A Four Decade Analysis of Equity Returns in the Japanese Financial Market (2020)

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Abstract
The purpose of this study is to examine returns on Japanese equities over nearly a four-decade period and to compare results among the four decades and the entire period of the study. "Long memory" modeling of time series developed to predict slowly moving time series is a method to predict longtime components of time series data. Previously, other studies indicated some progress in producing results of predictability by these "long memory" analyses. The authors examined statistically for some of the reasons why long memory forecasting may not be very suitable for predicting equity returns over lengthy periods. Data secured from a source that collects information on Japanese equity returns enabled a study of possible explanations of why lengthy predictions are difficult. The analysis is of an application to financial time series and does not dispute the use of long memory modeling in other applications. The conclusions made are therefore not universal but only to the use in financial engineering and time series analysis. Future work should consider the cost effectiveness of long-memory modeling in other forms of financial time series analysis.

Key Words: *Long memory modeling, Time series components, Japanese equity market, Long-run dependence*

Introduction

One studies Japanese equity markets because of the great growth in its equity markets in the 1980s and subsequent fluctuations in later years and the problem of explaining fluctuations in the predictability of monthly stock prices in Japan. Ziemba and Schwartz (1991) and Ziemba and Ziemba (2012) produced evidence indicating that the dynamics of the Japanese markets had significant effects on the prices of Japanese securities. Many of these include Rothlein and Jarrett (2002), Jarrett and Kyper (2005a, 2005b, 2006), Caporale and Gil-Alana (2002), and Kubata and Takehara (2003).

Studies of changes in the Japanese economy in the 1980s through the 1990s and into the new century produce evidence to identify shocks in the Japanese markets leading to changes in the predictability in prices, thus reducing the accuracy of listed Japanese equities. Nagayasu (2000) documented the era when Japan went from great growth in its asset prices to virtual stagnation producing the worst crises in Japan since the outcome of World War II. Furthermore, Ray, Jarrett, and Chen (1997) produced evidence of both temporary and permanent components in the time series of a sample of listed Japanese equities. The last study, using ARFIMA time series methods, identified these components but also indicated some of the great difficulties in predicting prices of Japanese securities. They showed that the inclusion of the temporary component in a sample of 15 individual listed Japanese firms. Japanese equities contain 5% to 15% of permanent components, and thus, there may be a small amount of predictability in

Japanese equity prices. Nagayasu (2003), using the ARFIMA-FGARCH model, studied the efficiency of the Japanese equity market by examining the statistical properties of the return and volatility of the Nikkei 225. He found that there is a long-range dependence. This differs from the notion of the efficient market hypothesis (EMH) and is valid for the sample periods studied. This suggests that the equity market reform of the early 2000s did not produce major efficiency gains.

In addition to the Japanese study noted above, others have made similar studies in other equity markets. These studies include Agiakloglou, Newbold, and Wohar (1992), Baillie (1996), Baillie, Bollerslev, and Mikkelsen (1996), Barkoulas, Baum, and Travlos (2000), Bollerslev and Mikkelsen (1996), Lo (1991, 1997), Mills (1993), Sadique and Silvapulle (2001), Davidson and Li (2015), and hi and Ho (2015). In all, these studies conclude that forecasting stock returns is a very difficult and exceptionally rare case when the future is barely predictable over the long term. This is not surprising but is often the case.

Data Analysis

In this study, we examine the evidence concerning the lack of powerful long memory permanent components in a lengthy period of time series data on returns to the Japanese equity market. As a number of previous studies, we collected data over four decades from the PACAP databases on Japanese equity markets kept at the University of Rhode Island/CBA (e-mail: pacapd@etal.uri.edu).

The purpose of this study is to determine what factors in the time series of Japanese equity prices may cause this great difficulty in prediction. We propose to study the value weighted and equal weighted monthly return over a lengthy period to explain the inability of predicting accurately Japanese equity prices.

In particular, we study the history of equity prices for the Japanese (Tokyo) stock exchange over a lengthy period on what may have caused these prices to have changed during the time span.

Stated differently, long-run dependence (long-run memory) is very important in explaining equity behavior. For example, if long-run memory is present such as in predicting the overflow of a river causing floods beyond its banks, one may take action by increasing the height of the riverbanks to prevent future overflow of the river. This analogy, if present in the time series of equity returns, may permit one to adjust his/her financial decision making to reduce the disturbing effects of serial long-term dependence. Hence, our goal is to examine if serial dependence produced changes that differ in several time periods.

In addition, because we have collected data on Japanese equity over a lengthy period in Japanese currency, we transformed the data in two ways. One set of time series over a four-decade time horizon applies the principle of "value-weighted monthly returns," identified as MVRMWD in the data set of the time series. A second time series is "equal-weighted monthly" returns identified by the variably name MERMWD. We distinguish the two data sets because the original data in Japanese currency are transformed into U.S. currency and we wish to see if the two methods yield similar results and there is no transformation bias.

