

See discussions, stats, and author profiles for this publication at: <https://www.researchgate.net/publication/396969042>

Impact of Macroeconomic Variables on Container Throughput: The Case Study of Sri Lanka

Conference Paper · October 2025

CITATIONS

0

READS

9

3 authors, including:



Chathula Jayabanu Nayanalochana

University of Colombo

7 PUBLICATIONS 2 CITATIONS

SEE PROFILE



Samathanam Joseph Francis

University of Colombo

30 PUBLICATIONS 43 CITATIONS

SEE PROFILE

Impact of Macroeconomic Variables on Container Throughput: The Case Study of Sri Lanka

A.M. Thalagala*, P.C.J. Nayanalochana, and S.J. Francis

Department of Economics, University of Colombo

**ayomi.thalagala@gmail.com*

Keywords: Container Throughput, Direct Inward and Outward Movements, ARDL Model, Macroeconomic Variables, Time Series Analysis

Introduction

Container shipping plays an essential role in international trade, facilitating the efficient, secure, and standardized cargo movements between countries. Container throughput, typically measured in Twenty-Foot Equivalent Units (TEU), is the volume of cargo transported in containers through ports, including inward, outward movements, re-stowing, and transshipments. It is an important indicator to measure port efficiency and competitiveness (World Bank, 2025).

Previous studies show that container throughput is closely associated with macroeconomic conditions. GDP and GDP per capita are positively correlated with container demand, as economic growth stimulates both production and consumption (Matczak, 2020; Rashid, 2021). Inflation rate, exchange rate, and GDP have significant relationships with throughput, with GDP being an especially strong predictor (Iwu, 2021). While population growth contributes to containerized trade by increasing consumption and production (Rashid, 2021), foreign trade also has a very strong correlation with container turnover (Matczak, 2020).

As an island economy, Sri Lanka depends heavily on its seaports for international trade (Weerakoon & Perera, 2014). As such, this study specifically focuses on understanding the impact of domestic macroeconomic variables on direct container throughput. In this study, for clarity, container throughput refers to direct inward and outward container movements in Sri Lanka. Transshipment volumes, which involve containers handled in Sri Lanka that are destined for or arriving from other countries, are excluded from the analysis, as they are primarily influenced by external regional factors rather than Sri Lanka's macroeconomic indicators. The general objective of the study is to investigate this dynamic relationship between container throughput and macroeconomic

variables, while the specific objectives include identifying which macroeconomic variables significantly influence container throughput, analysing the long-run effects of these variables, and assessing their short-run impacts.

Methodology

This study employs a time series analysis using the Autoregressive Distributed Lag (ARDL) model to examine the relationship between macroeconomic indicators and container throughput in Sri Lanka. This research is based on annual time series data from 1994 to 2023. The data were gathered from the Central Bank of Sri Lanka and the World Bank. All real-valued macroeconomic indicators and inward/outward container movements were log-transformed to make the data more normal, stabilize the variance, and improve the accuracy of the model. Before model estimation, the stationarity of each variable was tested using the Augmented Dickey-Fuller (ADF) unit root test. The results indicated that some variables were stationary at level form (I(0)), while others became stationary after first differencing (I(1)), satisfying the precondition for the ARDL model.

In this study, inward and outward container throughput in Sri Lanka is modelled as the dependent variable using the ARDL (2,2) framework. The ARDL model includes two lagged values of container throughput and two lagged values of each of the explanatory variables: exchange rate (LKR/USD), GDP per capita growth, inflation, population growth, and trade balance. The trade balance is measured as the trade deficit, with positive values indicating a deficit. The augmented ARDL ($p, q1, q2, q3, q4, q5$) model can be specified as follows:

$$\begin{aligned} \ln INWARD_OUTWARD_THROUGHPUT_t = & \beta_0 + \\ & \sum_{i=1}^p \beta_{1i} \ln INWARD_OUTWARD_THROUGHPUT_{t-i} + \\ & \sum_{i=1}^{q1} \beta_{2i} \ln EXCHANGE_RATE_{t-i} + \\ & \sum_{i=1}^{q2} \beta_{3i} GDP_PER_CAPITA_GROWTH_{t-i} + \sum_{i=1}^{q3} \beta_{4i} INFLATION_{t-i} + \\ & \sum_{i=1}^{q4} \beta_{5i} POPULATION_GROWTH + \sum_{i=1}^{q5} \beta_{6i} \ln TRADE_BALANCE_{t-i} + \varepsilon_t \end{aligned} \quad (1)$$

