The Impact of Exchange Rate Fluctuations on Singapore Residents' Consumption: An Analysis Based on the ARDL Model

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Abstract

Singapore, recognized as a leading global economy, has drawn significant interest due to its exceptional GDP per capita and distinctive consumer behavior trends. Focusing on Singapore, this research investigates how currency value volatility influences household spending and its implications for the broader economic framework. Through an examination of Singapore's recent economic indicators and consumption patterns, it was observed that exchange rate instability exerts a pronounced adverse effect on domestic expenditure. Concurrently, sustained increases in GDP per capita were shown to markedly enhance citizens' purchasing power; however, consumption patterns have evolved toward greater intricacy and heterogeneity. Utilizing empirical methods, the analysis incorporates three key variables: currency exchange rates, income per capita, and demographic size, evaluating how these factors shape Singapore's internal consumer demand. The methodology employs an autoregressive distributed lag (ARDL) framework, with historical data spanning 1980–2023 analyzed to elucidate the long-term interplay between exchange rate dynamics, income levels, and domestic spending. Additional findings indicate that Singapore's consumer expenditure is influenced not just by currency volatility and income per capita, but also by demographic scale, as population growth correlates positively with aggregate consumption levels. Long-term analyses further reveal that exchange rate instability imposes a disproportionately stronger and detrimental effect on consumer activity, whereas short-term currency variability is associated with a statistically notable boost in consumption. This study's contribution lies in clarifying both immediate and prolonged effects of exchange rate shifts on Singapore's internal consumer markets, offering empirical support for policymakers seeking to mitigate exchange rate risks and foster sustained consumption expansion. Enhanced comprehension of the linkage between currency volatility and spending enables targeted interventions to counteract adverse outcomes and bolster economic resilience through strategic exchange rate management.

Keywords: Exchange Rate Fluctuations, Singapore, GDP Per Capita, Population, ARDL

Introduction

Singapore, as a global hub for trade and finance, has an economy that is highly reliant on external trade, exhibiting a typical export-oriented economic structure. Compared to other countries, the consumption patterns of Singaporean residents are particularly sensitive to international market fluctuations. This sensitivity is primarily due to the fact that almost all consumer goods in Singapore are imported, and their prices are directly affected by exchange rate volatility. Fluctuations in the value of the Singapore dollar (SGD) not only influence the actual prices of goods but also indirectly affect consumer behavior by altering purchasing power and psychological expectations.

In the context of economic globalization, the exchange rate of the Singapore dollar against major international currencies has shown a complex trend. Uncertainties in the international financial markets, adjustments in the monetary policies of major economies, and changes in regional trade relations can all lead to significant fluctuations in the SGD. These fluctuations have a direct impact on Singapore's import costs and domestic price levels, and they also pose potential shocks to the overall level and structure of consumer spending.

Singapore's per capita GDP has been growing steadily in recent years and ranks among the highest globally. This not only reflects the efficient operation and strong competitiveness of Singapore's economy but also indicates that residents enjoy a relatively high level of income and quality of life. However, consumption growth has not kept pace entirely with the increase in per capita GDP. The issue of high savings rates and relatively low consumption willingness among residents still persists in Singapore. How to promote resident consumption through economic policies and boost domestic demand has become an important issue in Singapore's economic policy agenda.

Moreover, changes in population structure are increasingly affecting consumption. Singapore's total population growth is slowing down, and the challenge of an aging population is becoming more pronounced. These demographic shifts not only affect the scale of consumption but also alter its structure, with significant increases in demand for sectors such as healthcare, education, and living services.

This research centers on analyzing the linkage between household expenditure in Singapore and currency volatility, with particular emphasis on how shifts in exchange rates alter consumption patterns through their influence on imported goods' pricing and citizens' purchasing capacity. Furthermore, the investigation delves into the roles of income per capita and demographic changes in shaping consumer behavior, aiming to comprehensively identify the drivers underlying domestic spending decisions. The study's contributions are threefold: broadening the scope of inquiry into currency volatility-consumption dynamics;offering evidence-based insights into open-economy consumer theory; and informing policy design for Singapore's monetary authorities to stabilize consumption and advance sustainable growth, while serving as a framework for other trade-dependent nations to decipher exchange rate impacts on domestic markets.