Big Data Analytics

First, we analyze and compare the returns for the Japanese stock market for the entire roughly four-decade sample of value weighted monthly returns denoted in the following table and figure as variable MVRMWD. The table consists of five panels—that is, Moments, Descriptive Statistics, and Statistical Tests for Location, Quantiles, and Extreme Observations. In the first panel (Moments), observe that the mean is very small in comparison to the standard deviation. Skewness is slightly negative and kurtosis—that is, the state or quality of flatness or peakedness of the curve describing a frequency distribution in the region about its mode. In this case, a value of 1.353 or so indicates that there are a few extremes in the data than would be seen in a normal curve whose measure would be about 3. The coefficient of variation of 981.354 (the standard deviation divided by the mean) would indicate that the mean would not be a good predictor because the standard deviation is large with respect to the mean.

The second panel contains the descriptive statistics. Note that the mean and median differ by a factor of about 10:1, indicating that the data are highly skewed, as noted in the first panel on moments. The standard deviation relative to the mean would also be very large and corroborates the findings of the coefficient of variation noted in the first panel. In addition, the other measures of variation—the variance, range, and interquartile range—show also that the data are widely dispersed.

The third panel contains the Tests for Location: µ0 = 0, which were the t-test, M, and signed rank. All three tests indicated that the null hypothesis should be reject at small p-vales of 0.3030, 0.0147, and 0.0102. Hence, the means were nonzero and positive whether they were tested by parametric or rank statistics. Finally, the last two panels of Table 1 show the wide distribution of the data based on quantiles, quartiles, and extreme observations.

For the entire period of the study, the return on Japanese equities tended to be positive but widely distributed and at no time tend to be easily predictable. The question remains, how can one observe the wide distribution over a lengthy period? Hence, in the next sections, we observe the pattern in the roughly four decades of the study to determine why the permanent component of the time series repeats in each new decade.

Table 1
Comparing Japan Stock Market Return by Decade
Value Weighted Monthly Return (MVRMWD)

Moments (Univariate Procedure)			
N	**455**	**Sum Weights**	**455**
Mean	**0.00525402**	**Sum Observations**	**2.390581**
Standard Deviation	**0.05156059**	**Variance**	**0.00265849**
Skewness	**0.151716**	**Kurtosis**	**1.35303696**
Corrected Sum of Squares	**1.20695631**		
Coefficient of Variation	**981.354192**	**Standard Error of the Mean**	**0.0024172**

Descriptive Statistics			
Location		**Variability**	
Mean	**0.005254**	**Std. Deviation**	**0.05156**
Median	**0.0005576**	**Variance**	**0.00266**
Interquartile Range	**0.05635**	**Range**	**0.37645**

Tests for Location: $\mu_0 = 0$			
Test	**Statistic**	***P*-value**	**Heading**
t	**2.1736**	**Pr > abs (t)**	**0.0303**
M	**26.5**	**Pr ≥ abs (M)**	**0.0147**
Signed Rank (S)	**7,199**	**Pr ≥ abs (S)**	**0.0102**

Quantiles	
Quantile	**Estimate**
Maximum	**0.1791**
99%	**0.1367**
95%	**0.0898**
90%	**0.0638**
75% (Q3)	**0.0342**
50% (Median, Q2)	**0.0056**
25% (Q1)	**-0.0222**
10%	**-0.0585**
5%	**-0.0792**

Note: Q is for quartile.

Extreme Observations			
Lowest	**Highest**		
Value	**Observation**	**Value**	**Observation**
-0.1973	**405**	**0.1367**	**228**
-0.1963	**188**	**0.1410**	**290**
-0.1571	**226**	**0.1464**	**193**
-0.1388	**408**	**0.1579**	**134**
-0.1266	**404**	**0.1791**	**189**

Analysis by Decade

Presented in the Tables 2–5 is the same analysis for each decade referred in the table as a group. Group = 1 refers to the first decade of data collected from the source noted before. In turn, Group = 2, 3, and 4 refer to each new decade. The analysis for each decade is the same as in Table 1. Note that the number of observations is smaller than the entire sample studied; hence, with less degrees of freedom, the significant tests for location may vary. We expect the moments and descriptive statistics to vary as well. By observing the mean rates of return, we observe in Tables 2–5 that the mean rates of return were extremely small but with a declining trend with the largest value in Group = 2. The coefficients of variation again were very large indications of the wide diversity in the mean rates for each firm listed on the exchange. Furthermore, for all the groups, 1, 2, 3, and 4 indicated that the test of hypothesis of mean equals zero could not be rejected. The p-values tended to be very large regardless of whether the test was a t-test or nonparametric analysis was performed.

