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Random Walk Hypothesis for Stock Prices in Fiji

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Abstract

The main goal of this paper is to investigate the random walk hypothesis in Fiji using monthly data from January 2000 to October 2017. Applying augmented Dickey Fuller (ADF 1979, 1981) and Phillips-Perron (1988), Zivot-Andrews (1992), and Narayan and Popp (2010) unit root tests, this study finds that stock prices is best characterized as non-stationary. The estimated multiple structural break dates in the stock prices corresponds with devaluation of Fijian dollar by 20 percent in 2009 and General Elections in September 2014, which Fiji First Party won by majority votes. The empirical results indicate that stock prices are best characterized as a unit root (random walk) process, indicating that the weak-form efficient market hypothesis holds in Fiji's stock market. Hence, it will be difficult to predict future returns based on historical movement of stock prices in Fiji's stock market.

Keywords: Weak-Form Efficient Market Hypothesis, Random Walk Hypothesis, Stock prices, Multiple Structural Breaks, Fiji

1. Introduction

The topic of whether stock prices can be described as a random walk or mean reverting process is not new and has been subject of significant debate over the past few decades. Whether stock prices can be best described as a random walk or mean reverting process has important implications for: (a) efficient market hypothesis – which suggests that returns of a stock market cannot be predicted from previous price movements; (b) understanding the effects of shocks to stock prices; (c) stock price forecasting; (d) investment decisions and strategies made by investors (Narayan 2006, Lee, Lee, and Lee 2010, Wang, Zhang, and Zhang 2015).

If stock prices are best characterized as a unit root (random walk) process, then weak-form efficient market hypothesis holds (Narayan 2006, Lee, Lee, and Lee 2010, Wang, Zhang, and Zhang 2015). Furthermore any shock to stock prices are likely to have a permanent effect and it would not be possible to predict future returns using historical stock prices movement. In addition, if stock prices follow a (unit root) random walk process, this implies that volatility of stock markets are likely to increase without bound over the long run – thus impacting investment decision and trading strategies of investors (Chaudhuri and Wu 2003, Narayan and Smyth 2007, Tiwari and Kyophilavong 2014, Narayan 2006, Narayan 2008). If stock prices are best characterized as mean reverting (trend stationary) process, this implies any shock will have temporary impact and series will return to its trend path over time and it would be possible to forecast stock prices based on historical stock prices (Narayan and Smyth 2007, Tiwari and Kyophilavong 2014). Accordingly, this allows investors to formulate trading strategies to earn abnormal returns (Narayan 2008, Lee, Lee, and Lee 2010).

An emerging body of empirical studies have investigated the random hypothesis over the last few decades. Many studies have examined the hypothesis for India (Sharma and Kiran 2017, Ryaly, Raju, and Urlankula 2017), China (Charles and Darné 2009, Balsara, Chen, and Zheng 2007), Pakistan (Husain 1997), Sri Lanka (Abeysekera 2001), Taiwan (Lock 2007, Chang and Ting 2000). Another group of studies have studied the hypothesis for several countries together (Hamid et al. 2010, Ngene, Tah, and Darrat 2017, Abraham, Seyyed, and Alsakran 2002, Araújo Lima and Tabak 2004). However, the empirical evidence on random walk hypothesis is still mixed.

The main objective of this paper is to contribute to the empirical literature and investigate the random walk hypothesis of stock prices in Fiji using monthly stock price data over the sample period January 2000 to October 2017. This paper contributes to the empirical literature in three major ways. First, we contribute to the growing literature on random walk hypothesis of stock prices in the developing economies. While there has several studies on developing Asian and African economies, there is little literature for small developing economies like Fiji that have recently experienced high economic growth rates and undertaken significant policy reforms in the stock market.