Literature Review

This chapter aims to review the relevant literature on the impact of per capita GDP and exchange rate volatility on domestic consumption in Singapore.It seeks to comprehensively

organize the existing research findings in this field,identify research gaps,and lay the groundwork for this study.Per capita GDP and exchange rate volatility have far-reaching impacts on the economy,covering multiple aspects such as trade balance,inflation,investment,and consumption.For Singapore,a developmental economy highly reliant on imports and exports as well as foreign capital,exploring the impact of per capita GDP and exchange rate volatility on domestic consumption is of great significance.The literature review provides important theoretical and empirical support for understanding the practical impact of per capita GDP and exchange rate volatility and their role in consumption.By systematically reviewing and analyzing the existing literature,this chapter will provide a solid theoretical foundation and empirical basis for this study.It ensures that the research findings can make valuable contributions to the existing knowledge system and offer useful references for policymakers,economists,and other stakeholders interested in the impact of per capita GDP and exchange rate volatility on domestic consumption in Singapore. As a fundamental driver of aggregate demand, household spending constitutes a substantial share of a nation's GDP (OECD, 2009). Private consumption, or household final expenditure, encompasses the monetary value of goods and services utilized by individuals over a defined timeframe. This category spans durable items (e.g., vehicles, appliances), government-regulated licenses and permits, and nondurable commodities (World Bank, 2015). Dernburg (1985) further characterized consumption as the utilization of products and services to fulfill diverse human requirements.

Keynes(1936)proposed that consumption expenditure increases with revenue growth but at a slower rate than revenue growth.This view has been verified in empirical studies across multiple countries.Duesenberry(1949)further pointed out that consumption is influenced not only by absolute income levels but also by perceptions of relative income.Consumption is an important indicator of economic vitality,and Singapore's consumption pattern is influenced by various factors.Chia Ngee Choon(2011)noted that Singapore's consumption behavior is characterized by a relatively large proportion of basic consumption(such as housing,healthcare,and education)and significant consumption upgrades among the middle class and high-income groups driven by rapid growth in per capita GDP,especially in service consumption.

Prevailing analytical frameworks for exploring exchange rate-consumption linkages integrate classical interest rate principles and Keynesian income-driven consumption models, augmented by international real business cycle (IRBC) theory and purchasing power parity (PPP) constructs. Conventional methodologies, such as the balance-of-payments equilibrium model, posit that external payment equilibrium governs currency valuation, hypothesizing that rising import costs trigger proportional adjustments in foreign exchange rates (Mussa, 1984). Furthermore, exchange rates act as a pivotal lever for aligning import-export price differentials, with currency markets exerting significant influence over macroeconomic variable dynamics (Gandolfo, 1986). Recent scholarship attributes anomalous consumption-exchange rate patterns to extensions of IRBC models incorporating imperfect asset markets and price rigidities in local currency valuations (Pavlidis et al., 2017). Empirical analyses, however, reveal inconsistent associations between exchange rates and consumption, as theoretical correlations fluctuate contingent upon modeling premises.

Existing literature emphasizes the need for further research to deepen the understanding of the per capita GDP and rate of exchange volatility influence on residents expending in Singapore.Future research can explore other channels and mechanisms through which per capita GDP and exchange rate volatility affect consumption,considering the role of specific industries or population groups.By filling these analysis gaps,and this research aims to enhance the understanding of the relevant issues.

Based on the literature review analyzed above,this paper conducts model tests on the following three hypotheses in order to clearly understand the exchange rate volatility and per capita GDP influence on local residents consumption in Singapore.

H1:There is no cointegration relationship between Singapore's consumption and per capita GDP and exchange rate fluctuations.
H2:GDP per capita does not affect consumption in Singapore. H3:Exchange rate fluctuations do not affect consumption in Singapore.

Methodology and Data
ARDL (Autoregressive Distributed Lag) Model
This research utilizes the autoregressive distributed lag (ARDL) cointegration approach to investigate bidirectional temporal interactions among consumption levels, income per capita, and currency value fluctuations across both extended and immediate horizons. Developed by Pesaran and Shin (1999) and extended by Pesaran et al. (2001), the ARDL framework accommodates variables exhibiting stationarity at level I(0) or first-difference I(1), even with mixed integration orders. Compared to the Engle-Granger method, ARDL demonstrates enhanced robustness in limited-sample contexts while capturing both immediate adjustments and persistent equilibrium dynamics (Pesaran and Shin, 1999). Furthermore, the model's error correction term (ECT) is obtained via straightforward linear computation, enabling efficient estimation of equilibrium reversion (Banerjee et al., 1993). The analysis evaluates linkages among consumption (CONS), income per capita (PGDP), and exchange rate volatility (ERV), while accounting for additional covariates. An unrestricted error correction specification is applied within the ARDL framework, yielding the final model formulation (Equation 1).