In addition, the same set of tables indicated the wide diversity in the returns from decade to decade. At no time did we observe a pattern of growth as exhibited in the tables for each decade. The evidence seems to suggest that the Japanese equity market did not appear to have a positive growth during the decades but did exhibit wide variation, skewness, and kurtosis in the distribution of returns. This may suggest that a permanent component in the time series data was not present. Analysis of data suggests that long memory modeling may not be available as a panacea for predicting future returns in the Japanese equity market.

Table 2

Comparing Japan Stock Market Return by Decade Value Weighted Monthly Return (MVRMWD) Group = 1

Moments –(Univariate Procedure)			
N	**119**	**Sum Weights**	**119**
Mean	**0.0121775**	**Sum Observations**	**1.449122**
Standard Deviation	**0.03212**	**Variance**	**0.00103169**
Skewness	**0.29980506**	**Kurtosis**	**2.02395426**
Corrected Sum of Squares	**0.12173992**		
Coefficient of Variation	**263765208**	**Standard Error of the Mean**	**0.00294444**

Mean	**0.012177**	**Std. Deviation**	**0.03212**
Median	**0.009441**	**Variance**	**0.00103**
		Range	**0.22198**
		Interquartile Range	**0.03269**

Tests for Location: μo = O			
Test	**Statistic**	***P*-value**	**Heading**
t	**4.135766**	**Pr > abs (t)**	**S.0001**
M	**18.5**	**Pr abs (M)**	**0.0009**
Signed Rank	**1,592**	**Pr abs (SJ)**	**0.0001**

Quantiles	
Quantile	**Estimate**
Maximum	**0.1235**
99%	**0.1082**
95%	**0.0662**
90%	**0.0509**
75% (Q3)	**0.0282**
50% (Median, Q2)	**0.0094**
25% (QlQi)	**-0.0045**
10%	**-0.0251**
5%	**-0.392**
1%	**-0.0618**
Minimum	**-0.0985**

Note: Q is for quartile

Extreme Observations			
Lowest	Highest		
Value	Observation	Value	Observation
-0.0984	112	0.0732	115
-0.0618	80	0.0838	9
-0.0481	85	0.0870	1
-0.0428	6	0.1082	23
-0.0392	114	0.1235	110

Table 3

Comparing Japan Stock Market Return by Decade Value Weighted Monthly Return (MVRMWD)

Group = 2

Moments (Univariate Procedure)			
N	120	Sum Weights	120
Mean	0.0006542	Sum Observations	0.78504
Std. Deviation	0.06311431	Variance	0.00398342
Skewness	0.0226193	Kurtosis	0.98950479
Corrected Sum of Squares	0.47402645		
Coefficient of Variation	964.755513	Std. Error Mean	0.00576152

Descriptive Statistics			
Location		Variability	
Mean	0.006542	Std. Deviation	.06311
Median	0.005635	Variance	0.00398
		Range	0.37541
		Interquartile Range	0.07417

Tests for Location: μo = 0

Test	Statistic	P value	
t	1.135464	Pr > abs (t)	0.2585
M	6	Pr .!: abs (M)	0.37541
Signed Rank (S)	456	Pr .!: abs (SJ)	0.2339

Quantile

Quantile	Estimate
Maximum	0.1791
99%	0.1579
95%	0.1290
90%	0.0763
75% (Q3)	0.0409
50% (Median, Q2)	0.0056
25% (Q1)	0.0333
10%	0.0697
5%	0.0976
1%	0.1571
Minimum	0.1963

Note: Q is for quartile.

Extreme Observations

Least		Highest	
Value	Observation	Value	Observation
0.196303	188	0.131426	211
0.157149	226	0.136679	228
0.124507	182	0.0146419	193
0.124503	187	0.157948	134
0.112875	190	0.179105	189

Table 4

Comparing Japan Stock Market Return by Decade Value Weighted Monthly Return (MVRMWD)

Group = 3

Moments (Univariate Procedure)			
N	120	SUM Weights	120
Mean	0.0010967	Sum Observations	0.131604
Std. Deviation	0.05101579	Variance	0.00260261
Skewness	0.19039713	Kurtosis	0.3175241
Corrected Sum of Squares	0.309855		0.30971067
Coefficient of Variation	4651.75421	Std. Error of the Mean	0.00465708

Descriptive Statistics			
Location		**Variability**	
Mean	0.00110	Std. Deviation	0.05102
Median	0.00309	Variance	0.00260
		Range	0.26458
		Interquartile Range	0.08118

Tests for Location: μo = 0

Test	Statistic	*P*-Value	Heading
t	0.235491	Pr > abs (t)	0.8142
M	3	Pr abs(M)	0.6483
Signed Rank (S)	16	Pr abs (S)	0.9668