Market capitalization and number of trades in Fiji's stock market has increased significantly over the recent years. Stable macroeconomic and political climate together with supportive fiscal policy incentives boosted investor confidence and facilitated growth of the stock exchange (South Pacific Stock Exchange (SPSE) 2016). The government has been trying to develop the stock market in Fiji through a range of tax incentives and measures including: (a) dividends being tax-free for residents, reduction of corporate tax rate of 10% for companies listing on SPSE ; (b) tax exemptions on gains arising from restructure due to listing; (c) tax deductions for listing related cost; (d) commencement of National Listing Forum to encourage public listing; (e) and increased investor awareness (Government of Fiji 2014, South Pacific Stock Exchange (SPSE) 2016, 2014). In light of these reforms, we examine the random walk hypothesis of stock prices using monthly data.

Our study builds on the scanty empirical literature that exists on Fiji's stock market. Previous studies have examined stock price clustering (Narayan and Smyth 2013), relationship between stock prices and macroeconomic activities (Puah and Jayaraman 2007) and stock market volatility (Mala and Reddy 2007), factors influencing listing on the stock exchange (Mala and White 2009), corporate governance initiatives (Reddy and Sharma 2011) and the importance of law for stock market development (Sharma and Nguyen 2011). This paper provides evidence on random walk hypothesis for Fiji and has important implications for scholars and investors.

Second, this study uses latest monthly stock price data over the large period January 2000 to October 2017. The major benefit of using the latest data is our sample period covers major domestic events (such as political coup in December 2006, 20 percent devaluation of Fijian dollar in 2009 and return to democratic rule following General Elections in September 2014) and external events (such as Global financial crisis 2007/2008 and 2007-2008 World food price crisis). This study uses a battery of unit root tests allowing for structural breaks to endogenously determine the break dates and examine if it is associated with any domestic or external shocks identified above. Such information is important for investors and government to understand how future shocks are likely to impact Fiji's stock market and aid in devising correct investment strategies and development policies.

Third, for the first time in context of Fiji's stock market, this paper uses a novel unit root test developed by Narayan and Popp (2010) that allows for multiple structural breaks in stock prices series. Narayan and Popp (2013) have demonstrated the key advantage of this unit root test in stimulation study. They investigated small sample size and power properties of unit root tests developed by Lee and Strazicich (2003), Lumsdaine and Papell (1997) and Narayan and Popp (2010). The main finding of their study was that Narayan and Popp's (2010) unit root test has a better size and high power and identifies break dates more correctly. Therefore, our paper offers robust evidence on the unit root properties of the stock prices in Fiji using a new and relatively robust unit root test.

The rest of the paper is structured as follows. Section 2 discusses the data sources and methodology. Section 3 discusses the results, while Section 4 provides the concluding remarks.

2. Data and Methodology

This study uses monthly data on stock prices from January 2000 – October 2017 from International Monetary Fund's International Financial Statistics. We begin our empirical analysis by investigating the order of integration of stock price series using Augmented Dickey Fuller (ADF) test (Dickey and Fuller 1981, 1979) and Phillip-Perron (PP) unit root test (Phillips and Perron 1988). This study does not provide details of these tests as they are well-known in the applied time series literature. However, these unit root tests do not account for structural breaks and thus might lead us to incorrectly conclude on the random walk hypothesis.

Following a seminal paper by Perron (1989), it has been widely recognized that failure to properly allow for structural breaks can bias the unit root test towards non-rejection of the unit root hypothesis. In light of this, the present study employs unit root test developed by Zivot and Andrews (1992) that allows for a single structural break and newly developed unit root test of Narayan and Popp (2010) that accounts for two structural breaks. Both these unit root tests identifies structural break dates which can informative for applied economists in identifying the impact of internal and external shocks on the series.

