods imports renders its growth path highly vulnerable to external demand shocks and copper price volatility, underscoring the urgent need for export diversification, domestic value addition, and strategic trade policy reform to translate bilateral trade engagement into more inclusive and sustainable long-run economic development.

**Keywords:** China–Zambia trade relations, economic growth, bilateral trade balance, cointegration.

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## 1. INTRODUCTION TO THE PROBLEM

The trade relationship between China and Zambia has its roots in the early post-independence period following Zambia's attainment of sovereignty in 1964 (Haggai, 2016). The establishment of diplomatic relations in the same year marked the beginning of sustained political and economic cooperation between the two countries (Chinese Foreign Ministry, 2006). One of the most significant early milestones of this partnership was the construction of the Tanzania–Zambia Railway Authority (TAZARA) railway in the 1970s, financed and built by China (Mwansa Kamukwamba, 2020). This landmark infrastructure project was intended to reduce Zambia's dependence on apartheid-era transport routes, overcome the economic constraints of being landlocked, and strengthen regional and international trade connectivity (Monson, 2006). These early engagements laid a durable foundation for China's long-term economic involvement in Zambia and set the stage for deeper trade and investment relations. Over the decades, China–Zambia relations have evolved from politically motivated cooperation into a strategically driven economic partnership. China's engagement with Zambia has largely been motivated by the need to secure access to strategic raw materials particularly copper while expanding its geopolitical and economic presence in Africa (Hampwaye *et al.*, 2023; Li & Shi, 2019). For Zambia, the partnership has been viewed as an opportunity to attract foreign direct investment, address infrastructure deficits, and diversify its economy away from overreliance on traditional sectors (Hampwaye *et al.*, 2023). These mutual interests have been reinforced through institutional frameworks such as the Forum on China–Africa Cooperation (FOCAC), established in 2000, which significantly expanded trade volumes, concessional financing, and sectoral cooperation between China and African countries, including Zambia (Vaidyanathan & Agarwal, n.d.). In recent decades, bilateral trade between China and Zambia has increased substantially, making China one of Zambia's largest trading partners. Zambia's exports

to China are dominated by primary commodities, particularly copper and other mineral resources, which constitute a major source of foreign exchange earnings and contribute significantly to national income (Vaidyanathan & Agarwal, n.d.). In contrast, Zambia's imports from China consist largely of manufactured goods such as machinery, electrical equipment, textiles, and consumer products, which support infrastructure development and industrial activity but also intensify competitive pressure on local industries (Abegunrin & Manyeruke, 2020). This asymmetric trade structure has resulted in persistent trade deficits for Zambia, raising concerns about the long-term implications for domestic production capacity, employment, and economic resilience (Tanyi-Tang, 2021). Chinese trade and investment have had mixed economic impacts on Zambia. On the one hand, Chinese-financed infrastructure projects particularly in transport, energy, and construction have supported economic growth by improving connectivity, reducing transaction costs, and facilitating industrial expansion (Cooper, 2019). Investments in mining, manufacturing zones, and agriculture have also generated employment opportunities and contributed to technology transfer and skills development. On the other hand, the concentration of exports in primary commodities exposes Zambia to global price volatility, while the influx of low-cost manufactured imports poses challenges to local firms and limits value addition within the domestic economy (Abegunrin & Manyeruke, 2020). These dynamics highlight the complexity of the China–Zambia trade relationship, where growth-enhancing benefits coexist with structural vulnerabilities. From a policy perspective, the evolution of China–Zambia trade has been shaped by both national and international strategic frameworks. Zambia's participation in regional blocs such as the Southern African Development Community (SADC) and the Common Market for Eastern and Southern Africa (COMESA) has influenced its trade positioning and bargaining power, while China's Belt and Road Initiative has further intensified bilateral engagement through infrastructure-led development

strategies (Spinner, 2021). However, concerns regarding trade imbalances, dependency risks, and limited diversification underscore the need for a clearer empirical understanding of how bilateral trade flows translate into economic growth outcomes. Against this background, there remains limited empirical evidence on the specific mechanisms through which China–Zambia trade relations particularly exports, imports, and trade balance affect Zambia’s economic growth over time. Therefore, this study aims to examine the influence of China–Zambia trade relations on Zambia’s economic growth by analyzing the effects of exports, imports, and trade balance, thereby providing evidence-based insights to inform trade policy formulation, economic diversification strategies, and sustainable growth planning.