Quantiles

Quantile	Estimate
Maximum	0.1410
99%	0.1149
95%	0.0838
90%	0.0628
75% (Q3)	0.0405
50% (Median, Q2)	0.0031
25% (QlQi)	0.0407
10%	0.0643
5%	0.0776
1%	0.0856
Minimum	0.1235

Note: Q is for quartile

Extreme Observations

Lowest		Highest	
Value	Observation	Value	Observation
0.123537	283	0.102495	286
0.085585	306	0.109559	350
0.084380	318	0.113935	246
0.084048	329	0.774880	293
0.079367	241	0.141038	290

Table 5

Japan Stock Market Return by Decade Value Weighted Monthly Return (MVRMWD) Group = 4

Moments (Univariate Procedure)			
N	**96**	**Sum Weights**	**96**
Mean	**0.000258**	**Sum Observations**	**0.02481**
Std. Deviation	**0.05536**	**Variance**	**0.003064**
Skewness	**0.57034**	**Kurtosis**	**1.13855**
Coefficient Variation	**21,415.1414**	**Corrected sum of square**	**0.29111**
		Std. Error of the Mean	**0.0056497**

Descriptive Statistics			
Location		**Variability**	
Mean	**0.000258**	**Std. Deviation**	**0.05536**
Median	**0.003503**	**Variance**	**0.00306**
Interquartile Range	**0.06946**	**Range**	**0.31095**

Tests for Location: μo = 0			
Test	**Statistic**	**P_value**	**Heading**
t	**0.045752**	**Pr > abs (t)**	**0.9636**
M	**5**	**Pr abs (M)**	**0.3584**
Signed Rank	**107**	**Pr abs (SJ)**	**0.6979**

Quantiles	
Quantile	**Estimate**
Maximum	**0.0036**
99%	**0.1136**
95%	**0.0898**
90%	**0.0720**
75% (Q3)	**0.0350**
50% (Median)	**0.0035**
25% (QlQi)	**0.0344**
10%	**0.0629**
5%	**0.1027**
1%	**0.1973**
Minimum	**0.1973**