$$\Delta \ln CONS_t = \alpha_1 + \sum_{i=1}^{p} \pi_i \Delta \ln CONS_{t-i} + \sum_{i=0}^{q} \delta_i \Delta EXV_{t-i} + \sum_{i=0}^{r} \beta_i \Delta \ln PGDP_{t-i}$$

$$+ \sum_{i=0}^{s} \gamma_i \ln POP_{t-i} + \varphi_1 \ln CONS_{t-1} + \varphi_2 EXV_{t-1} + \varphi_3 \ln PGDP_{t-1} + \varphi_4 \ln POP_{t-1} + \varepsilon_t$$

(1)

Where Δ represents the difference operator, ε_t is the white noise, and p, q, r, s represent the lag of the variable. φ_i represents the long-term estimate, while π_i, δ_i, β_i, γ_i is the short-term dynamic coefficient. In the equation, ΔCONS is the explained variable, and the following are the assumptions regarding the long-term relationship.

H0: $\varphi_1 = \varphi_2 = \varphi_3 = \varphi_4 = 0$ i.e., No cointegration between variables
H1: at least one of $\varphi_i \neq 0$ i.e., Cointegration between variables

Data

This study uses data from Singapore from 1980 to 2023 look into the influence of GDP per capita and exchange rate on local residents expending in Singapore. The data used to analyze the research indicators are from the World Bank database. To understand the trends and patterns of GDP per capita, exchange rate and consumption levels, we first need to test the data to gain insight into the central tendency, variability and relationship between the variables. The description and theoretical basis of the variables are summarized in Table 3.1 below.

Table 1

Data Description, Theoretical Justification and Sources

Variable	Description	Theoretical Justification	Source
CONS	Consumption	Consumption is a key driver of economic growth and development,forming a significant part of Singapore's GDP.	WORLD BANK
ERV	Exchange rate Volatility	Exchange rate fluctuations affect many variables, such as exports, imports, consumption and investment	Calculation From Author
PGDP	Per capita GDP	Per capita GDP reflects the average income or output per person in an economy.	WORLD BANK
POP	Population	Population growth, especially in areas with higher growth rates, will increase consumption. Discretionary consumption will increase with population growth, regardless of whether people's overall income increases.	WORLD BANK

Descriptive Statistics

Results and Discussion

Table 4.1

Data Description

	LNCONS	ERV	LNPGDP	LNPOP
Mean	10.6951	-0.0101	4.3912	6.6025
Maximum	11.3187	0.1272	4.9466	6.7721
Minimum	9.8546	-0.0775	3.6927	6.3827
Std. Dev.	0.4485	0.0411	0.3689	0.1226
Observations	44	44	44	44

Table 1 summarizes the descriptive statistics of the variables, including their central tendency (mean), dispersion (variance), and range (maximum and minimum values). The complete numerical outcomes are tabulated in the preceding section for detailed reference.

Enhanced Dickey-Fuller Test and Lag Selection
Table 2
Unit root results

	At level	1ST Difference	STATIONARITY DECISION
LNCONS	-1.6709	-4.4352 ***	I(1)
ERV	-3.9805 ***	-8.3010 ***	I(0)
LNPGDP	-2.6323	-4.6862 ***	I(1)
LNPOP	-2.2763	-3.8005 ***	I(1)

Table 2 shows that we have performed an ADF stationarity test to see if they are stationary. I(1) and I(0) represent stationarity at the first difference and level, respectively. We can also determine the integration order of the variables to ensure that no variable has an integration order higher than the first order. Looking at the horizontal ADF test on the above variables, only ERV is stationary, represented by I(0), and the other variables are not stationary. Then we perform a first-order difference ADF test on the variables, and all variables attained stationarity at the first order, represented by I(1).