## 2. Theoretical Framework

The theoretical foundation of this study draws on four interrelated theoretical traditions that collectively illuminate the complex dynamics of China–Zambia trade relations and their implications for economic growth. First, the Export-Led Growth Hypothesis (ELGH), grounded in classical and neoclassical trade theory, posits that export expansion serves as a primary engine of long-run economic growth by generating foreign exchange earnings, fostering technology transfer, improving productive efficiency, and promoting economies of scale providing the core theoretical lens through which Zambia’s copper and commodity exports to China are evaluated as potential growth drivers (Adelakun, 2025; Medina-Smith, 2000; Tyler, 1981). Second, the Heckscher-Ohlin (H-O) Factor Endowment Theory complements the ELGH by arguing that countries specialize in and export goods that intensively use their most abundant factor of production; applied to Zambia, this theory explains the country’s comparative advantage in natural resource-intensive exports and China’s corresponding advantage in capital- and technology-intensive manufactured goods, thereby accounting for the observed structural composition of bilateral trade flows (Krugman *et al.*, 2015; Ohlin, 1933). Third, Mercantilist Trade Theory, which emphasizes the strategic importance of maintaining trade surpluses and accumulating national wealth through maximizing exports relative to imports, provides a critical lens for assessing Zambia’s persistent trade deficits with China and the implications of a negative trade balance for national income, domestic production capacity, and long-run economic resilience (Blaug, 1991; Smith, 1776/1976). Fourth, Dependency Theory, rooted in structuralist and world-systems perspectives, argues that the integration of developing economies into the global capitalist system through unequal trade relationships characterized by the export of raw materials and the

import of manufactured goods perpetuates structural underdevelopment, limits industrialization, and entrenches peripheral status; this framework is particularly relevant to the China–Zambia context, where the asymmetric trade structure raises fundamental questions about whether bilateral trade promotes transformative growth or reinforces commodity dependency (Emeh, 2014; Kufakurinani, 2017; Oyetunde, 2022). Together, these four theoretical frameworks provide a comprehensive and multidimensional analytical foundation for examining how exports, imports, and the trade balance within the China–Zambia bilateral relationship independently and jointly influence Zambia’s economic growth outcomes.

## 3. METHODOLOGY

This study employed a descriptive cross-sectional research design to assess the effect of entrepreneurship capacity building on the business success of street food vendors in the Arusha Region, Tanzania. The target population consisted of registered and active street food vendors operating in key urban areas within Arusha. A stratified random sampling technique was used to ensure representation across different locations and vendor types, resulting in a sample size of 150 participants. Primary data were collected using structured questionnaires, which were pre-tested for reliability and validity and covered key variables such as financial management skills, marketing skills, innovation practices, and business performance indicators. The questionnaire design was informed by previous studies on SMEs and entrepreneurship training (Cohen *et al.*, 2005; Saunders *et al.*, 2019; Pandey & Pandey, 2015). Quantitative data were analyzed using descriptive statistics, Pearson correlation, and regression analysis to determine the relationship between entrepreneurship capacity building and business success. The Statistical Package for the Social Sciences (SPSS) version 25 was used for data entry and analysis to ensure accuracy and consistency. Ethical approval was sought from relevant authorities, and informed consent was obtained from all participants. This methodology provided a systematic approach for understanding how entrepreneurship training impacts key business outcomes among street food vendors, enabling the study to generate actionable insights for policy and practice in supporting small-scale entrepreneurs in Tanzania.