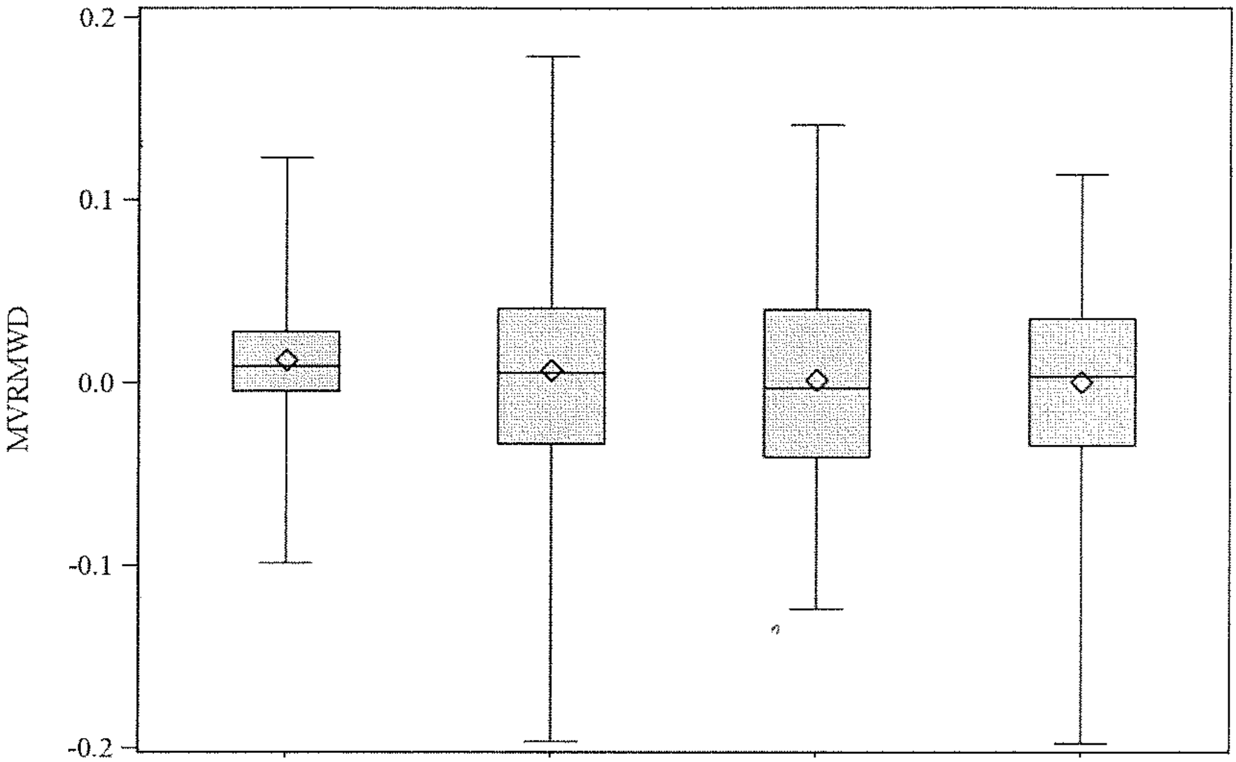
Note: Q is for quartile

Extreme Observations			
Lowest		**Highest**	
Value	**Observation**	**Value**	**Observation**
0.197343	**405**	**0.089771**	**455**
0.138821	**408**	**0.102213**	**445**
0.126562	**404**	**0.103183**	**422**
0.104901	**424**	**0.109199**	**399**
0.102674	**448**	**0.113605**	**368**

Graphical Analysis

Finally, we observe boxplots of the data on Japanese equity returns by decade in Figure 1. From left to right, the boxplot represents mean (diamond), median (the horizontal line through the box), the limits of the interquartile range (upper and lower limits of the box), and the upper lower range of the data for each decade. Note that for decade 1, the box tends to have less variation than for the remaining three decades. The range is also narrower in decade 1 than for the remaining decades. The mean and median return are very near to each other, with decade 2 having a mean and median that are approximate. The boxplot shows that the Japanese equity returns have not shown any growth and are near zero. The boxplot itself shows visually the same conclusion that we observe in the moments, descriptive statistics, hypothesis tests, quantiles, and extreme observation noted in Tables 2–5. We may conclude that the Japanese equity returns have stagnated over the lengthy study, and most important, the results appear to verify the conclusions from previous studies of long memory modeling. If we were to buy the entire market, we would observe that wealth creation would be very slow. However, investors do not usually buy an entire equity market but instead purchase and sell individual securities or market baskets of securities. The like result is that these market baskets would be difficult to predict their returns if the selection process was random. Forecasting such a market basket of securities may be undesirable. We must be extremely careful in selecting equities to purchase in this market, and this has ramifications for mutual funds and exchange-traded funds.

Figure 1
Boxplot to Compare Japan Stock Market by Decades MVRMWD Variable
MVRMWD by Group 2, 3, 4, and 5



Data Analysis for Equal Weighted Monthly Returns

The analysis of the equal weighted monthly returns (MERMWD) is performed in the same manner as in the previous sections. First, we examine the data for the entire four decades; in turn, we examine the data decade by decade as denoted by Groups 1–4. Finally, we compare the boxplots of the four decades. We begin with Table 6 where the data for the entire four-decade time series sample characteristics appear.

Table 6
Equal Weighted Monthly Return (MERMWD)

Moments (Univariate Procedure)			
N	**455**	**Sum Weights**	**455**

Quantiles	
Quantile	**Estimate**
Maximum	**0.2563**
99%	**0.1509**
95%	**0.1011**
90%	**0.0742**
75% (Q3)	**0.4138**
50% (Median, Q2)	**0.0112**
25% (Q1)	**0.0215**
10%	**0.0583**
5%	**0.0855**
1%	**0.4167**
Minimum	**0.1891**

Mean	**0.00878095**	**Sum Observations**	**3.995334**
Std. Deviation	**0.05696745**	**Variance**	**0.00324529**
Skewness	**0.06207574**	**Kurtosis**	**1.56248128**
Corrected Sum of Squares	**1.4733619**		
Coefficient of Variation	**648.76**	**Standard Error Of the Mean**	**0.00267068**

Descriptive Statistics			
Location		**Variability**	
Mean	**0.008781**	**Std. Deviation**	**0.05697**
Median	**0.11278**	**Variance**	**0.00325**
Interquartile Range	**0.06286**	**Range**	**0.44543**

Tests for Location: $\mu_0 = 0$			
Test	**Statistic**	***P*_value**	***P-value***
t	**3.287915**	**Pr > abs (t)**	**0.0011**
M	**36.5**	**Pr ≥ abs (M)**	**0.0007**
Signed Rank (S)	**10,312**	**Pr ≥ abs (S)**	**0.0002**

Note: Q is for quantile.

