Variance Ratio Test of Random Walk for Foreign Trade: The Study in India during the Globalization Era of 1990s

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Abstract

The paper investigates the random walk properties of foreign trade. The data used in the empirical test correspond to monthly exports and imports of India in the globalization era of 1990s. The test of random walk employed in this study is the variance ratio test, developed by Lo and Mackinlay. The empirical results indicate that the series contain large permanent component and small temporary component for both exports and imports. This suggests that foreign trade follows a random walk.

Keywords: Variance Ratio Test, Random Walk, Globalization, Foreign Trade

1. Introduction

Globalization is a process when an economy gets integrated with the rest of the world, particularly through trade, investment and financial flows (Loots, 2002; Nayyar, 2002). It is considered as a natural process of historical change and possible path for future world economy, which supposedly increases wealth and prosperity for all the countries. Globalization is not a new strategy in India. However, the 1990's are an eventual in terms of policy changes and these changes have been taking place at various levels and various ways. These include devaluation of rupee, dismantling import license system, full convertibility on trade account, fiscal retrenchment and credit squeeze, abolition of export subsidies, introduction of import entitlement scheme for exporters, unification of the exchange rates, removal of the quantitative restrictions, massive reduction in the tariff rates and protection rates, easing the restrictions on foreign investments and so forth (Ramakrishna, 2003).

The consequences are, however, very mixed, in terms of success and failure. The success include restoration of economic growth, stability in inflation rate, favorable current account BOPs, increasing trade openness (see Figure 1), mounting FDI inflows, strong foreign exchange reserve, public-private dichotomy, reduction of poverty, increasing human development, growing mass of educated people, integration of financial markets and booming stock markets are the most notable ones. The failures include growing fiscal deficit as well as revenue deficit, low and stagnant tax-GDP ratio, low performance of social sector, weak public delivery system, disempowerment, bureaucratic hurdles, inefficiency public sector, infrastructural deficiencies, growing income inequalities, jobless growth and mounting regional disparity (Pradhan, 2006). In this paper, we are very keen in studying the trade behaviour in India. In particular, the paper investigates the random walk properties of foreign trade during the globalization era of 1990s.

The rest of the paper is organized in the following fashions: Section II discusses the methodology. Section III presents results and discussion. Section VI concludes with policy implications thereof.

2. Methodology and Data Descriptions

The objective this study is to examine the random walk behaviour of foreign trade, both for exports and imports. So the corresponding hypothesis is that there is presence of random walk in both exports and imports. To verify the same, the study presents a method that defines a structure in which a time series is either trending or mean-reverting. What is defined as being trending respectively mean-reverting should be seen in relation to the characteristics of a random walk (Lock, 2007; Fong et al., 1997; Pagan, 1996; Chow and Denning, 1993; Sargan and Bhagava, 1983; Dickey and Fuller, 1981). The motivation of this study is derived from the fact that for modelling financial time series and developing quantitative tools for trading, it is necessary to know as much as possible about the structure of the time series. The

Variance Ratio (VR) test, originally suggested by Lo and Mackinly (1988), is a very well studied method used to test the random walk hypothesis against stationary alternatives. Doing so, the VR is built around the linear property that the increments of random walk must be a linear function of the time interval (Lindemann et al., 2005; Kim and Whang, 2003; Smith and Ryoo, 2003; Nath and Reddy, 2002; Urrutia, 1992; Lo and Mackinly, 1989). The intuition behind the variance ratio test is the following:

Let Y_t denote the log of a variable at time t. The variable is said to increment in a random walk fashion, if it is in the following time series format:

$$Y_t = \beta + Y_{t-1} + \varepsilon_t \tag{1}$$

Here β is an arbitrary drift parameter and ε_t is the random disturbance allowed to vary with time and deviate from normality. The specification of Y_t is far more lenient then the traditional random walk specification, which restricts ε_t to being identically and independently distributed (i.i.d.).

If the movement of Y_t does follow a random walk, then variance of $\{Y_t - Y_{t-1}\}$ is 1/k variance $\{Y_t - Y_{t-k}\}$. That is as follows:

$$1/k[Var(Y_t - Y_{t-k})] = Var(Y_t - Y_{t-1}) \tag{2}$$

$$1/k[Var(\Delta_{Y_t}{}^k)] = Var(\Delta Y_t) \tag{3}$$

$$1/k = \frac{Var(\Delta Y_t)}{Var(\Delta^k Y_t)} \tag{4}$$

$$\frac{Var(\Delta^k Y_t)}{Var(\Delta Y_t)} = 1 \tag{5}$$

$$\frac{\sum_{t=1}^{n}\left(\Delta^k Y_t - \Delta^k \overline{Y}\right)}{k\sum_{t=1}^{n}\left(\Delta Y_t - \Delta \overline{Y}\right)} = 1 \tag{6}$$

Where, K is the length of the long term variance; Y_t is the actual time series in levels, ΔY_t is $Y_t - Y_{t-1}$, $\Delta^k Y_t = Y_t - Y_{t-1}$, $\Delta \overline{Y}$ is the mean value of the short term changes and $\Delta^k \overline{Y}$ is the mean value of the long term changes.

In short, the variance ratio test can be explained as

$$Z(k) = \frac{1}{k} X\left\{ Var(X_{t-k}) \middle/ Var(X_t) \right\} \tag{7}$$

The above equation presents three possibilities:

1. If the series follow a random walk, this ratio should equal unity.

2. If the series is stationary, the ratio will tend to zero.

3. If the series exhibit mean reversion, Z (k) should lie between zero and one.

4. The value of Z (k) above one indicate that a current increase in the value of the share price will be reinforced in the future by further positive increase.