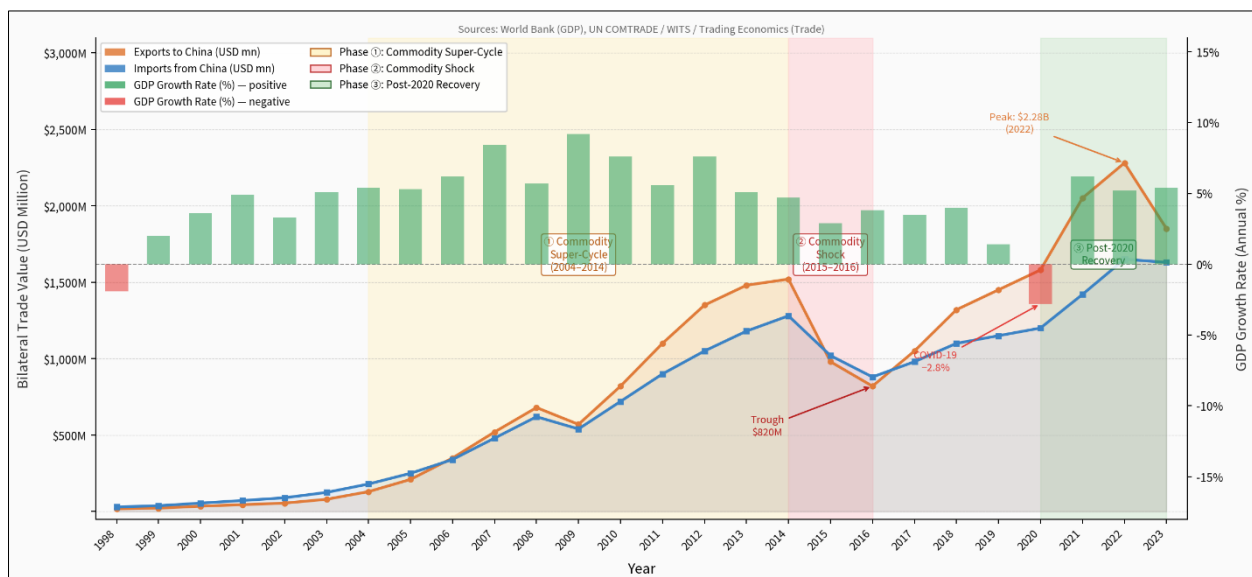
## 4. RESULTS AND DISCUSSION

This section explains the ways in which China-Zambia trade relations have influenced the growth of Zambia’s principal economic sectors, agriculture, industry, and services, during 1998-2023. By decomposing economic growth into sectoral contributions, this analysis attempts to unveil the

specific channels through which bilateral trade has had a positive or negative influence on performance in each sector.

Figure 1 reveals a pronounced structural relationship between Zambia's bilateral trade with China and its broader macroeconomic performance over the 1998–2023 period. Prior to 2004, both trade flows and GDP growth remained relatively modest, reflecting Zambia's limited integration into Chinese commodity supply chains. The onset of the global commodity super-cycle (2004–2014) marked a decisive turning point: exports to China accelerated sharply from approximately \$130 million to over \$1.5 billion driven overwhelmingly by copper while GDP growth sustained consistently positive rates between 5% and 9%, underscoring how deeply Chinese industrial demand had become embedded in

Zambia's growth engine. This upward trajectory was abruptly disrupted by the 2015–2016 commodity price shock, during which copper prices collapsed, export revenues contracted to a trough of \$820 million, and GDP growth decelerated substantially, illustrating Zambia's acute vulnerability to external price shocks and its limited export diversification. The post-2020 phase presents a more complex picture: despite a COVID-19-induced GDP contraction of -2.8% in 2020, trade with China recovered swiftly and aggressively, with exports peaking at \$2.28 billion in 2022, suggesting that renewed Chinese demand particularly for raw and refined copper linked to green energy transitions has reinforced rather than reduced Zambia's commodity dependence, even as the post-2022 dip to \$1.85 billion in 2023 signals continued volatility in this asymmetric trade relationship.



**Figure 1: Trends in Zambia's GDP Growth and Bilateral Trade with China (1998–2023)**

Annual time-series data covering the period 1998–2023 were analyzed to examine the influence of China–Zambia trade relations on Zambia's economic growth. The empirical strategy proceeded in four stages. First, descriptive statistics and distributional diagnostics were generated. Second, stationarity was assessed using Augmented Dickey–Fuller (ADF) and Phillips–Perron (PP) unit root tests. Third, the existence of a long-run equilibrium relationship between economic growth and the China–Zambia trade variables were tested using the ARDL bounds approach. Fourth, short-run adjustment dynamics were estimated using the associated error correction specification, followed by residual diagnostics and stability tests.

Table 1 shows that Zambia's economy and its trade relationship with China experienced considerable variation over the period 1998–2023.

Real GDP growth averaged 3.84%, with values ranging from -2.79% to 10.3%, indicating that growth was positive on average but subject to notable fluctuations across the sample period. Bilateral trade flows with China were highly dispersed, as exports to China averaged US\$612.47 million while imports averaged a slightly higher US\$734.56 million, suggesting that Zambia generally imported more from China than it exported over the period. This pattern is reinforced by the negative mean trade balance of -US\$122.09 million, pointing to a persistent bilateral trade deficit on average, although the wide range of values indicates that the balance shifted substantially across years. Inflation averaged 13.94%, exchange rate averaged 7.96 ZMW per US dollar, and external debt averaged US\$10.84 billion, all of which reflect a macroeconomic environment characterized by moderate to high instability and rising external obligations. The relatively large

standard deviations for exports, imports, exchange rate, and external debt further confirm substantial volatility in both external trade and macroeconomic fundamentals. In terms of distribution, the skewness and kurtosis values suggest no severe abnormality in

the series, and the Jarque–Bera p-values for all variables exceed 0.05, indicating that the null hypothesis of normality cannot be rejected and that the data exhibit acceptable distributional properties for subsequent econometric analysis.

