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THE TIME SERIES ANALYSIS OF EXPORTS AND IMPORTS FOR THE US

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Abstract *This study attempts to analyse the time series properties of exports, imports and exchange rate for the US. We empirically examine the presence of a cointegrating relationship between the exports, imports and the exchange rate using the monthly time series data from January, 1994 to September, 2023. The stationarity of the time series variables is tested using the Augmented Dickey-Fuller unit root test and the existence of a long run relationship between the variables is tested using Johansen's multivariate cointegration test. The findings from the study show that there is no cointegrating relationship between exports, imports and the exchange rate for the US, implying that the macroeconomic policies of the US are not effective enough to bring her exports and imports in long-run equilibrium. These findings from the study can provide significant implications for national policymakers and the researchers alike.*

Keywords: *Time Series, Exports, Imports, Stationarity, Lag Length, International Budget Constraint*

JEL Classification: *F41, C22, C32*

INTRODUCTION

The exchange rate is recognised to be a decisive link between the internal economy of a country and international economy (Williamson, 2009). The United States holds the world's largest national economy and is leading global trader[1]. The currency appreciation results in a lower effective price for imported goods while the currency depreciation results in a higher effective price for imported goods. The exchange rate exerts a strong influence on a country's trade (Kemal & Qadir, 2005). Understanding the mechanisms through which exchange rates impact the export and import of an economy is essential for understanding the broader economic situation of the economy.

To the best of the author's knowledge, there exists no published literature analysing the cointegrating relationship between exports, imports and the exchange rate for the US using the data including the post-COVID period. The purpose of this study is to fill this void.

The remainder of this research is organised as follows. A review of previous empirical studies on the cointegrating relationships between exports, imports and the exchange rates for some economies in the world are given in section 2. A description of the data and the time series variables used in the research are described in section 3. The econometric methodology used in the research, the empirical findings and the detailed interpretations are presented in section 4. The last section concludes the paper with a summary of the findings, the conclusions drawn from the research study, and the implications of the study for policy makers and the researchers alike.

LITERATURE REVIEW

The long-run equilibrium relationship between export and import has received considerable attention from researchers; see, for example, Fountas and Wu (1999), Granger (1986), Gould and Ruffin (1996) and Husted (1992) among others. They have used data from both developed and developing economies. In this section, we review a selected number of papers from the plethora of studies.

Husted (1992) analysed quarterly data for the exports and imports for the USA for the period 1967–1989. The conclusions drawn from the research study suggest the presence of a long-run equilibrium relationship between these variables. They further document that the sign on the estimated cointegrating coefficient was positive. Similarly, Kemal and Qadir (2005) analysed the long-run relationship and the short-run dynamics among real exchange rate, exports and imports movements for Pakistan. The authors

[1] https://ustr.gov/issue-areas/economy-trade

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found that there exists a long-run relationship between the variables for Pakistan. They further mention that the real exchange rate was negatively associated with the exports and positively associated with the imports.

Choong et al. (2004) found the evidence of a long-run relationship between imports and exports in Malaysia for the period 1959–2000 using Johansen's cointegration test. Tang (2005) had some concerns regarding the lag length selection in Johansen's test. Contrary to Choong (2004), Tang (2005) found no evidence of a cointegrating relationship between exports and imports for Malaysia. They also added that cointegrating the relationship between exports and imports for Malaysia as documented by Choong et al. (2004) required further investigation before it could be generalised.

Sekmen and Saribas (2007) studied the cointegration and causality relationships among exchange rate, export and import for Turkey. They used monthly data from 1998 to 2006, and employed cointegration test, vector error correction model, variance decomposition and impulse response function for their analysis. The authors found that there exists a cointegrating relationship and a bidirectional relationship between exports and imports. Mukhtar and Rasheed (2010) empirically examined the long run relationship between exports and imports for Pakistan using quarterly data for the period 1972–2006. The authors found that there was a long run relationship between exports and imports for Pakistan, and that the country was not in violation of its international budget constraint. They further document that there exists a bidirectional causality relation between exports and imports for Pakistan.

Sweidan (2013) studied the effect of exchange rate on exports and imports in Jordan. Using time series data from1976 to 2009, the authors found that the effect of exchange rate on exports and imports was active in the short run. They also document that Jordan's foreign exchange market would be unstable if exchange rate policy devaluation would be adopted. Similarly, Chaudhary et al. (2016) studied the long and short run relationship of the exchange rate with exports and imports of major South-Asian and Southeast Asian countries for the period between 1979 and 2010. The authors analysed the data using the ARDL approach to cointegration and a VECM. The findings show that there exists a long-run relationship between exchange rate and exports in most of the countries sampled for the research study. However, the findings show that there exists a long-run relationship between exchange rate and imports in only one of the countries sampled for the research study. Furthermore, the findings show the presence of a short-run relationship between the variables in most of the countries sampled for the study.

