Exploring The Nexus Between Exchange Rates and India's Pharmaceutical Export Performance.

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Abstract

The Indian pharmaceutical sector is a booming and thriving industry among other exporting industries, and it is well-known around the world for its "generic and low-cost medicines." Over the last nine years, the pharmaceutical sector has regularly earned a trade surplus at a CAGR of 9.43%. Until September 2021, total pharma export was 87864cr ($11.88 billion) compared to total import of 33636cr ($4.66 billion), resulting in a trade surplus of 54228cr ($7.22 billion). The key segments of the Indian pharmaceutical industry are generic drugs, over-the-counter medications, bulk meds, vaccines, contract research and manufacturing, biosimilar, and biologics. India has 500 API (Active pharmaceutical ingredient), which accounts for 8% of global API, and it is a key supplier of generic medicine, accounting for 20% of global supply with 60000 different generic brands across 60 therapeutic categories. After the 1970s, the pharmaceutical sector made considerable strides. Foreign MNEs controlled 99% of the 1704 pharmaceuticals and pharmaceutical patents in India between 1947 and 1957, accounting for 80% of the market. The Patent Act of 1970 supports the use of reverse engineering to create new products using alternative procedures. As a result, this pharmaceutical industry grew to become a key producer in the global market. The advancements made by the pharmaceutical industry over the last five decades have strengthened the belief of the government and pharmaceutical companies by improving socioeconomic conditions through job creation, lowering health-care costs, and promoting economic development by increasing competitive strength. Thus, the present research paper endeavours to highlight the relationship between the exports pharmaceutical industry and the exchange rate during 1995 to 2022 by applying Co-integration and VAR granger causality Test. Data has been gathered for this purpose from a number of sources, including the yearly reports of the pharmaceutical department, the RBI statistics handbook, CMIE, and UNCTAD data. Exports from the pharmaceutical sector and the exchange rate over the same time period were used as the variables for the analysis. There are a number of tests that may be used to determine whether a series is stationary, but our study took into account the PP (Philips-Perron) test, the Phillips–Perron test. The results of the Philips-Peron test, which was used to examine the unit root, indicate that variables are non-stationary at level and stationary at first difference. Co-integration and VAR models are used to examine the relationship's nature. The structure of VAR models allows one to explain endogenous variable values based on their prior observed values. The

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Johnson co-integration test revealed that these two have no long-term relationship. The findings of the VAR granger causality test indicate that there is no meaningful causal association between these two variables.

Introduction

The Indian pharmaceutical sector is a prominent global player, renowned for its extensive export activities. It comprises a diverse range of pharmaceutical products, including generics, over-the-counter medications, bulk drugs, vaccines, contract research and manufacturing, biosimilars, and biologics. India holds a leading position worldwide in the supply of DPT, BCG, and Measles vaccines. On the global stage, the Indian pharmaceutical industry plays a substantial role by providing cost-effective and high-quality generic drugs to millions of people worldwide. It ranks third in pharmaceutical production by volume globally. India's ability to maintain lower costs without compromising quality is evident through its large number of United States Food and Drug Administration (USFDA) approved pharmaceutical plants outside the US. Additionally, there is a significant presence of World Health Organization (WHO) Good Manufacturing Practices (GMP)-compliant facilities, along with approvals from regulatory authorities in other countries. In terms of its contribution to the Indian economy, the pharmaceutical sector accounted for approximately 1.32% of the Gross Value Added (at 2011-12 constant prices) in the fiscal year 2020-21. During the fiscal year 2021-22, the total annual turnover of the pharmaceutical industry reached Rs. 3,44,125 crore (USD 42.34 billion). In the same period, pharmaceutical exports amounted to Rs. 1,74,955 crore (USD 23.5 billion), while imports totalled Rs. 60,060 crore (USD 8.06 billion), resulting in a trade surplus of Rs. 1,14,895 crore (USD 15.44 billion), [Annual report 2022-23].