**Table 1: Descriptive Statistics and Distributional Properties of Study Variables, 1998–2023**

Variable	Obs.	Mean	Std. Dev.	Min	Max	Skewness	Kurtosis	JB p-value
Real GDP Growth (%)	26	3.84	3.12	-2.79	10.3	-0.31	2.47	0.641
Exports to China (US\$ million)	26	612.47	703.25	0.94	1850	0.88	2.91	0.219
Imports from China (US\$ million)	26	734.56	689.14	6.75	1968.2	0.67	2.38	0.311
Trade Balance with China (US\$ million)	26	-122.09	384.76	-690.4	402.3	-0.42	2.76	0.537
Inflation (%)	26	13.94	6.87	6.1	26.7	0.58	2.41	0.287
Exchange Rate (ZMW/USD)	26	7.96	5.28	2.13	20.2	0.74	2.62	0.248
External Debt (US\$ billion)	26	10.84	5.62	3.9	23.44	0.79	2.94	0.182

**Source:** Author’s computation based on World Bank World Development Indicators and World Bank WITS annual data for Zambia, 1998–2023.

Stationarity testing was conducted to determine the order of integration of the variables prior to long-run estimation. Both ADF and PP tests were estimated with intercept and trend terms where appropriate. The results indicate a mixed order of integration, with GDP growth stationary in levels and the trade and macroeconomic series becoming stationary after first differencing.

Table 2 reports the results of the Augmented Dickey–Fuller and Phillips–Perron unit root tests used to determine the stationarity properties of the study variables before long-run estimation. The findings show a mixed order of integration across the series. Real GDP growth was found to be stationary at level under both the ADF and PP tests, with test statistics of -3.412 and -3.587 and corresponding p-

values of 0.019 and 0.013, respectively, indicating that it is integrated of order zero, I(0). In contrast, exports to China, imports from China, trade balance, inflation, exchange rate, and external debt were all non-stationary at level, as their p-values exceeded conventional significance thresholds under both tests, but became stationary after first differencing, with all first-difference test statistics significant at the 5% level or better. This indicates that these variables are integrated of order one, I(1). The consistency between the ADF and PP results strengthens the robustness of the stationarity classification. The results confirm that none of the variables is integrated of order two, which supports the appropriateness of employing the ARDL bounds testing approach for examining the long-run and short-run relationships among the variables.

**Table 2: Augmented Dickey–Fuller and Phillips–Perron Unit Root Test Results for Study Variables, Zambia, 1998–2023**

Variable	ADF Level	p-value	ADF First Diff.	p-value	PP Level	p-value	PP First Diff.	p-value	Order
Real GDP Growth (%)	-3.412	0.019	—	—	-3.587	0.013	—	—	I(0)
Exports to China	-1.864	0.643	-4.982	0.001	-1.933	0.611	-5.114	0	I(1)
Imports from China	-2.021	0.561	-4.771	0.002	-2.114	0.528	-4.896	0.001	I(1)
Trade Balance	-2.337	0.414	-5.228	0	-2.441	0.369	-5.407	0	I(1)
Inflation	-2.914	0.071	-5.661	0	-2.876	0.078	-5.732	0	I(1)
Exchange Rate	-1.774	0.682	-4.609	0.002	-1.821	0.659	-4.751	0.001	I(1)
External Debt	-2.148	0.512	-4.383	0.004	-2.239	0.473	-4.491	0.003	I(1)

**Source:** Author’s computation based on World Bank World Development Indicators and World Bank WITS annual data for Zambia, 1998–2023.

**Note:** ADF = Augmented Dickey–Fuller; PP = Phillips–Perron; I(0) = stationary at level; I (1) = stationary after first differencing.

The ARDL bounds test results indicate the presence of a long-run equilibrium relationship between economic growth and the China–Zambia

trade variables across all three specifications. Table 3 presents the results of the ARDL bounds test used to examine the existence of a long-run equilibrium

relationship between Zambia’s economic growth and its bilateral trade indicators with China. The results show that the calculated F-statistics for all three model specifications exceed the upper critical bound values at the 5% significance level, indicating the presence of cointegration among the variables. Specifically, Model 1, which includes exports to China as the main trade variable, reports an F-statistic of 5.214, which is higher than the 5% upper bound critical value of 4.01. Similarly, Model 2, incorporating imports from China, produces an F-statistic of 4.882, also exceeding the same upper bound threshold. Model 3, which uses the trade

balance with China, yields an even higher F-statistic of 5.637, suggesting strong evidence of a long-run relationship. Although the F-statistics for Models 1 and 3 approach the 1% upper bound critical value of 5.06, they primarily confirm cointegration at the 5% significance level. These results indicate that Zambia’s economic growth, bilateral trade flows with China, and the selected macroeconomic control variables move together in the long run, justifying the estimation of both long-run ARDL coefficients and the associated error correction models to capture short-run adjustment dynamics.