Granger Causality
Table 3
The results of Granger Causality

Null Hypothesis:	Obs	F-Statistic	Prob.
ERV doesn't Granger Cause LNCONS	42	3.0777	0.0580
LNCONS doesn't Granger Cause ERV		0.4268	0.6558
LNPGDP doesn't Granger Cause LNCONS	42	3.0451	0.0597
LNCONS doesn't Granger Cause LNPGDP		4.1177	0.0243
LNPOP doesn't Granger Cause LNCONS	42	0.1201	0.8871
LNCONS doesn't Granger Cause LNPOP		14.3834	0.0000

Based on the Table 3 Granger causality findings , ERV has a Granger-causal on CONS, whereas CONS does not Granger-cause ERV. This indicates a unidirectional causal link from ERV to CONS, suggesting that changes in the exchange rate can influence consumption patterns. Additionally, there is a bidirectional causal association between PGDP and CONS (at the 10% significance level). Furthermore, a unidirectional causal relationship exists between CONS and population (POP), with CONS being able to Granger-cause POP.

Bound test
Table 4
Bound test result

Test Statistic	Value
F-statistic	49.5158

	10%		5%		1%	
Sample Size	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)
35	2.958	4.1	3.615	4.913	5.198	6.845
40	2.933	4.02	3.548	4.803	5.018	6.61
Asymptotic	2.72	3.77	3.23	4.35	4.29	5.61

Based on the bound test outcomes presented in Table 4, the F-statistic is calculated to be 49.5158. Consulting the critical values reveals that 49.5158 exceeds the benchmark of 6.61, which implies that the model exhibits a cointegration relationship.

Estimated Long-Run Model（CE）
Table 5
Long-run Model results

Variable	Coefficient	Std. Error	t-Statistic	Prob.
ERV	-0.4020	0.1333	-3.0152	0.0046
LNPGDP	0.6709	0.0887	7.5638	0.0000
LNPOP	2.4026	0.4353	5.5199	0.0000

Table 5 presents the long-term equilibrium model results derived from the ARDL (1, 2, 0, 3) regression. The p-value for ERV is 0.0046, which is below 0.01, indicating that exchange rate fluctuations significantly influence Singapore's consumption in the long-term, and the coefficient is -0.402. Based on these results, both per capita GDP and population size play a crucial role in driving Singapore's consumption growth. Specifically, a 1% rise in per capita GDP corresponds to a 0.67% increase in Singapore's total consumption, highlighting the significance of the LNPGDP coefficient. Additionally, a 1% increase in population leads to a 2.4% increase in total consumption, underscoring the importance of a population base in supporting Singapore's consumption and economic dynamics. In the long term, to boost domestic consumption and economic growth, Singapore may need to enhance its attractiveness to talent.

Estimated Short Run Error Correction Model
By estimating short-run and error correction models, you can gain insight into the dynamic relationships between variables and the correction to equilibrium.

$$\Delta LNCONS_i = \alpha_1 + \sum_{i=1}^{p} \pi_{1i}\Delta LNCONS_{i-i} + \sum_{i=0}^{q} \delta_{1i}\Delta ERV_{i-i} + \sum_{i=0}^{r} \gamma_{1i}\Delta LNPGDP_{i-i} + \sum_{i=0}^{s} \beta_{1i}\Delta LNPOP_{i-i} + \varphi ECT_{i-i} + \varepsilon_t$$

Selected model: ARDL
(1,2,0,3)

Table 6
Estimated Short Run Error Correction Model

Variable	Coefficient	Std. Error	t-Statistic	Prob.
COINTEQ*	-0.9276	0.0628	-14.7604	0.0000
D(ERV,2)	-0.1754	0.0328	-5.3401	0.0000
D(ERV(-1),2)	0.0730	0.0390	1.8696	0.0704
D(LNPOP,2)	1.2831	0.2642	4.8563	0.0000
D(LNPOP(-1),2)	-0.3266	0.2498	-1.3076	0.2001
D(LNPOP(-2),2)	-1.0151	0.3253	-3.1207	0.0037
C	-0.0061	0.0018	-3.3882	0.0018

$$ECT_{t-1} = \ln CONS_{t-1} - (-0.402ERV_{t-1} + 0.6709\ln PGDP_{t-1} + 2.4026\ln POP_{t-1})$$

As displayed in Table 6, the error correction model reveals that the parameter estimate for lagged currency volatility (ERV) stands at 0.073, accompanied by a p-value of 0.0704. This indicates that currency variability exerts a favorable immediate influence on Singapore's consumer expenditure, signifying a constructive stimulus. Furthermore, the coefficient of the error correction term demonstrates the pace at which economic variables return to their steady-state equilibrium after exogenous shocks. In this case, the negative and outstanding coefficient of the ECT (-0.9276, p-value = 0.0000) indicates a strong adjustment mechanism toward a long-term stable state. This implies a long-term causal relationship among GDP per capita, exchange rate fluctuations, population size, and Singapore's consumption. The highly significant result also suggests that the system adjusts relatively quickly, returning to long-term equilibrium within approximately one year.