Extreme Observations			
I Lowest		**Highest I**	
Value	**Observation**	**Value**	**Observation**
0.1891	**188**	**0.1509**	**228**
0.1674	**405**	**0.1663**	**350**
0.1669	**226**	**0.1768**	**189**

0.1581	**187**	**0.2294**	**193**
0.1467	**190**	**0.2563**	**276**

Again, the number of observations is 455 as in Table 1, but the mean rate of return is 0.0088 (rounded to four decimal places), indicating less than a 1-percent rate of return compared with 0.00525 for the value weighted monthly return in Table 1. The coefficient of variation is again very large (648.76); the skewness coefficient is much smaller for the equal weighted monthly returns (0.0621), but the kurtosis is larger at 1.5625 than for the value weighted monthly returns. Hence, this distribution tends to be less skewed but more flattened. The descriptive statistics indicate that this distribution contains less variation about the mean even though it is still large, but the skewness is no longer negative—that is, the median is larger than the mean. The tests for location (t-test, M, and S) all reject the hypothesis that the mean equals zero at very small levels (0.0011, 0.0007, and 0.0002).
The quantiles and quartiles of the data show large distances between each border of the quantiles and quartiles. Last, the extreme observation at their lowest and highest values are a large number in comparison to the size of the time series data set. Hence, the range of the data and interquartile range tend also to be very large, indicating wideness in the data set.

Data Analysis by Decade of Equal Weighted Monthly Returns
Tables 7–10 contain the same analysis as appearing in Tables 2–5 for the value weighted monthly returns. The sizes of the sample for each decade correspond to the analysis in each decade. Group = 1 and 2 (the first and second decades) possess the largest mean and median rates of return with very large coefficients of variation but not as large for the same statistic in Tables 2 and 3 (the same groups by value weighted data). Skewness and kurtosis statistics tend to indicate similar results in Tables 7 and 8 as they do in Tables 2 and 3. Tables 9 and 10 again show similar results as in Tables 4 and 5. Hence, the method of weighting may show different values for the moments and descriptive statistics; the statistical tests of
$\mu0 = 0$ do indicate different results. However, the most stunning result refers to the comparison in the results in Tables 7 and 8 with Tables 9 and 10. Again, the results indicate that for decades (groups) 1 and 2, the mean rates are statistically different from zero, whereas in decades 3 and 4, this is not statistically evident. This corroborates the results in Tables 2 and 3 in comparison to Tables 4 and 5. Hence, the methods of weighting the monthly returns did not affect the interpretation of the results. Japanese equity returns by months deferred as time passed. The result is not an anomaly but indicate that time components did change and returns were probably influenced by changes in the Japanese economy.

Table 7
Comparing Japan Stock Market Return by Decades
Group 1

Moments (Univariate Procedure)			
N	**119**	**Sum Weights**	**119**
Mean	**0.0152**	**Sum Observations**	**1.8102**
Std. Deviation	**0.0299**	**Variance**	**0.00089**
Skewness	**0.0764**	**Kurtosis**	**0.0957**

Corrected Sum of Squares	**0.1053**		**0.1053**
Coefficient of Variation	**196.3424**	**Std. Error Of the Mean**	**0.0027**

Descriptive Statistics			
Location		**Variability**	
Mean	**0.0152**	**Std. Deviation**	**0.0299**
Median	**0.0299**	**Variance**	**0.0009**
Interquartile Range	**0.0417**	**Range**	**0.1601**

Tests for Location: $\mu_0 = 0$			
Test	**Statistic**	***P*-value**	***P-value***
t	**5.5560**	**Pr > abs (t)**	**≤.0001**
M	**25.5**	**Pr ≥ abs (M)**	**≤.0001**
Signed Rank (S)	**1923**	**Pr ≥ abs (S)**	**≤.0001**

Quantiles	
Quantile	**Estimate**
Maximum	**0.0964**
99%	**0.0858**
95%	**0.0596**
90%	**0.0535**
75% (Q3)	**0.0351**
50% (Median, Q2)	**0.0172**
25% (Q1)	**0.0066**
10%	**0.0228**
5%	**0.0388**
1%	**0.0568**
Minimum	**0.0636**

Note: Q is for quantile.

Extreme Observations			
I Lowest		**Highest I**	
Value	**Observation**	**Value**	**Observation**
0.0636	**57**	**0.0672**	**115**
0.0568	**112**	**0.0678**	**108**
0.0431	**7**	**0.0788**	**9**
0.0409	**76**	**0.0858**	**36**
0.0396	**34**	**0.0964**	**12**

Table 8
Comparing Japan Stock Market Return by Decades
Group 2

Moments (Univariate Procedure)			
N	120	Sum Weights	120
Mean	0.0118	Sum Observations	1.4180
Std. Deviation	0.0671	Variance	0.0045
Skewness	0.1101	Kurtosis	1.3312
Corrected Sum of Squares	0.5357		
Coefficient of Variation	567.7790	Std. Error Of the Mean	0.0061

Descriptive Statistics			
Location		Variability	
Mean	0.0118	Std. Deviation	120
Median	0.147	Variance	0.0045
Interquartile Range	0.0620	Range	0.4186

Tests for Location: $\mu_0 = 0$			
Test	Statistic	*P*--value	*P*-value
t	3.287915	Pr > abs (t)	0.0011
M	36.5	Pr ≥ abs (M)	0.0007
Signed Rank (S)	10,312	Pr ≥ abs (S)	0.0002

Quantiles	
Quantile	Estimate
Maximum	0.2295
99%	0.1768
95%	0.1302
90%	0.0841
75% (Q3)	0.0443
50% (Median, Q2)	0.0147
25% (Q1)	0.0175
10%	0.0713
5%	0.1013
1%	0.1669
Minimum	0.1891

Note: Q is for quantile.