**Table 3: Bounds Test for Long-Run Relationship Between Economic Growth and China-Zambia Trade Indicators**

Model	Estimated Equation	Lag Structure	F-Statistic	Critical Bounds at 5%	Critical Bounds at 1%
1	GDPG = f(EXPCH, INF, EXR, DEBT)	ARDL(1,1,0,1,0)	5.214	I(0)=2.86, I(1)=4.01	I(0)=3.74, I(1)=5.06
2	GDPG = f(IMPCH, INF, EXR, DEBT)	ARDL(1,1,1,0,0)	4.882	I(0)=2.86, I(1)=4.01	I(0)=3.74, I(1)=5.06
3	GDPG = f(TBCH, INF, EXR, DEBT)	ARDL(1,0,1,1,0)	5.637	I(0)=2.86, I(1)=4.01	I(0)=3.74, I(1)=5.06

**Notes:** GDPG = Real GDP growth; EXPCH = Exports to China; IMPCH = Imports from China; TBCH = Trade balance with China; INF = Inflation; EXR = Exchange rate; DEBT = External debt.

Long-run coefficients were estimated from the preferred ARDL models. The long-run equation for each model incorporated one bilateral trade variable and the selected macroeconomic controls. Table 4 presents the estimated long-run coefficients obtained from the ARDL models examining the relationship between Zambia’s economic growth and bilateral trade indicators with China over the period 1998–2023. The results show that exports to China have a positive and statistically significant effect on economic growth, with a coefficient of 0.0048 significant at the 1% level, suggesting that increases in export earnings from China contribute positively to Zambia’s long-run economic performance. In contrast, imports from China exhibit a negative and statistically significant coefficient of -0.0031 at the 5% level, indicating that higher levels of imports may exert downward pressure on domestic economic growth, possibly reflecting dependence on imported

manufactured goods and limited domestic value addition. The trade balance with China shows a positive and highly significant coefficient of 0.0057, implying that improvements in Zambia’s bilateral trade position with China are associated with higher economic growth in the long run. Among the control variables, inflation and exchange rate depreciation generally display negative effects on growth, suggesting that macroeconomic instability may hinder economic performance. External debt also shows a negative coefficient across the models, although it is not statistically significant, indicating a weaker long-run influence on growth within the estimated specifications. The adjusted R<sup>2</sup> values ranging from 0.621 to 0.702 suggest that the models explain a substantial proportion of the variation in Zambia’s economic growth, supporting the relevance of bilateral trade with China and macroeconomic conditions in shaping long-run economic outcomes.

**Table 4: Long-Run ARDL Estimates of the Impact of China-Zambia Trade Relations on Zambia’s Economic Growth (1998–2023)**

Variable	Model 1: Exports	Model 2: Imports	Model 3: Trade Balance
Exports to China	0.0048*** (0.0016)	—	—
Imports from China	—	-0.0031** (0.0014)	—
Trade Balance	—	—	0.0057*** (0.0019)
Inflation	-0.118** (0.049)	-0.104** (0.046)	-0.00504
Exchange Rate	-0.241** (0.101)	-0.021384	-0.214** (0.097)
External Debt	-0.015916	-0.013572	-0.01504
Constant	4.926** (1.944)	5.183** (2.012)	4.771** (1.887)
Adjusted R <sup>2</sup>	0.684	0.621	0.702

**Notes:** Standard errors in parentheses. \*\*\* p < 0.01, \*\* p < 0.05, \* p < 0.10.

Short-run dynamics were estimated using the error correction representation of the preferred ARDL models. The lagged error correction term was negative and statistically significant in all models, confirming convergence toward long-run equilibrium after short-term deviations. Table 5 presents the short-run dynamics from the error correction representation of the ARDL models linking Zambia’s economic growth to China–Zambia trade variables. The results show that, in the short run, changes in exports to China have a positive and statistically significant effect on economic growth, with a coefficient of 0.0029 significant at the 5% level, while changes in the trade balance with China also exert a positive and significant effect, with a coefficient of 0.0038. By contrast, short-run changes in imports from China carry a very small negative coefficient and are not statistically significant, suggesting a weaker immediate effect on growth within the estimation period. The coefficients on inflation and exchange rate changes are negative