Diagnostic Checking
Table 7
Breusch-Godfrey Serial Correlation LM Test

F	0.0175	P-value of F	0.9827
n×R^2	0.0499	P-value of Chi(2)	0.9753

The residuals of the model were subjected to the Breusch-Godfrey autocorrelation test, the outcomes of which are summarized in Table 7. Owing to the limited data size (n < 50), the F-statistic was prioritized for interpretation, yielding a value of 0.0175 and an associated p-value of 0.9827. The failure to reject the null hypothesis at conventional significance thresholds suggests no statistically detectable autocorrelation in the model's error structure.

Table 8
White Heteroskedasticity Test

F	1.0408	P-value of F	0.4489
n×R^2	14.7292	P-value of Chi(2)	0.3969

White's heteroscedasticity test was applied to the model residuals, with diagnostic outcomes detailed in Table 8. The computed test statistic (Obs*R-squared = 14.7292) corresponds to a p-value of 0.3969, failing to reject the null hypothesis at standard significance levels. This implies that the model residuals exhibit homoscedasticity, thereby satisfying the assumption of constant variance across observations.

Table 9
RAMSEY Test Result

	Value	df	Probability
F-statistic	1.6434	(3, 27)	0.2027
Likelihood ratio	6.7085	3	0.0818

The Ramsery normative test was performed on the model, and the results are shown in Table 9 above. The p-values of all test results are greater than 0.05, which indicates that the model is not incorrectly specified and is normative.
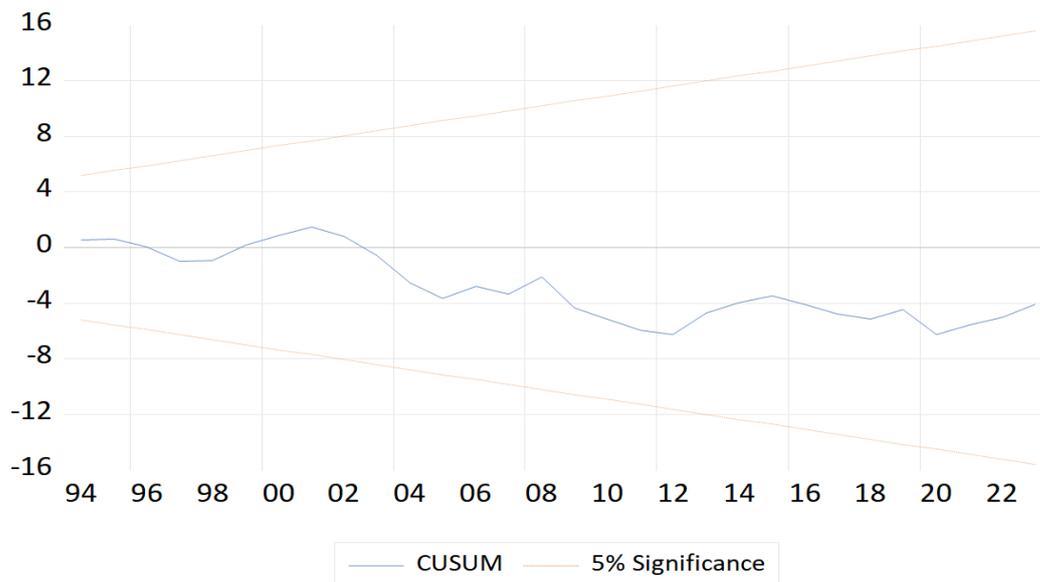
Stability Test