Oluyemi and Isaac (2017) examined the effect of exchange rates on imports and exports in Nigeria. Using monthly data from 1996 to 2015, the authors found that exchange rate had a positive and insignificant effect on imports. They also found a negative and insignificant effect on exports at lag 1 but positive and insignificant effect at lag 2. They further conclude that the exchange rate in Nigeria was not affected by the imports and exports.

DATA AND THE VARIABLES USED IN THE STUDY

The present study is based on monthly time series data for the period between 1994 and 2023 for the United States. These data are obtained from the database of the Federal Reserve Bank of St. Louis (https://fred.stlouisfed.org/) and consist of the variables, "Exports," "Imports" and the "Exchange rate." The Exports refer to the exports of goods and services (Balance of Payments Basis) and the Imports refer to imports of goods and services (Balance of Payments Basis). Both are in millions of dollars and are seasonally adjusted. In addition, the exchange rate refers to the Real Broad Effective Exchange Rate for the United States. The time series variables are expressed in natural logarithms prior to the empirical analysis because the logarithmic transformation often stabilises the variance of the data. Econometric software Eviews and statistical software package R are used for cleaning the data and statistical analyses.

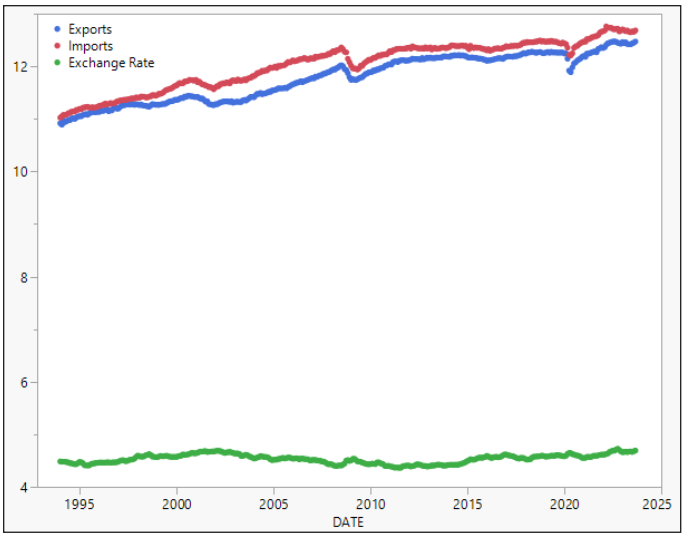

Fig. 1: Export, Import, and Exchange Rate for the US: 1994-2023

Time series plots for the exports, imports and exchange rates for the US (in logarithmic scales) are shown in Fig. 1 above. The plot suggests that the time series data for exports and imports have upward trends while the one for exchange rates is fairly constant. The summary statistics for exports,

imports and the exchange rates presented in Table 1 below show that these variables have means equal to 11.784, 12.034 and 4.534 with their respective standard deviations of 0.441, 0.451 and 0.087. This study includes the maximum range of the data for these variables available to the author at the time of analysis.

Table 1: Summary Statistics for Exports, Imports, and Exchange Rates

Statistics	Exports	Imports	Exchange Rate
Mean	11.784	12.034	4.534
Median	11.881	12.185	4.547
Maximum	12.475	12.761	4.727
Minimum	10.892	11.025	4.362
Std. Dev.	0.441	0.451	0.087

ECONOMETRIC METHODOLOGY AND FINDINGS

Following the convention, the first step in studying the presence of a cointegrating relationship between the time series variables in econometric analyses is to test the stationarity of each of the variables. This test of stationarity is also known as the unit root test. Under this test, the null and the alternative hypotheses are as follows:

H_0: The time series variable is not stationary (the variable has a unit root).

H_1: Time series variable is stationary (the variable does not have a unit root).

If the p-value for the test is less than a specified value of the level of significance, then we reject the null hypothesis and we conclude that the time series variable is stationary, and thus, does not have a unit root.

The test of stationarity is conducted using Augmented Dickey-Fuller (Dickey & Fuller, 1979), and Phillip-Perron (Phillips & Perron, 1988) and the results are reported below in Tables 2 and 3, respectively. The figure there indicates that, in both tests, all the time series variables are not stationary in their levels. However, all three time series variables become stationary when their first differences are considered. Thus, we conclude that all the time series variables are integrated of order 1 or I (1).

Table 2: Augmented Dickey-Fuller Unit Root Test Results

Variables	Levels		First Differences	
	Test Statistics	*p*-Values	Test Statistics	*p*-Values
Export	-1.336	0.6136	-14.795	0.0000***
Import	-1.585	0.4890	-7.575	0.0000***
Exchange Rate	-1.250	0.6535	-12.222	0.0000***

Notes: *** denotes the statistical significance at 1% level of significance.