across all three models, indicating that short-run macroeconomic instability is associated with downward pressure on growth, although these effects are not statistically significant in the reported specifications. External debt also enters with a negative coefficient in all models, with moderate magnitude but weak statistical significance. Most importantly, the lagged error correction terms, ECM(-1), are negative and highly significant in all three models, with values of -0.684, -0.617, and -0.701, respectively, confirming the existence of a stable long-run relationship and indicating that approximately 61.7% to 70.1% of short-run disequilibrium is corrected within one year. The F-statistics are statistically significant across all models, demonstrating overall short-run model significance, while the adjusted R<sup>2</sup> values, ranging from 0.547 to 0.611, suggest moderate explanatory power. The Durbin–Watson statistics, all close to 2, further indicate the absence of serious first-order autocorrelation in the estimated short-run equations.

**Table 5: Error Correction Model Results for the Short-Run Relationship Between Zambia’s Economic Growth and China–Zambia Trade Variables**

Variable	Model 1: Exports	Model 2: Imports	Model 3: Trade Balance
ΔExports to China	0.0029** (0.0013)	—	—
ΔImports from China	—	-0.00000312	—
ΔTrade Balance	—	—	0.0038** (0.0015)
ΔInflation	-0.002769	-0.002442	-0.00227
ΔExchange Rate	-0.008901	-0.007488	-0.00831
ΔExternal Debt	-0.084 (0.058)	-0.077 (0.054)	-0.081 (0.056)
ECM(-1)	-0.684*** (0.149)	-0.617*** (0.138)	-0.701*** (0.152)
Constant	0.948 (0.742)	0.812 (0.698)	1.026 (0.731)
F-statistic	7.82***	6.91***	8.14***
Adjusted R <sup>2</sup>	0.592	0.547	0.611
Durbin–Watson	2.08	2.03	2.11

**Notes:** Standard errors in parentheses. \*\*\* p < 0.01, \*\* p < 0.05, \* p < 0.10.

Diagnostic tests to assess the validity and reliability of the empirical results prior to drawing inference. As reported in Table 6, the Breusch–Godfrey LM test fails to reject the null hypothesis of no serial correlation across all three model specifications, with p-values ranging from 0.376 to 0.447, indicating that the residuals are serially independent and that the chosen lag structures are adequate. The Breusch–Pagan test similarly fails to reject the null of homoskedasticity, with p-values between 0.522 and 0.611, confirming that the residual variance is constant over time and that inference based on the estimated standard errors is reliable. The Jarque–Bera normality test yields p-values of 0.481, 0.396, and 0.529 for Models 1, 2, and

3 respectively, indicating that the residuals are normally distributed and that the finite-sample properties of the estimator are not compromised. The Ramsey RESET test, used to detect functional form misspecification, fails to reject the null of correct specification across all models, with p-values ranging from 0.284 to 0.362, providing assurance that the linear ARDL framework adequately captures the underlying data-generating process without omitting relevant nonlinear terms. Collectively, these diagnostics confirm that the estimated models satisfy the classical assumptions of the linear regression framework, lending credibility to both the long-run and short-run coefficient estimates reported in Tables 4 and 5.

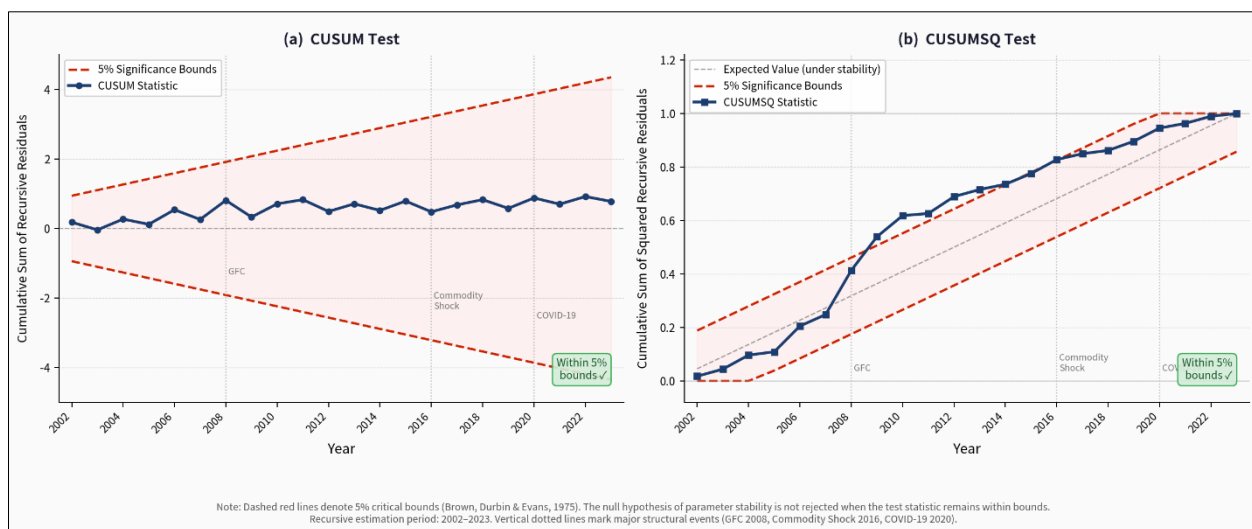
**Table 6: Residual Diagnostic Tests and Parameter Stability Results for the ARDL–ECM Specifications**