Here the test of random walk is equivalent to testing the null hypothesis that (1/k) times the variance of the k-differences over the variance of the first difference, that is, the variance ratio, is equal one. Thus, our null hypothesis of random walk becomes:

$$H_0 : \sigma_K{}^2 / \sigma_1{}^2 = 1 \tag{8}$$

　　Where, $(1/K)Var(Y_t - Y_{t-k}) = \sigma_K{}^2$ and $Var(Y_t - Y_{t-1}) = \sigma_1{}^2$

The data correspond to monthly exports and imports of India during 1990 to 2010 and has been collected from Hand Books of Statistics on Indian economy, RBI.

3. Empirical Results and its Discussion

This section discusses the empirical results of Variance Ratio (VR) test. The results of VR, denoted by $\sigma_K{}^2 / \sigma_1{}^2$, for k= 1 to k= 16 is presented in Table 1. The results suggest that the variances increase with proportionate to time. It is observed that (1/k) times the random variables of k-differences vary widely over time what suggests that the series do not follow a stationary trend. The values of variance ratio are more than unity in most of the cases. This indicates that the series are not pure random walk. This is true for exports, imports and total trade. It is to be noted that this

fluctuations are partly temporary and partly permanent (see Cochrane, 1988). The random walk follows the permanent component of a change and the stationary series follows the temporary part of a change. In fact, VR is used to measure the permanent or random walk component of the time series. The estimated results indicate that the foreign trade in India during the globalization era of 1990s contains a large permanent or random walk component and a small temporary or stationary component. That is the empirical evidence presented in this paper confirms the hypothesis that foreign trade follows a random walk.

4. Summary and Conclusions

The paper has attempted to examine the random walk properties of foreign trade in India during the globalization era of 1990s. The variance ratio test, developed by Lo and Mackinlay, has been used to investigate the same. The variance ratio test indicates that variances of time series are not stationary. It increases in proportionate to time. This indicates that the time series follow a random walk. The empirical results also indicate that the series contain large permanent component and small temporary component. These findings suggest that foreign trade, both exports and imports, are governed by a random walk. To summarize, it is concluded that variance ratio is a useful tool to detect structure, i.e. trending and/ or mean-reverting behaviour, in time series.

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Table 1. Variance ratio test

K	1	2	3	4	5	6	7	8	10	12	16
N	204	203	202	201	200	199	198	197	195	193	189
Exports											
σ_K^2	0.00231	0.00248	0.00283	0.00336	0.0036	0.00379	0.00347	0.00391	0.00396	0.00485	0.0054
σ_K^2/σ_1^2	1.0000	1.0740	1.225	1.4532	1.4545	1.467	1.502	1.6935	1.714	2.090	2.3400
Imports											
σ_K^2	0.00215	0.00189	0.00259	0.002964	0.00353	0.00371	0.00425	0.00441	0.0051	0.00528	0.007131
σ_K^2/σ_1^2	1.0000	0.8756	1.2047	1.3805	1.6419	1.7256	1.9767	2.0554	2.372	2.456	3.32100
Total Trade											
σ_K^2	0.001676	0.00144	0.00184	0.00221	0.00243	0.00259	0.00292	0.003129	0.00349	0.00357	0.00427
σ_K^2/σ_1^2	1.0000	0.859	1.0979	1.3186	1.4499	1.545	1.7422	1.86695	2.082	2.1342	2.5477

Note: σ^2 represents variance; K represents corresponding lag; N represents total sample size.
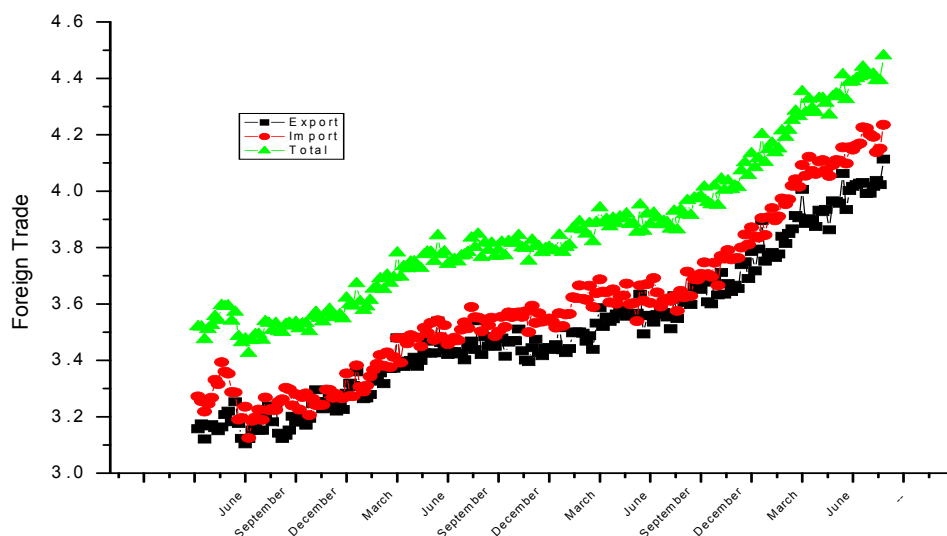
Figure 1. Visual Plots of Foreign Trade in India (at Log Level)

Source: Hand Book of Statistics, Reserve Bank of India,

Government of India, New Delhi