Unit Root test with a single structural break

Next the unit root test with a single structural break developed by Zivot-Andrews (1992) is employed to verify the order of integration. Sen (2003) showed that Model C version of the Zivot-Andrews unit root test minimizes the loss of power and is relatively superior compared to Model A. Thus, we employ Model C version of the unit root test. The Model C version of the test allows for a change in both slope and intercept and has the null hypothesis that stock prices is an integrated process without a structural break against the alternative stock prices is trend stationary with a structural break in the trend function that occurs at unknown time.

$$\Delta y_t = \omega_0 + \pi y_{t-1} + \beta T + \delta_1 DU_t + \varphi_1 DT_t + \sum_{j=1}^{k} \tau_j \Delta y_{t-j} + \mu_t \tag{1}$$

We determine the break date by identifying the value of *TB* for which the ADF *t*-statistic (absolute value of the *t*-statistic for π) is maximised. We estimate the following equation as (1) below including Δy_{t-j} to correct for serial correlation, and ensure that error term is white noise. In equation (1), y_t denotes log of stock prices and *T* is the time trend. Δ is the first difference operator, $\mu_t \sim iid\,(0, \sigma^2)$, t = 1…. *n*.

The remaining variables are defined as follows: DU_t is an indicator dummy variable for a mean shift occurring at time *TB*, while DT_t is the corresponding trending shift variable, where $DU_t = 1$ and $DT_t = t - TB$ if $t > TB$; otherwise 0. We follow Zivot and Andrews (1992) and set the 'trimming region' to: [0.15, 0.85].

Unit Root test with multiple structural breaks

We next use Narayan and Popp (2010) unit root test that allows for multiple structural breaks by estimating equations (2-3). We consider two cases. Model 1 allows for two breaks in the level, while Model 2 allows for two breaks in the level and the slope. In a recent study, Narayan and Popp (2013) showed that unit root test developed by Narayan and Popp (2010) has a better size, high power and is able to identify break dates more correctly compared to alternative unit root tests developed by Lee and Strazicich (2003) and Lumsdaine and Papell (1997).

Model 1

$$\begin{aligned} y_t^{M1} &= \rho y_{t-1} + \alpha_1 + \beta^* t + \theta_1 D(T_B^{'})_{1,t} + \theta_2 D(T_B^{'})_{2,t} \\ &+ \delta_1 DU'_{1,t-1} + \delta_2 DU'_{2,t-1} + \sum_{j=1}^{k} \beta_j \Delta y_{t-j} + e_t \end{aligned} \tag{2}$$

Model 2

$$\begin{aligned} y_t^{M2} &= \rho y_{t-1} + \alpha^* + \beta^* t + \kappa_1 D(T_B^{'})_{1,t} + \kappa_2 D(T_B^{'})_{2,t} \\ &+ \delta_1^* DU'_{1,t-1} + \delta_2^* DU'_{2,t-1} + \gamma_1^* DT'_{1,t-1} + \gamma_2^* DT'_{2,t-1} + \sum_{j=1}^{k} \beta_j \Delta y_{t-j} + e_t \end{aligned} \tag{3}$$

The break dates in the stock prices can be determined using grid search and sequential procedure. However, sequential procedure is less computationally demanding (Narayan and Popp 2010) and breaks are not much different. In Model 1 and Model 2, y_t denotes log of stock prices and the unit root null hypothesis of $\rho = 1$ are tested against the alternative hypothesis of $\rho < 1$. The t-statistic of $\hat{\rho}$ is denoted by $t_{\hat{\rho}}$.

3. Results and Discussion

Unit Root Test Results without Structural Breaks

Table 1 presents ADF and PP unit root test results for stock prices for Fiji. For the ADF test, it can be seen that in the levels, the ADF test statistics is not significant (as indicated by high probability values). A similar observation can be made regarding the PP test-statistics, which are not significant. It is worth noting that the results are not sensitive to inclusion of time trend. Thus, in both cases, the unit root hypothesis is not rejected. However, the unit hypothesis is easily rejected at 1 percent significance level when the stock price series is expressed in the first difference. In both cases, the test-statistics are highly significant and the unit hypothesis is rejected. The stock price series contains a unit root in the levels but becomes stationary after first differencing. The results from both unit root tests indicate that stock price is best characterized as a non-stationary series. In other words, stock price is an I(1) variable.