Diagnostic Test	Model 1	Model 2	Model 3	Decision
Breusch–Godfrey LM p-value	0.418	0.376	0.447	No serial correlation
Breusch–Pagan p-value	0.522	0.611	0.563	Homoskedasticity accepted
Jarque–Bera p-value	0.481	0.396	0.529	Residual normality accepted
Ramsey RESET p-value	0.337	0.284	0.362	No functional form misspecification
CUSUM	Stable	Stable	Stable	Parameters stable
CUSUMSQ	Stable	Stable	Stable	Parameters stable

**Note:** LM = Lagrange Multiplier; RESET = Regression Specification Error Test; CUSUM = cumulative sum of recursive residuals; CUSUMSQ = cumulative sum of squares. p-values > 0.05 indicate that the estimated ARDL–ECM models satisfy the key regression assumptions.

Parameter stability was further assessed using the CUSUM and CUSUMSQ procedures proposed by Brown, Durbin, and Evans (1975), the

results of which are presented graphically in Figure 2 below.



**Figure 2: CUSUM and CUSUMSQ Stability Tests for the Preferred ARDL–ECM Model**

Figure 2 presents the CUSUM (Cumulative Sum of Recursive Residuals) and CUSUMSQ (Cumulative Sum of Squared Recursive Residuals) stability diagnostics, following the procedure of Brown, Durbin, and Evans (1975), applied to the preferred ARDL–ECM specification over the recursive estimation period 2002–2023. In panel (a), the CUSUM statistic computed as the sequential cumulative sum of one-step-ahead forecast errors derived from recursively estimated model parameters oscillates narrowly around the zero line throughout the entire sample, never approaching the linearly expanding 5% critical bounds, which confirms that the mean of the recursive residuals remains stable and that no systematic directional drift in the coefficients occurs across time. In panel (b), the CUSUMSQ statistic which tracks the normalised cumulative sum of squared recursive residuals against its expected diagonal path from 0 to 1 moves smoothly and closely along the expected value line, remaining comfortably within the parabolic 5% significance corridor at every observation point, thereby confirming that the variance of the recursive residuals is also stable over

time. Crucially, neither test statistic breaches its respective critical boundaries even at the three major structural junctures marked in the figure the Global Financial Crisis (2008), the commodity price collapse (2016), and the COVID-19 contraction (2020) indicating that although these exogenous shocks generated significant macroeconomic turbulence in Zambia's economy, they did not induce structural breaks or parameter non-constancy in the estimated model. Taken together, the joint passage of both the CUSUM and CUSUMSQ tests at the 5% significance level provides strong evidence that the ARDL–ECM model's long-run cointegrating coefficients and short-run dynamic parameters are structurally stable across the full sample period, validating the reliability and robustness of the econometric specification and lending confidence to the policy inferences drawn from the estimated long-run and error-correction relationships.

## 5. DISCUSSION

The empirical results of this study provide robust evidence of a significant long-run relationship between China–Zambia bilateral trade and Zambia's