The ARDL Bounds Test was conducted to test for the existence of a long-run equilibrium relationship among the variables. Once cointegration was established, the Error Correction Model (ECM) was estimated to quantify short-run adjustments. To ensure model validity, diagnostic tests were carried out. The Breusch-Godfrey LM Test was used to detect autocorrelation in the residuals of a regression model. The Breusch-Pagan-Godfrey Test was used to check

heteroskedasticity, where residual variance depends on predictors. The Jarque-Bera Test was used to check if residuals follow a normal distribution. CUSUM test and CUSUMSQ test were used to check the stability of the model over time. A VIF test was conducted to detect multicollinearity.

Results and Discussion

Table 1. ADF Test Results

Variable	Level		1st Difference	
	Intercept	Trend & Intercept	Intercept	Trend & Intercept
Inward/Outward Throughput	0.0830	0.9598	0.0002**	0.0001**
GDP per Capita Growth	0.8043	0.9226	0.0000**	0.0214*
Inflation	0.0032**	0.0158*	0.0000**	0.0000**
Population Growth	0.0211*	0.0082**	0.0000**	0.0000**
Exchange Rate	0.9892	0.9297	0.0002**	0.0008**
Trade Balance	0.5801	0.9584	0.0003**	0.001**

Source: Author generated

Note: P values are represented in table. * denotes statistical significance at 5% level and ** denotes statistical significance at 1% level.

The ADF unit root test results included in Table 1 shows that the null hypothesis of the time series having a unit root was rejected for some variables. The combination of I(0) and I(1) variables justifies the application of the ARDL model approach.

The F statistic of the bound test of 6.0037 exceeds the upper bound critical value at the 1% significance level. This result provides strong statistical evidence to reject the null hypothesis of no level relationship among the variables.

To assess the multicollinearity among the explanatory variables, the Variance Inflation Factor (VIF) was calculated. All VIF values were below the accepted threshold 5, indicating that multicollinearity is within acceptable limits.

Table 2. Cointegration results

<i>Dependent Variable: INWARD OUTWARD THROUGHPUT</i>			
Variable	coef	t-Stat	p-values
C	6.41	6.56	0.00
Exchange rate	0.86	6.60	0.00
GDP per capita growth	0.06	3.22	0.01
Inflation	-0.02	-2.89	0.01
Population growth	0.16	3.16	0.01
Trade balance	0.14	2.22	0.04

Source: Author generated

As shown in Table 2, the cointegration test results show the long-run estimation of the ARDL model which provides valuable insights to understand how macroeconomic variables influence container throughput in Sri Lanka over time. The results show that the exchange rate, GDP per capita growth, inflation, and population growth are statistically significant at the 1% level. The trade balance is significant at the 5% level. The positive and statistically significant coefficient on foreign exchange implies that a unit increase in the exchange rate is associated with a 0.86 unit increase in container throughput in the long run. The depreciation of the Sri Lankan Rupee tends to make exports more competitive because Sri Lankan goods become cheaper for foreign buyers. This encourages more exports, boosting outbound container volumes. A one unit increase in GDP per capita growth corresponds to a 0.06 unit increase in container throughput. It indicates that rising income levels stimulate trade and container activity. The results show that one unit increase in inflation leads to a 0.02 decrease in throughput. A possible explanation is that an increase in prices leads to a loss of purchasing power, so when inflation rises, the cost of trade and shipping increases, reducing container volumes. A one-unit increase in population growth leads to a 0.16 increase in container throughput. A growing population typically causes higher consumption and demand for goods, which leads to higher imports, and it may also increase the labour force, companies, and businesses, which can lead to higher exports, affecting container throughput. The trade balance variable has been interpreted in the context of Sri Lanka's continuous trade deficit. It shows that a one-unit increase in the trade deficit causes a 0.14-unit increase in the container throughput. Since most imported goods, including consumer goods and raw materials, are transported in containers, higher imports increase containerized cargo traffic.