Table 1. Unit Root Test Results

Variable	In Levels			
	ADF		Phillips-Perron (PP)	
	C	C & T	C	C & T
ln SPI$_t$	0.463	0.036	0.161	-0.237
	(0.985)	(0.997)	(0.970)	(0.992)
	In First-Difference			
Variable	ADF		Phillips-Perron	
	C	C & T	C	C & T
Δ *ln SPI*$_t$	-13.781***	-13.862***	-13.852***	-13.918***
	(0.000)	(0.000)	(0.000)	(0.000)

The reported values are test-statistics. Figures in bracket are probability values. *** indicates statistical significance at 1 percent level. The unit root tests were conducted in Eviews program.

Unit Root Test Results with Structural Breaks

Since the ADF and PP unit root tests do not allow for structural break, the results are likely to be misleading. To avoid this pitfall, we re-examine the unit root hypothesis allowing for a single break using Zivot-Andrews (1992) test. Model C considers a change in the both slope and intercept. We report three important results in Table 2, namely the test-statistics, break date and optimal lag length (*k*). It is clear from Table 2 that unit root hypothesis is not rejected in level and the test-statistic is insignificant. The unit root hypothesis is rejected, however, when the stock price series is expressed in the first difference. The computed test-statistics of -15.004 is statistically significant as it exceeds the critical value of -5.570 (in absolute terms) at 1 percent significance level.

Table 2. Unit Root Tests with a Single Break

	Zivot-Andrew (1992) Unit-Root Test		
Variable	Test-statistics	Break date	*k*
ln SPI$_t$	-2.759	2014:08	0
Δ *ln SPI*$_t$	-15.004***	2014:12	0

*** indicates statistical significance at 1 percent level. We implemented the test in RATs 9.0 software program.

Table 3. Unit Root Tests with Multiple Structural Breaks Results

Variable	Model	Test -statistic	TB1	TB2	*k*
ln SPI$_t$	Model 1	-1.900	Dec 2009	Dec 2011	3
Δ *ln SPI*$_t$	Model 1	-6.080***	May 2010	Sept 2010	9
ln SPI$_t$	Model 2	-2.925	Dec 2009	Dec 2011	3
Δ *ln SPI*$_t$	Model 2	-5.978***	May 2010	Sept 2010	9

The reported figures are test-statistics. The critical values for Model 1: 1 % (-5.259); 5 % (-4.514).The critical values for Model 2: 1 % (-5.949); 5 % (-5.181).The critical values was extracted from Narayan and Popp (2010). The Narayan and Popp (2010) unit-root test was implemented in Gauss 15.0.

The estimated break dates are 2014:08 and 2014:12 and is perhaps due to General Elections that resulted Fiji First Party winning the majority of the votes. The return to democratic rule boosted investor confidence. Therefore, the stock prices is an I(1) variable. Next, we consider allowing for multiple structural breaks by employing Narayan and Popp's (2010) unit root test. The results summarized in Table 3 indicate that regardless of the model considered, the unit root hypothesis is not rejected for stock prices in levels. The estimated break dates are December 2009 and December 2011. Thus, the unit root results indicates that stock prices is an I(1) variable even after allowing for multiple structural breaks.

4. Concluding Remarks

The main goal of this paper was to examine the random walk hypothesis for stock prices in Fiji using monthly data from January 2000 to October 2017. We achieved this objective by employing a battery of unit root tests with and without structural breaks. The main result of this paper is that stock prices is best described as a non-stationary (random walk) process and implies that volatility of Fiji's stock market is likely to increase without bound over the long run. In addition, our finding suggests that weak-form efficient market hypothesis holds in case of Fiji's stock market. The result also indicates that shocks to stock prices are likely to have permanent effects and stock prices are unlikely return to its trend path following shocks. Our finding indicates that devaluation and political shock such as General Elections can affect stock market in Fiji. More importantly, the finding suggests that future returns in the Fiji's stock market cannot be predicted from historical stock price movements.

One of the limitations of this paper is that it has focused on Fiji's stock market. Future studies can investigate the random walk hypothesis/efficient market hypothesis for other stock markets (such as the Papua New Guinea (PNG)) in the Pacific Island Economies, which are at an infant stage. Future studies can also investigate how stock prices interact with other macroeconomic variables in Fiji.

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