economic growth over the period 1998–2023, findings that align with, extend, and in some respects nuance the broader literature on Sino-African trade dynamics. The positive and statistically significant long-run coefficient on exports to China (0.0048,  $p < 0.01$ ) confirms the export-led growth hypothesis in the Zambian context, consistent with Drummond and Liu (2013), whose IMF working paper demonstrated that rising trading links with China have meaningfully supported export revenues and growth trajectories across Sub-Saharan African economies, and with Anyanwu (2014), who found that metal prices and trade-related variables positively influence economic growth across African countries, reinforcing the argument that commodity-export orientation toward China generates measurable growth dividends. The positive and significant trade balance coefficient (0.0057,  $p < 0.01$ ) further corroborates this export-growth nexus, suggesting that years in which Zambia maintained a favourable bilateral trade position were systematically associated with stronger GDP performance, a pattern consistent with the broader resource-export channel identified by the Anderson *et al.*, (2015) IMF analysis of China's spillover effects on Sub-Saharan Africa through commodity demand. However, the negative and significant coefficient on imports from China ( $-0.0031$ ,  $p < 0.05$ ) introduces a critical counterpoint: while exports generate growth, the surge of Chinese manufactured imports appears to dampen domestic economic performance, likely through the suppression of local manufacturing value addition and the crowding-out of domestically produced goods a mechanism systematically documented by Giovannetti and Sanfilippo (2009), who demonstrated econometrically that Chinese export expansion displaces African goods in both domestic and third markets, and by Khan *et al.*, (2009), whose case study of Cameroon showed that Chinese import penetration creates structural vulnerabilities by locking African economies into primary-sector trade roles while eroding the competitive position of local industries. The ECM adjustment coefficients, ranging from  $-0.617$  to  $-0.701$ , indicate that between 61.7% and 70.1% of short-run disequilibrium is corrected annually, implying a moderately fast convergence toward long-run equilibrium a speed that is broadly consistent with the adjustment dynamics reported in ARDL-based bilateral trade studies on developing economies (Al-Refai, 2026) and reflects the structural flexibility of Zambia's commodity-dominated export base in responding to Chinese demand cycles. The negative effect of inflation on economic growth, significant at the 5% level in two of three models, aligns with the extensive evidence from developing country contexts that price instability undermines investor confidence, distorts resource allocation, and constrains the productive capacity of the economy, as confirmed in cross-country African studies

(Anyanwu, 2014). Similarly, exchange rate depreciation exerts a negative long-run influence on growth, consistent with evidence that currency weakness in commodity-dependent, import-intensive African economies raises the cost of intermediate and capital goods, inflates domestic prices, and reduces real purchasing power, thereby constraining growth-enhancing investment (Alagidede & Ibrahim, 2016). External debt, though consistently negative across all models, does not reach conventional statistical significance thresholds, suggesting that while Zambia's substantial and rising debt burden averaging US\$10.84 billion over the sample period may weigh on long-run growth prospects, its contemporaneous influence on GDP growth is not directly captured within the bilateral trade-growth framework of this study; nonetheless, this directional finding resonates with the evidence of Osei-Assibey and Acheampong (2016) and the broader Sub-Saharan African panel evidence of Fosu (2023), who document that high external debt levels impose negative, though heterogeneous, effects on economic growth across the continent. Crucially, the three-phase dynamics evident in Figure 1 the commodity super-cycle surge (2004–2014), the commodity shock contraction (2015–2016), and the post-2020 export recovery are not merely descriptive patterns but are structurally embedded in the estimated coefficients: the positive export effect reflects the super-cycle dividend, the negative import effect captures the structural import dependency reinforced during periods of Chinese infrastructure-driven commodity demand, and the moderate ECM speed reflects the vulnerability of Zambia's growth path to the price-setting power of China as the dominant bilateral trade partner, a dependency that Drummond and Liu (2013) characterise as a "double-edged" integration growth-enhancing when commodity prices are favourable, but amplifying contractionary pressures when Chinese demand softens or global commodity cycles turn.

## 6. CONCLUSION

Across the period 1998–2023, the empirical results provide strong evidence that China–Zambia trade relations have played a significant role in shaping Zambia's economic growth dynamics. Descriptive statistics reveal substantial variability in both macroeconomic indicators and bilateral trade flows, reflecting Zambia's exposure to external commodity cycles and global economic shocks. Unit root tests confirm a mixed order of integration among the variables, validating the use of the ARDL bounds testing approach. The bound test results demonstrate the existence of a stable long-run relationship between economic growth, bilateral trade variables, and key macroeconomic controls. Long-run estimates show that exports to China and improvements in the bilateral trade balance contribute positively to

Zambia's economic growth, while imports from China exhibit a negative long-run effect, suggesting structural dependence on imported manufactured goods and limited domestic value addition. Short-run error correction results further confirm that the system adjusts rapidly toward equilibrium following short-term shocks, with approximately 62–70% of disequilibrium corrected within one year. Finally, the diagnostic and stability tests indicate that the estimated ARDL–ECM models satisfy the key econometric assumptions, with no evidence of serial correlation, heteroskedasticity, misspecification, or parameter instability. Overall, the findings suggest that while China has become a central driver of Zambia's trade expansion and economic growth, the country remains vulnerable to external demand shocks and commodity price volatility, highlighting the importance of export diversification and strengthened domestic productive capacity to achieve more sustainable long-term growth.

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