Pharmaceutical production in India commenced during the 1910s with the establishment of 'Bengal Chemical and Pharmaceutical Works' in Calcutta through private initiatives. The pharmaceutical industry made significant strides after the 1970s, driven by a shift in the patent policy adopted by the Indian government. Prior to the early 1970s, a majority of pharmaceutical consumption relied on imports. Between 1947 and 1957, foreign Multinational Enterprises (MNEs) held 99% of the 1704 drugs and pharmaceutical patents in India, controlling 80% of the market. However, in 1970, the Indian government introduced the "Process Patent Act," which played a pivotal role in transforming the Indian pharmaceutical industry into the largest contributor of pharmaceutical products among developing countries. The implementation of this patent act in 1970 encouraged the process of reverse engineering to create new products using alternative processes. Consequently, the pharmaceutical industry emerged as a major producer in the global market. Furthermore, the transition from the "process patent regime" to the "process and produce patent regime" under the 'TRIPS agreement' of the World Trade Organization (WTO) in 2005 marked a significant milestone for the industry. [Singh, 2018]

As can be seen from the description above, India's pharmaceutical export has performed remarkably well in the export sector. There is a theory that when exports increase, demand for local currency increases, which leads to higher exchange rates as home money is sought after by consumers overseas to pay for goods and services. Contrarily, domestic goods and services will be more expensive if the value of the domestic currency is higher than that of other countries, which will lead to more imports and less exports. So, the primary aim of this study is to assess the causal relationship between the nominal rate of exchange and pharmaceutical exports over the period spanning from 1995 to 2022.

Review of literature

Numerous studies have examined the trends in patent activity and exports within the Indian pharmaceutical industry following India's compliance with TRIPS in 1995 and the introduction of the product patent regime on January 1, 2005. These studies have indicated that the Patent Act of 2005 has been a catalyst for the development of the pharmaceutical sector in India. The implementation of this patent act created a sense of urgency regarding the establishment of world-class research facilities, the initiation of new drug delivery systems, and the pursuit of research on new molecules. Most of these studies have a descriptive nature, with only a limited focus on exploring the relationship between patent filings and exports. These research papers have supported the idea that innovation-driven exports have flourished, even though Indian firms predominantly export generic versions of patented products, and the proportion of patented products in exports is minimal. And while there have been a few studies that have focused on the connection between the pharmaceutical industry's exports and the rate of exchange, this study will concentrate on how the two are related.

Database and Methodology

This study aims to examine the correlation between the export performance of the Indian pharmaceutical industry and the influence of exchange rate fluctuations on pharmaceutical exports. The analysis utilizes causality analysis techniques, focusing on data from the period spanning 1995 to 2022. Data for this research has been sourced from various reputable outlets, including the annual reports of the pharmaceutical department, RBI statistical handbook, CMIE, and UNCTAD data. The variables under investigation encompass the pharmaceutical industry's export figures and exchange rate data. The information is displayed in nominal terms. All data series are converted to the natural logarithmic(ln) form to attain stationarity in variance. Using the Johnson's cointegration test and VAR (Vector Autoregressive), the study investigates the long-term and short-term relationships between the variables lnPE (log of Pharmaceutical Export) and lnRE (log of Exchange Rate). There are a number of tests that may be used to determine whether a series is stationary, but our study took into account the PP (Philips-Perron) test, the Phillips–Perron test (named after Peter C. B. Phillips and Pierre Perron) is a unit root test. That is, it is used in time series analysis to test the null hypothesis that a time series is integrated of order 1. It builds on the Dickey–Fuller test of the null hypothesis �=1 in Δ��=(�−1)��−1+��, where Δ is the first difference operator. Whilst the augmented Dickey–Fuller test addresses this issue by introducing lags of Δ��as regressors in the test equation, the Phillips–Perron test makes a non-parametric correction to the t-test statistic [Davidson and MacKinnon, 2004] since it is robust enough to account for the presence of autocorrelation and heteroscedasticity (Phillips, 1998). The following models are used to analyse the causal relationship between exchange rate and pharmaceutical export.

$PE=a_0+a_1RE$ (1)

$RE=b_0+b_1PE$ (2)

Here PE refers to pharmaceutical export, RE refers to rate of exchange and $a_0, a_1, b_0,$ and b_1 are coefficients of equation (1) and (2).

Co-integration and VAR models are used to examine the relationship's nature. The structure of VAR models allows one to explain endogenous variable values based on their prior observed values. These models differ slightly from structural vector autoregressive (SVAR) models in that they allow for the explicit modelling of contemporaneous interdependence between the variables on the left side. The dependent variable in a VAR model depends on both the independent and dependent variables' lag values. The models are as follows.

$lnPE=C_1\sum^{P}_{J=1} \alpha_{1i}\Delta RE_{t-j} +\sum^{p}_{j=i}\beta_{1i}\Delta PE_{t-i}$

$lnRE=C_1\sum^{P}_{J=1} \alpha_{2i}\Delta PE_{t-j} +\sum^{p}_{j=i}\beta_{2i}\Delta RE_{t-i}$

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here, Δ shows the first difference stationary.