Extreme Observations			
Lowest		**Highest**	
Value	**Observation**	**Value**	**Observation**
0.1891	**188**	**0.1351**	**184**
0.1669	**226**	**0.1410**	**219**
0.1581	**187**	**0.1509**	**228**
0.1467	**190**	**0.1768**	**189**
0.1039	**199**	**0.2295**	**193**

Table 9
Comparing Japan Stock Market Return by Decades
Group 3

Moments (Univariate Procedure)			
N	**120**	**Sum Weights**	**120**
Mean	**0.0038**	**Sum Observations**	**0.4502**
Std. Deviation	**0.0665**	**Variance**	**0.0044**
Skewness	**0.5862**	**Kurtosis**	**0.9239**
Corrected Sum of Squares	**0.5259**		
Coefficient of Variation	**1,772.0605**	**Std. Error Of the Mean**	**0.0061**

Descriptive Statistics			
Location		**Variability**	
Mean	**0.00375**	**Std. Deviation**	**0.06648**
Median	**0.00079**	**Variance**	**0.00442**
Interquartile Range	**0.08963**	**Range**	**0.39386**

Tests for Location: $\mu_0 = 0$			
Test	**Statistic**	***P*-value**	***P-value***
t	**0.6181**	**Pr > abs (t)**	**0.5376**
M	**1**	**Pr ≥ abs (M)**	**0.9273**
Signed Rank (S)	**57**	**Pr ≥ abs (S)**	**8821**

Quantile	**Estimate**
Maximum	**0.2563**
99%	**0.1663**
95%	**0.1145**
90%	**0.0958**
75% (Q3)	**0.0473**
50% (Median, Q2)	**0.0008**
25% (Q1)	**0.0424**
10%	**Quantile**
5%	**0.0855**
1%	**0.1296**
Minimum	**0.1375**

Note: Q is for quantile.

Extreme Observations			
Lowest		**Highest**	
Value	**Observation**	**Value**	**Oberservation**
0.1375	**275**	**0.1280**	**348**
0.1296	**272**	**0.1374**	**286**
0.1219	**283**	**0.1381**	**290**
0.1178	**274**	**0.1663**	**350**
0.0910	**263**	**0.2563**	**276**

Table 10
Comparing Japan Stock Market Return by Decades
Group 4

Moments (Univariate Procedure)			
N	**96**	**Sum Weights**	**96**
Mean	**0.0033**	**Sum Observations**	**0.3169**
Std. Deviation	**0.0557**	**Variance**	**0.0031**
Skewness	**0.3094**	**Kurtosis**	**0.1209**

Corrected Sum of Squares	**0.2946**		
Coefficient of Variation	**1686.8887**	**Std. Error Of the Mean**	**0.0057**

Descriptive Statistics			
Location		**Variability**	
Mean	**0.0033**	**Std. Deviation**	**0.0557**
Median	**0.0027**	**Variance**	**0.0031**
Interquartile Range	**0.0771**	**Range**	**0.4392**

Tests for Location: $\mu_0 = 0$			
Test	**Statistic**	***P*-value**	***P-value***
t	**0.5808**	**Pr > abs (t)**	**0.5627**
M	**0**	**Pr ≥ abs (M)**	**1.0000**
Signed Rank (S)	**213**	**Pr ≥ abs (S)**	**0.0771**

Quantile	**Estimate**
Maximum	**0.1181**
99%	**0.1181**
95%	**0.0876**
90%	**0.0742**
75% (Q3)	**0.0452**
50% (Median, Q2)	**0.0027**
25% (Q1)	**0.0320**
10%	**0.0678**
5%	**0.0921**
1%	**0.1674**
Minimum	**0.1674**