Table 3 shows the Error Correction Model results, which represent the short-run relationships between container throughput and macroeconomic variables. The error correction term is significant and negative. The value implies that approximately 56.95% of disequilibrium from the previous period is corrected in the current period, indicating a relatively fast speed of adjustment towards the long-run equilibrium. The current GDP per capita growth and current population growth have significant positive effects on container throughput. Lagged inflation is positively significant, suggesting that past periods of high inflation may lead to increased container throughput in the short term. This may occur because past domestic inflation levels encourage people to import more goods to avoid higher future costs, as they expect prices to continue rising. However, according to the cointegration results in Table 2, inflation has a negative and significant long-run impact on container throughput. It can be because rising domestic prices cause higher production and operational costs which discourage exports, making domestically produced goods less competitive in the international market. On the other hand, high inflation usually weakens the currency, discouraging imports of goods. Hence, the first lag in the trade balance is highly significant and negative, indicating that a higher trade deficit in the previous period is associated with a reduction in container throughput in the current period, possibly due to adjustments in imports and exports or constraints on foreign exchange. Moreover, current inflation, current trade balance and exchange rate are not significant, indicating that their movements do not have an immediate impact on container throughput.

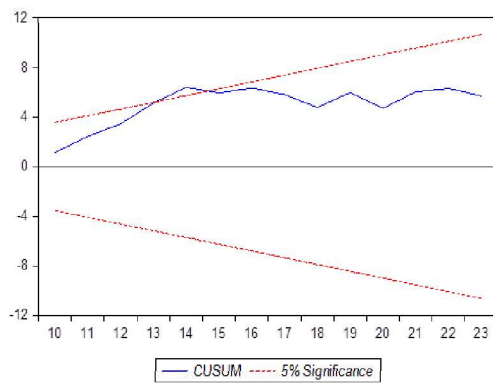
Table 3. Error Correction Model Results

<i>Dependent Variable: INWARD OUTWARD THROUGHPUT</i>			
Variable	coef	t-Stat	p-values
D(Exchange rate)	-0.0751	-0.63	0.54
D(GDP per capita growth)	0.0172	4.96	0.00
D(Inflation)	-0.0008	-0.65	0.53
D(Inflation(-1))	0.0043	3.06	0.01
D(Population growth)	0.0581	5.55	0.00
D(Trade balance)	0.0312	0.85	0.41
D(Trade balance(-1))	-0.1543	-5.23	0.00
CointEq(-1)	-0.5695	-7.75	0.00

Source: Author generated

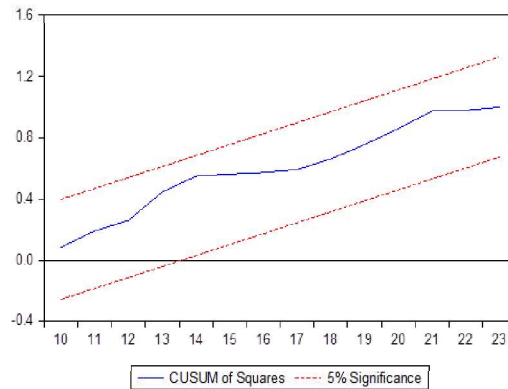
To check the ARDL model validity, diagnostic tests were conducted. The Jarque Bera test was conducted to identify whether the residuals of the model are normally distributed. Since p value (0.918) is greater than 0.05, the null hypothesis of normally distributed residuals cannot be rejected. It indicates that residuals are approximately normally distributed, satisfying one of the key assumptions of regression analysis. Serial correlation was tested using Breusch Godfrey test. The p value of F-statistic is higher than 0.05, while the p value of nR^2 is less than 0.05. Since this study involves a small sample size, the F statistic is considered more reliable. Therefore, it can be concluded that there is no strong evidence of serial correlation among residuals. The Breusch Pagan Godfrey test was conducted to examine the presence of heteroskedasticity. The p values of both the F-statistic and nR^2 are higher than 0.05 so the null hypothesis of homoskedasticity cannot be rejected.

Fig. 1. CUSUM test results



Source: Author developed

Fig. 2. CUSUM of squares test results



Source: Author developed

Both CUSUM (Figure 1) and CUSUM of Squares (Figure 2) tests were conducted to test the stability of the ARDL model. The CUSUM test results confirm that the cumulative sum of recursive residuals remains within 5% significance boundaries while the test statistic approaches the upper bound once. The CUSUM of squares test provides stronger evidence of stability at 5% significance level.