Hypotheses

There is no causal relationship between the export of pharmaceutical industry and the exchange rate

Data analysis and interpretation

The time series analysis demands that variables be stationary in nature. (Gujarati 2007). The Phillips-Perron Unit root test is used to determine whether the data under consideration has a unit root. Table 1 shows the outcomes of the Unit Root Test for each variable in the level and first difference. The data trends are taken to be linear and constant when computing the unit root test. The results show that these variables are non-stationary at level due to the calculated value of lnPE and lnRE being greater than critical values at first difference, which is due to the calculated value of lnRE being less than the critical values of the statistics for log Rate of Exchange and log Pharmaceutical Export, respectively.

Table 1

Philips-Perron Test Results

Variables	**Level**		**First difference**		**Order of Integration**
	Intercept	Trend & Intercept	Intercept	Trend & Intercept	
lnRE	-0.99	-2.28	-6.21***	-6.07***	I (1)
lnPE	-1.27	-0.46	-3.42**	-3.69**	I (1)

Note: (*) significant at 10%; (**) significant at 5%; (***) significant at 1% based on MacKinnon (1996) one-sided p-values.

Test for Co-integration analysis

According to the Unit root discoveries, each variable is integrated into order 1, or I(1). Therefore, the Johnson and Jusilius co-integration test is used in our study to look at the long-term relationship between lnPE and lnRE. Selecting the appropriate lag time for the VAR technique is the first step. This study uses AIC (Akaike Information Criteria) statistics to estimate an unrestricted VAR model in level form of series and choose the suitable lag length in the model. The best lag period, which is One (1), is established using the AIC while also taking statistical significance into account. based on the supposition that the level data show no trend but the co-integration equations show an intercept.

The null hypothesis of No Co-integration has been accepted at the 5% level due to the Trace statistics (8.38) being below the critical value (15.49). The null hypothesis that more than one equation exists is accepted when trace statistics (1.52) recede the critical value (3.84). The critical value of 14.26 is below the maximum eigenvalue statistics (6.86), which prevents the null hypothesis that there is no co-integrating vector between lnRE and lnPE. No Co-integration has been allowed because the Trace and Max eigenvalue statistics are less than the crucial values in both at level and at most 1. This indicates that there is no long-term correlation between lnPE and lnRE. Since the findings indicate that there is no cointegration, so instead of using a VECM (Vector Error Correction Model), we could use a VAR (Vector Autoregressive model).

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Table 2

Co-integration between Pharmaceutical export and Rate of exchange

Variables	Hypothesis	A Trace		Hypothesis	Max eigenvalue	
	No. of CE(s)	Test statistics	Critical Value for 5% confidence interval	No. of CE(s)	Test statistics	Critical Value for 5% confidence interval
lnRE & lnPE	None R=0	8.384385	15.49471 (0.4252)	None H=0	6.861975	14.26460 (0.5056)
	At most 1 R=1	1.522410	3.841466 (0.2173)	At most H=1	1.522410	3.841466 (0.2173)

Note: Trace and Max-eigenvalue test indicates no co-integration at the 0.05 level, * denotes rejection of the null hypothesis at the 0.05 level.

Test for VAR (Vector Autoregressive Model)

The VAR model predicts a bidirectional link based on the absence of co-integration between variables. The VAR model is a multivariable model in which each variable is a function of its past lags and the past lags of other variables. In this study, AIC (Akaike Information Criteria) statistics are used to estimate an unrestricted VAR model in level form of series and choose the suitable lag length in the model. The ideal lag period is found using the AIC to be One (1).

Table No. 3 below displays the VAR results. The effects of lnPE (-1), lnRE (-1), and constant on the export performance of the pharmaceutical industry are demonstrated by the coefficient values of (0.998), (-0.114), and (0.580). According to the t statistics for lnPE (-1) that is (34.76), which is higher than the critical value (1.96), but lnRE (-1) that is (-0.806), which is less than the critical value (1.96), the values of lnRE (-1) have an appreciable and lnPE (-1) have no appreciable influence on the export of the pharmaceutical export. Similar to this, the coefficient values (0.04), (0.748), and (0.644) show the effects of dlnPE(-1), dlnRE(-1), and constant on the exchange rate, showing that the coefficient value of lnRE(-1) (0.748), whose t statistic value (6.47) is greater than the critical value (1.96), has a significant influence on the exchange rate, while the coefficient value of lnPE(-1) (0.043), Similar to this, the coefficient values (0.04), (0.748), and (0.644) show the effects of dlnPE(-1), dlnRE(-1), and constant on the exchange rate, showing that the coefficient value of lnRE(-1) (0.748), whose t statistic value (6.47) is greater than the critical value (1.96), has a significant influence on the exchange rate, while the coefficient value of lnPE(-1) (0.043), whose t statistics is (1.86) less than critical value (1.96) so it has no significant influence on exchange rate.