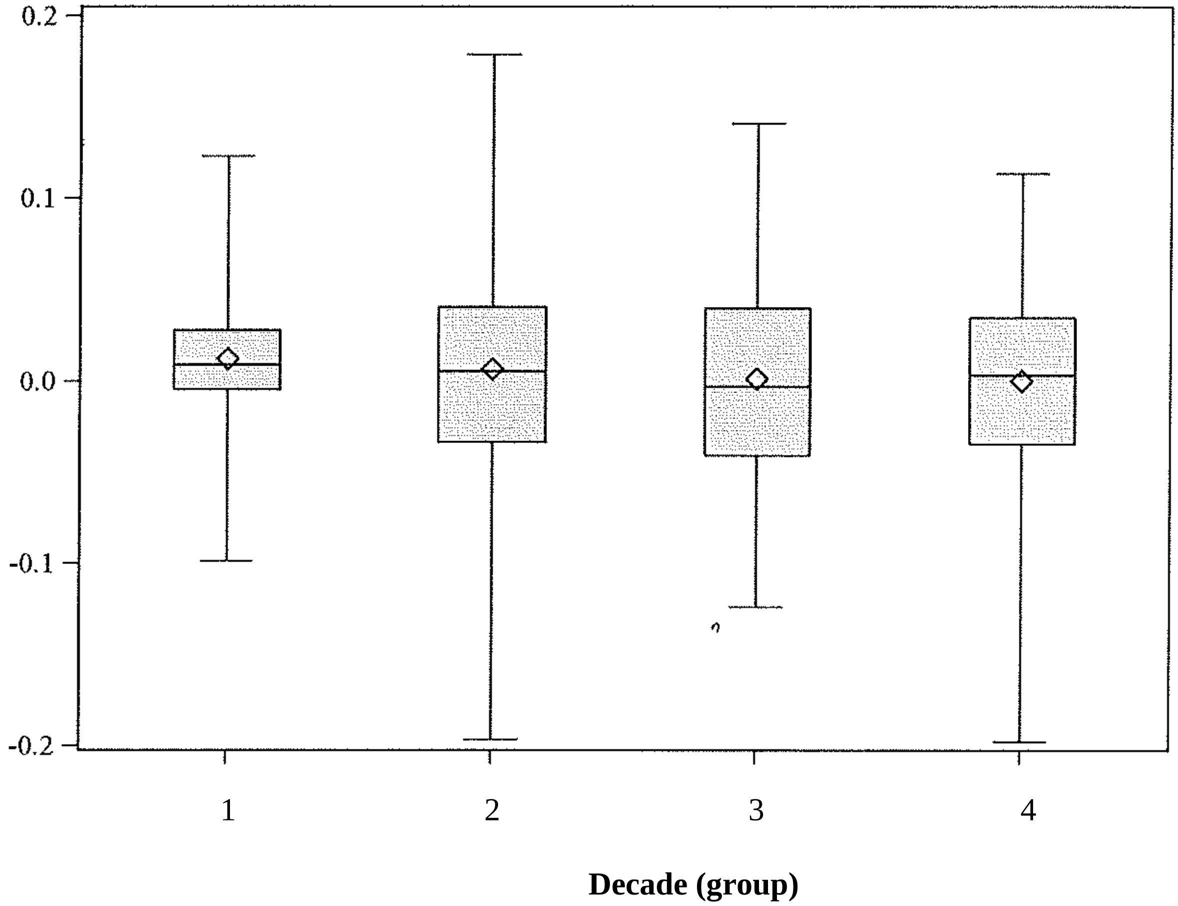
Note: Q is for quantile.

Extreme Observations			
Lowest		**Highest**	
Value	**Observation**	**Value**	**Observation**
	405		**445**
	448		**371**
	424		**413**
	404		**412**
	418		**422**

Boxplot Analysis of Equal Weighted Monthly Returns

By observing the boxplot by decade in Figure 2, we note its similarity to Figure 1, indicating that the method of weighting had little effect on the sample statistics developed to analytically observe the patterns in the data over the four-decade intervals. However, some results should be noted. The limits of the first decade's central box are the narrowest in decade 1 in Figure 1, and the same is true for Figure 2. The middle 50 percent boxes in decades 2–4 are larger than in decade 1 in both figures. The relation of the mean and median are also the same. Hence, it is likely that both methods of weighting did not change the results and conclusions that one can draw.

Figure 2
Boxplot to Compare Japan Stock Market Return by Decades MERMWD



Although the two figures were drawn using different time series, we observe the great similarity in the boxplots of monthly returns. Visual representation appears to indicate that the results are similar, not the same, and conclusions drawn from this visual information should be very similar.

Conclusions

The purpose of this study was to study if long memory modeling could possibly improve prediction of returns in at least one significant nationwide equity market. Previous studies indicated some predictability in producing results that would aid financial analysts and economists in forecasting returns to equity markets. This study does not dispute earlier results but clarifies some of the results of previous studies employing long memory modeling. We conclude that earlier studies may have opened the enthusiasm of utilizing these modern and well-respected time series methods. However, for the purpose of forecasting returns to equities, long memory modeling may simply not be enough to be useful. Although producing long memory modeling of equity returns may be economically cost-effective in managing one's portfolio decisions, alternatives may be more accurate and useful. This analysis concludes that there are great many uses of long memory modeling, but predicting future returns over a lengthy period may not be one of them.

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