Macrothink Institute™

International Journal of Accounting and Financial Reporting
ISSN 2162-3082
2019, Vol. 9, No. 1

A Comparative Study of the Temporal Characteristics of Closed-End Fund Discounts/Premiums

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Received: December 22, 2018 Accepted: January 4, 2019 Published: January 13, 2019

doi:10.5296/ijafr.v9i1. 14097 URL: https://doi.org/10.5296/ijafr.v9i1.14097

Abstract

The primary objective of this study is to compare the difference in temporal characteristics between municipal bond funds and domestic equity funds. The secondary objective is to identify the characteristics of the temporal behavior of closed-end fund discounts/premiums from a class of linear stochastic autoregressive-integrated-moving average (ARIMA (p, d, q)) models popularized by Box-Jenkins (1994). The tertiary objective is to examine the ability of the individually identified models to forecast out-of-sample closed-end fund discounts/premiums. Comparisons of the forecasting abilities will be made between the individually identified ARIMA (p, d, q) and random walk models using mean absolute percent error metric (MAPE) as criterion. For the weekly series our results show: out of 27 municipal bond closed-end funds, there are five following random walk model, thirteen following ARIMA(1,0,0) model, five following ARIMA(0,1,1) model, two following ARIMA(2,1,0) and one following each of ARIMA(0,1,2), and ARIMA(1,0,1) models; for the domestic equity (core) funds, out of twenty funds one follows the random walk model, six follow ARIMA(1,0,0) model, eight follow ARIMA(0,1,1), two follow ARIMA(2,1,0) and one follows each of ARIMA(0,0,1), ARIMA(0,0,2) and ARIMA(0,1,3) model. Except for one week out of the four weeks examined the forecast results for the weekly municipal bond closed-end funds do not show significant difference between the fund-specific ARIMA (p, d, q) models and the random walk model. Likewise, the forecast results for the weekly core funds do not show significant difference between the fund-specific ARIMA (p, d, q) models and the random walk model which is not consistent with the findings in Woan and Kline (2008). Our results show clearly that the ARIMA (p, d, q) models provide superior forecasts for the core funds with less than seventeen percent mean and median APEs to municipal bond funds with over fifty percent mean and median APEs in terms mean and median APEs. These results could be because the current data are from the rare persistent recessionary period of 2011 and 2012. Further research is needed to explain this phenomenon.

Keywords: Absolute percent error (APE), Municipal bond fund, Domestic equity fund, Autoregressive-integrated-moving average (ARIMA (p, d, q))

1. Introduction

Open-end fund (OEF) and closed-end fund (CEF) are two principal types of investment companies. When a CEF is organized, a fixed number of shares are issued at an initial public offering (IPO). Those shares then trade on the stock exchange. An OEF, by contrast, continuously offers their shares to investors. Investors who desire to sell their open-end shares actually have their shares redeemed by the fund. While OEF shares are purchased and redeemed at their net asset values (NAVs) determined at the close of each business day, the market price of a share of CEF is set by the market. It is worth noting that CEF shares are generally issued at premium and traded in the market at discount and occasionally at premium after an average of six months later. However, discounts/premiums disappear upon liquidation. This phenomenon persists in spite of the fact that the NAVs of both types of funds are readily determinable. This is the well-known closed-end fund puzzle. Brealey, Myers & Allen (2006) consider the puzzle as one of the "10 unsolved problems that seem ripe for productive research." (p.965). While this puzzle has been extensively investigated in the literature for equity and non-municipal bond CEF (e.g., Malkiel, 1977, 1995; Lee, Shleifer & Thaler, 1991; Pontiff, 1995, 1996; Woan, 2001a, 2002), Woan (2001b)'s study represents the first formal attempt to study closed-end municipal bond funds. It was generally believed (Abraham, Elan & Marcus, 1993) that bond funds should be selling at close to their NAVs since bonds represent fixed cash flows. Woan (200la) provided highly statistically significant evidence for government and corporate bond funds that is contrary to this belief. Pontiff (l996) presented the comment that municipal bond funds, due to short sale restriction, should generally be selling at premiums. However, Pontiff offered no evidence to support his comment. Woan (2001b)'s preliminary study and Woan and Kline's (2003) results provided highly statistically significant average discounts contrary to Pontiffs assertions for both national and single-state municipal bond CEFs. According to the industry statistics provided by the Closed-End Fund Association (2001), as of the end of 2000, national municipal bond closed-end funds have the largest net assets of over $38 billion followed by single state municipal bond closed-end funds with net assets around $14 billion. In 2000, these two types of funds posted average total returns of 16.7% and 15.6% based on market price and net asset value respectively compared to the negative 9.1% return of S&P500 Index. Thus, the study of the valuation of municipal bond funds is of great importance. All these research studies focus on identifying variables that could potentially explain the discount/premium variations. The results reported so far have been inconclusive and sometimes conflicting. Much more work will be necessary in order to provide more convincing and conclusive results in this area of research.