Figure 1 Plot of the cumulative Sum of Recursive Residuals

Figure 1 clearly shows that the parameters are stable; both the residual sum and the residual sum of squares move within bounds. The straight lines represent the critical bounds at the 5% significance level.
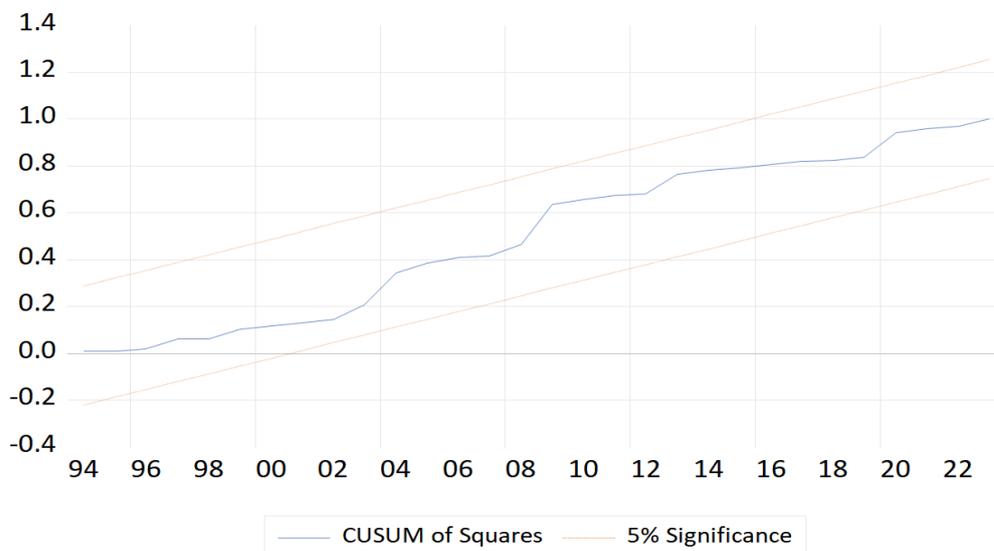

Figure 2 CUMSUM of Squares

As can be seen in Figure 2, the CUSUM plot is within the bounds; therefore, these statistics confirm the stability of the long-run coefficients of the regressors.
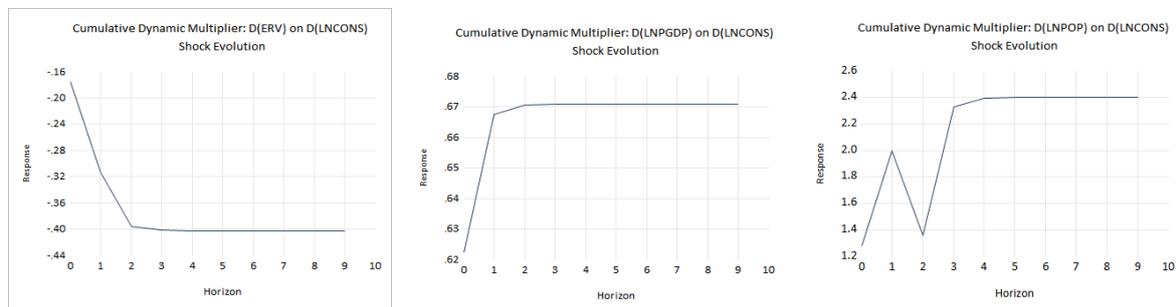
Impulse Response

Figure 3 Impulse Response

It can be observed from
Figure 3 that the response of exchange rate fluctuations to consumption is negative in the first two periods and shows a downward trend. From the second period, the impact of ERV on LNCONS has not changed. The response of per capita GDP to consumption has been positive in the first two periods and has shown an upward trend. The response of population to consumption is also positive. After reaching a peak in the first period, it began to decline, and then rose from the second period to the third period and did not change.

Conclusion and Suggestions
Conclusion
This research explores the interplay among consumption, exchange rate volatility, GDP per capita, and population in Singapore using the ARDL approach. The study aims to address several key objectives: understanding the association between total residents expending and rate of exchange fluctuations in Singapore, examining the trends in exchange rate movements, and analyzing the causal dynamics among these variables to derive policy insights.

Results from the unit root tests show that certain variables are non-stationary in their level forms. Nonetheless, once first differencing (I(1)) is applied, some of these variables become stationary while others are classified as I(0). The bound test cointegration analysis uncovers a cointegrated link among consumption, exchange rate volatility, GDP per capita, and population, implying a long-term equilibrium relationship among these factors in Singapore. Moreover, the study finds that the error correction term (ECT(-1)) is statistically significant, confirming the presence of a long-run connection among the variables. In addition, an ECT coefficient of -0.9276 suggests that the system adjusts swiftly back to equilibrium.