Table 3

VAR (Vector Autoregressive) results

	lnPE		lnRE	
	Coefficients	T statistics	Coefficients	T statistics
lnPE (-1)	0.998870	34.7684	0.043671	1.86175
lnRE (-1)	-0.114234	-0.80604	0.748842	6.47141
C	0.580508	1.58480	0.644649	2.15546

Note: (*) Significant at 1%, (**) Significant at 5%, (***) Significant at 1%

VAR Granger causality test

Granger-causality treats each variable as a dependent variable while treating every other variable, regardless of any lagged effects, as an independent variable. P-value less than 0.05 suggests that the dependent variable and independent variable are causally related. The table 4 below presents the VAR granger causality results. It is obvious that lnRE does not cause lnPE and lnPE does not cause lnRE because the probability value outcomes (0.42) and (0.06) are bigger than the crucial probability value (0.05).

Table 4

VAR Granger causality test results

	lnPE		***lnRE***	
	Chi-sq	Prob	Chi-sq	Prob
lnPE	-	-	3.466099	0.0626
lnRE	0.649693	0.42	-	-

Conclusions

The association between the export of the pharmaceutical industry and the exchange rate from 1995 to 2022 was tested using the traditional time series methods (Cointegration and VAR). Variables are non-stationary in level but stationary at first difference, according to the Unit root test based on the Philips-Perron (PP) test. The findings of the Johnson co-integration test, which was used to determine whether there was a long-term relationship between the two variables under consideration, indicate that there is not. The VAR test was used to determine how each variable affected the other variables, and VAR Granger causality test results showed that there is no significant causal connection between the exchange rate and pharmaceutical export.

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Appendices:

Appendix 1: Normality Test: Jarque-Bera test Results

Dependent variable	Skewness	Kurtosis	Test statistics	Probability
lnRE	-0.516300	2.356876	1.726517	0.421785
lnPE	0.225019	2.619017	0.405629	0.816430

Note: Null-Hypothesis: Variables are Normally distributed.

Appendix 2: Heteroscedasticity test Results (Breusch-Pagon Godfrey) Results

Dependent variable	R^2	F- Statistic	Heteroscedasticity Test statistics (Prob value)
lnRE	0.0062	0.163998	0.404967 (0.8480)
lnPE	0.1027	2.977417	-1.725519 (0.0963)

Note: Null Hypothesis: Homoscedasticity is present.

Appendix 3: Model Diagnostic Test Results:

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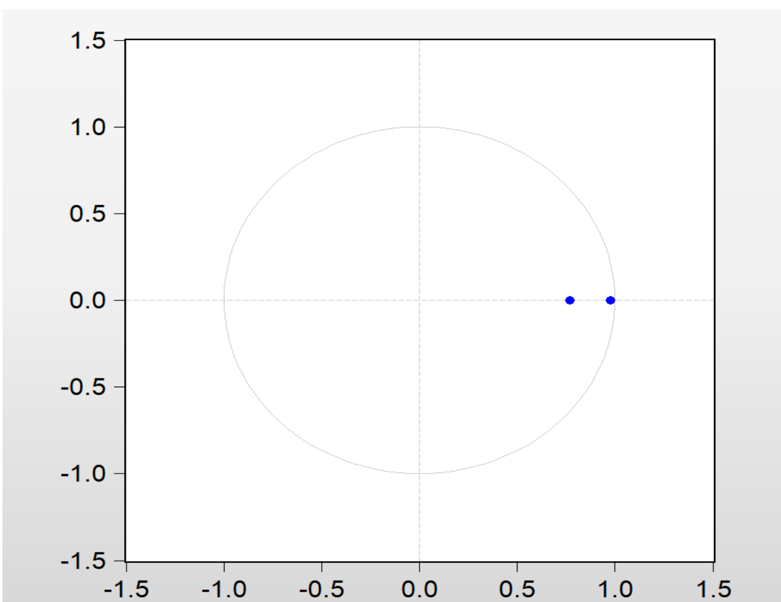
Dependent variable	VAR Normality Test (Jarque-Bera)	VAR Auto-correlation LM test	VAR Heteroscedasticity Test
lnRE	0.430721	2.024308	19.28613
lnPE	0.430721	2.024308	19.28613

Appendix 4: AR root Graph



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