Conclusion

This study has analysed the impact of macroeconomic variables on container throughput in Sri Lanka using time series annual data from 1994 to 2023. The Autoregressive Distributed Lag (ARDL) model is employed. Using Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) unit root tests, all variables were

tested for stationarity. The ARDL Bounds Test confirms the existence of a long-run relationship among the selected macroeconomic variables and container throughput. Long-run estimation results indicate that GDP per capita growth, exchange rate, inflation, and population growth are statistically significant at the 1% level, while trade balance is significant at the 5% level. Exchange rate, population growth, GDP per capita, and the trade balance have positive impacts, while inflation shows a negative effect on container throughput. The Error Correction Model (ECM) results indicate that in the short run, GDP per capita growth, population growth, and lagged inflation show positive and significant effects on container throughput, while the lagged trade balance is significantly negative. The error correction term indicates that approximately 57% of disequilibrium from the previous period is corrected in the current period. The model's validity is supported by diagnostic tests, including normality, serial correlation, heteroskedasticity, stability, and multicollinearity. Findings suggest that domestic macroeconomic performance plays a significant role in containerized trade in Sri Lanka.

These findings have important policy implications, suggesting that economic growth strategies, population-driven infrastructure planning, and price stability measures can enhance trade efficiency and port performance. The study has several limitations. Direct container movements were estimated by subtracting transshipment volumes from total traffic. In addition, the data was reported in thousands rather than exact container counts. Future research could extend this analysis by examining the impact of South Asian macroeconomic indicators on container transshipment volumes using panel data, providing deeper insights into Sri Lanka's role as a regional transshipment hub.

References

- Central Bank of Sri Lanka. (2024). *Annual reports* [Data set]. <https://www.cbsl.gov.lk/en/publications/economic-and-financial-reports/annual-reports>
- Danthanarayana, C. T., Francis, S. J., & Kumarage, A. S. (2024). Determinants of financial shortfalls in state-owned railway systems: An ARDL approach for Sri Lanka Railways. *International Journal of Accounting & Business Finance*, 10(1), 86–116. <https://doi.org/10.4038/ijabf.v10i1.153>
- Francis, S. J., Ravinthirakumaran, N., & Ganeshamoorthy, M. (2021). The impact of macroeconomic variables on stock prices in Sri Lanka: A bounds

testing approach. *International Journal of Accounting & Business Finance*, 7(Special Issue), 68–91. <http://doi.org/10.4038/ijabf.v7i0.108>

Hassler, U., & Wolters, J. (2005). *Autoregressive distributed lag models and cointegration* (Diskussionsbeiträge No. 2005/22). Freie Universität Berlin, Fachbereich Wirtschaftswissenschaft. <https://www.econstor.eu/bitstream/10419/28020/1/507401956.PDF>

Iwu, H. C. (2021, May). *Regression model for forecasting of container throughput in APM*

Jayashani, J. H. D., & Mudunkotuwa, R. (2021). Macroeconomic performance and its impact to container throughput at Port of Colombo. *CINEC Academic Journal*, 5(1), 153–158. <https://doi.org/10.4038/caj.v5i1.84>

Matczak, M. (2020). A simplified forecasting model for the estimation of container traffic in seaports at a national level – the case of Poland. *TransNav*, 14(1), 153–158. <https://doi.org/10.12716/1001.14.01.18>

Rashid, M. R. (2021). *Forecasting long-term container port throughput: The case of Chittagong Port* (Master's thesis, University of South-Eastern Norway).

Weerakoon, D., & Perera, N. (2014). The role of Sri Lanka in enhancing connectivity between South Asia and Southeast Asia (ADBI Working Paper No. 487, p. 4). Asian Development Bank Institute. Retrieved from <https://www.adb.org/sites/default/files/publication/156342/adbi-wp487.pdf>

World Bank. (2024). World Bank Open Data [Data set]. <https://data.worldbank.org/>

World Bank. (2025). Container port throughput (TEU: 20 foot equivalent units). World Development Indicators. <https://databank.worldbank.org/metadataglossary/world-development-indicators/series/IS.SHP.GOOD.TU>

Yang, D., Zhao, Y., & Yanagita, T. (2017). A frame study of correlation analysis between open macroeconomics system and container throughput. *Transportation Research Procedia*, 25, 2784–2796. <https://doi.org/10.1016/j.trpro.2017.05.233>