The Granger causality results show a unidirectional causal link from exchange rate volatility to consumption, implying that exchange rate fluctuations influence consumption. Additionally, there is a bidirectional causal association between PGDP and CONS, indicating that these variables are interdependent and mutually reinforcing. Furthermore, a unidirectional causal relationship exists from consumption to population in Singapore, suggesting that higher consumption levels may drive population growth.

The long-term equilibrium regression results reveal that the p-value for exchange rate volatility is 0.0046, which is below 0.05. This indicates that exchange rate fluctuations significantly impact Singapore's consumption in the long run. This finding suggests that stabilizing Singapore's exchange rate could mitigate its adverse effects on residents' consumption.

The stability of the regression parameters is validated through cumulative sum (CUSUM) and cumulative sum of squares (CUSUMSQ) diagnostics, which further corroborate the persistent influence of currency volatility on Singapore's consumer expenditure patterns over extended temporal horizons.

Impulse response analysis examines how a one-time shock influences both the present and subsequent values of endogenous variables. Consumption reacts negatively to exchange rate volatility during the initial two periods, exhibiting a declining pattern, and after the first period, its effect on consumption stabilizes. In contrast, the response of consumption to GDP per capita is positive and shows an upward trend in the first two periods. Population size also responds positively to consumption, peaking in the first period, declining afterward, and then rising again from the second period, remaining stable until the third period.

Suggestions
Over the past few decades, Singapore has reaped significant advantages from globalization. For instance, it sources essential food items from unconventional regions like Latin America and procures cost-effective goods from emerging economies with lower production expenses (such as China). These practices have helped mitigate imported inflation in Singapore and allowed its economy to expand more rapidly without the burden of increasing costs.However, globalization also presents challenges. An increasing number of labor-intensive and low-value-added manufacturing firms have relocated their production facilities from Singapore to countries with cheaper costs. This trend is likely to accelerate as Singapore's production costs continue to rise in the future.To address this situation, Singapore has strategically shifted up the value chain. It leverages its strengths in technological innovation and its world-class infrastructure—both physical and institutional—to capture high-value-added market segments that remain untapped.

Singapore's economic framework exhibits deep integration with global trade and currency markets, rendering it particularly susceptible to exchange rate instability—a factor that directly disrupts consumer expenditure and macroeconomic equilibrium. To mitigate such risks, a multifaceted strategy is proposed:Managed Exchange Rate Regime: Sustain the existing managed float system for the Singapore dollar (SGD), focusing on calibrating the SGD/USD exchange rate band through proactive monetary tools and reserve adjustments. This ensures alignment with export competitiveness and domestic demand stabilization; Strategic Market Intervention: Empower the Monetary Authority of Singapore (MAS) to deploy timely interventions during extreme currency volatility, including modifying the Singapore Nominal Effective Exchange Rate (SNEER) policy parameters (slope, bandwidth, and midpoint) to balance inflation control and post-crisis recovery; Reserve Diversification & Currency Basket Expansion: Augment foreign reserve holdings to buffer against external shocks while diversifying currency exposures (e.g., incorporating RMB and euro) to reduce USD-centric vulnerabilities; Enhanced Policy Communication: Strengthen MAS's transparency

in signaling exchange rate policy trajectories to curb speculative activities and anchor market expectations, thereby minimizing unwarranted exchange rate swings; Macroprudential Safeguards: Implement targeted financial regulations, such as dynamic loan-to-value (LTV) and total debt servicing ratio (TDSR) frameworks, to temper real estate speculation and prevent consumption volatility induced by asset price bubbles; Collectively, these measures aim to fortify Singapore's resilience against currency-driven economic disruptions, ensuring sustained consumption stability and systemic financial robustness.

Economic evolution is crucial to residents expending and overall national well-being. The following suggestions may help Singapore achieve sustainable economic growth: deepen economic cooperation with ASEAN, expand free trade agreements (FTAs) with ASEAN countries, and enhance trade convenience within the region; strengthen trade and investment cooperation under the Belt and Road Initiative to expand export markets; reduce dependence on re-export trade and promote the upgrading of the industrial chain to high value-added links, such as the development of the digital economy and knowledge-intensive industries; strengthen human capital investment and cultivate a highly skilled workforce that can adapt to the needs of emerging industries through vocational training programs and lifelong learning programs.

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