Table 3: Phillip-Perron Unit Root Test Results

Variables	Levels		First Differences	
	Test Statistics	*p*-Values	Test Statistics	*p*-Values
Export	-1.198	0.6764	-14.874	0.0000***
Import	-1.803	0.3789	-16.872	0.0000***
Exchange Rate	-1.239	0.6584	-12.652	0.0000***

Notes: *** denotes the statistical significance at 1% level of significance.

After confirming the stationarity of the time series variables, our next step is to determine the lag length of the vector autoregressive system. The Schwarz information criterion (SIC) identified a leg length of 2 (Table 4). We now use this lag length of 2 to conduct the Johansen's multivariate cointegration test (Johansen & Juselius, 1990)[2] to test for the long-run equilibrium relationship between the time series variables.

Table 4: VAR Lag Order Selection Criteria

Lag	LogL	LR	FPE	AIC	SC	HQ
0	506.575	NA	1.12e-05	-2.886	-2.853	-2.873
1	2806.372	1456.877	2.23e-11	-16.014	-15.881	-15.961
2	2869.735	124.183	1.63e-11	-16.325	-16.093*	-16.233
3	2888.580	36.610	1.54e-11	-16.382	-16.050	-16.250*

Note: LR: Likelihood Ratio Test, FPE: Final Prediction Error, AIC: Akaike Information Criterion, SC: Schwartz Information Criterion, HQ: Hannan-Quinn Criterion.

[2] The Johansen's multivariate cointegration test is widely used for examining the presence of a long run relationship between the variables (see, e.g., Kothari & Pathak (2020); Jagotra et al. (2019); Ranjani & Dharmadasa (2018); Gabriel & Devkota (2023)).

The null hypothesis for Johansen's multivariate cointegration test is H_0: r = 0 (There is no cointegrating relation between the time series variables). Rejecting this null hypothesis means that there is at least one cointegrating relationship between the time series variables. We will consider both the λ-trace and λ-max statistics options for the test.

The results for the Johansen's multivariate cointegration test are reported in Table 5 below. The figures there indicate that both the test statistics are smaller than the corresponding critical values. This suggests that the null hypothesis of existence of no cointegrating relationships between the variables is not rejected in both cases for a conventional level of significance. We thus conclude, based on the data in the study period, that there is no cointegrating relationships between exports, imports and exchange rates for the United States. It shows that the macroeconomic planning of the United States is unable in bringing exports and imports in long-run equilibrium. This also implies that the balance-of-payments crisis was not sustainable, and that the United States is in violation of her international budget constraint.

Table 5: Johansen Cointegration Test Results

Null Hypotheses	-Trace Statistic	5% Critical Value	-Max Statistic	5% Critical Value
$r = 0$	17.1861	29.7971	11.3623	21.1316
$r \leq 1$	5.8238	15.4947	4.7785	14.2646
$r \leq 2$	1.0454	3.8415	1.0454	3.8415

Notes: r is a hypothesised number of cointegrating equations.

Our finding of existence of no cointegrating relationship between exports, imports and the exchange rate for the United States is consistent with the finding of Devkota and Panta (2019), Konya and Singh (2008) and Tang (2004) who found no evidence of a cointegrating relationships between the exports and imports for Nepal, India and Malaysia, respectively. However, our finding is contrary to the findings of Kemal and Qadir (2005) and Mukhtar and Rasheed (2010) for Pakistan and Choong et al. (2004) for Malaysia. Our findings from this study can provide significant implications for national policymakers and the researchers alike.

SUMMARY AND CONCLUSIONS

The purpose of this study was to analyse the time series properties of exports, imports and exchange rate for the US. In particular, we empirically examined the presence of a cointegrating relationship between the exports, imports and the exchange rate using the monthly time series data from January, 1994 to September, 2023. The stationarity of the time series data was tested using the Augmented Dickey-Fuller unit root test. In addition, the existence of a long run relationship between the time series variables was tested using Johansen's multivariate cointegration test.

The findings from the study showed that the time series variables were not stationary in their levels. However, these variables became stationary when their first differences were considered. Then we proceeded to determine the lag length of the vector autoregressive system. The SIC identified a leg length of 2. We used this lag length to conduct Johansen's multivariate cointegration test to test for the long-run equilibrium relationship between the time series variables. The results from the test showed that there was no cointegrating relationship between exports, imports and the exchange rate for the US. This showed that the macroeconomic policies of the US were not effective enough in bringing the exports and imports of the US in a long-run equilibrium relationship. These findings from the study can provide significant implications for national policymakers and the researchers alike.

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