Woan and Kline (2008)'s study initiated the first attempt to unravel the close-end fund puzzle by using the class of linear stochastic ARIMA (p, d, q) models introduced by Box-Jenkins (1994). They focused on identifying the systematic paths, if they exist, fund discounts/premiums move over time, modeling the paths via the ARIMA (p, d, q) models with the objective of projecting future discounts/premiums. Accurate forecast of discounts/premiums is potentially important in a variety of decision-making context. Both theoretical argument and empirical evidence (Thompson 1978; Pontiff 1995, 1996) suggest that discounts/premiums are related to stock returns. Thus, accurate forecast of the discounts/premiums will be of great importance to investors. Their result indicates that the historical discount/premium time-series provide information that may be used to outperform the market supporting arguments made by Thompson (1978) and Pontiff (1996). In addition, the statistical pattern of discounts/premiums may also be useful in helping identify determinants of discounts/premiums. Woan (2014, 2017) could not confirm the results by using new data sets and fund-specific models. This study will attempt to synthesize Woan's results for comparison purpose.

To forecast the discounts/premiums with reasonable accuracy, an accurate description of the stochastic process that generates discounts/premiums is required**.** Thus, the second objective of this paper is to build a parsimonious model to describe the discount-generating processes that are useful for forecasting purpose. To accomplish this objective, we restrict ourselves to a class of linear stochastic autoregressive-integrated-moving-average (ARIMA (p, d, q)) models that make use of the historical information in the series to generate forecasts. We use the iterative identification, estimation and diagnostic checking strategy introduced by Box-Jenkins (1994). For the identified models to be useful, they must be subject to the acid test of forecasting accuracy. Thus, our tertiary objective is to assess the accuracy of forecasts of CEF's discounts/premiums derived from the identified ARIMA (p, d, q) models versus those obtained from the naïve random walk model in terms of MAPE.

The remainder of this article is organized as follows: In section 2, a brief review of the past studies related to closed-end fund discounts/premiums and the use of ARIMA models in accounting literature is provided. Section 3 describes the data. Section 4 presents the temporal characteristics of the discounts/premiums and their classifications. Section 5 presents the forecasting test results and section 6 presents the conclusion.

2. Literature Review and Justification for the Use of ARIMA (p, d, q) Model

An extensive review of earlier studies on CEF puzzle is provided by Woan & Kline (2003). Various accounting and market-based variables have been proposed to explain the general closed-end fund puzzle: expense ratio, turnover ratio, historical performance, diversification, unrealized capital gain, size, variances of securities in a fund portfolio, exposure to market risk, leverage, and, in the case of bond funds, average maturity. It is fair to say that the results so far have been conflicting and inconsistent at best. Thus, a multivariate model incorporating both the potential determinants and time series data could potentially introduce measurement errors thereby obscuring the research result

ARIMA (p, d, q) models, by contrast, have enjoyed success in the accounting literature. Recently, these models have also been recommended for predictive analytics in the area of Big Data analytics (Conrad Carlberg, 2018). These models were used to describe the time-series properties of quarterly accounting earnings (Foster 1977; Griffin 1977; Brown & Rozeff 1979) and annual accounting earnings (Watts & Leftwich 1977). These models were also used to describe the time-series properties of quarterly cash flow series (Hopwood & McKeown 1992; Lorek, Schaefer & Willinger 1993). Their forecasting abilities outperformed other multivariate regression models proposed in the accounting literature. Using MAPE as criterion Woan and Kline (2008) compare the accuracy of forecast results from random walk, premier and firm-specific ARIMA (p, d, q) models and found that firm-specific models outperform the random walk and premier models. Thus**,** we will employ ARIMA (p, d, q) models to fit the discount/premium time-series and assess the performance of the forecasting abilities of the fitted models against those derived from the naïve random walk model which was generally used to describe stock price series. Furthermore, we will compare the results from municipal bond funds with those from domestic equity funds.

3. Data

3.1 Data Source and Description

Weekly NAV and discount data of twenty-seven municipal bond funds and twenty-six domestic equity (core) closed-end funds from January 2011 to March 2012 were obtained from Lipper, a Thomson-Reuters Company. Due to missing data, the final sample includes twenty-seven municipal bond funds and twenty core funds with seventy-one weekly data. Except for model identification and classification to be comparable to Woan and Kline's study, for both core and municipal bond funds, we will use eighteen 54 weekly data with four as holdout sample for most of our reports unless otherwise indicated.

3.2 Summary Statistics

Table 1 presents the weekly summary cross-fund statistics for municipal bond funds. Fourty-six out of fifty four weeks show statistically significant ($\alpha = 5\%$) average premiums; only two weeks had average discounts; both are not significantly different from zero. The discounts/premiums range from a minimum of -6.90 discount to a maximum of 22.90 premium. The standard deviations range from 4.47 to 6.77. The means range from -1.55 discount to 5.64 premium; the medians range from -3.4 discount to 3.80 premium. Furthermore, forty-seven weeks out of fifty-four weeks saw number of premiums exceeding number of discounts. The data indicates that the number of times with funds trading at premiums (718) outnumbered number of times with funds trading at discounts (243) by approximately four hundred seventy-five over the fifty-four weeks. These results are consistent with Pontiff (1996)'s comments that municipal bond closed-end funds should generally be selling at premiums. These data are in stark contrast to those reported in Woan and Kline (2003) for national and single state bond funds which had average and median discounts.

Table 2 show the weekly summary cross-fund statistics for the domestic equity funds. In stark contrast to Woan and Kline (2008), the one sample t-test show significant (α=5%) cross-fund mean discounts over all 54 weeks when Woan and Kline (2008) reported none. The discounts/premiums range from a minimum of -22.9 to a maximum of 30.30. The standard deviations range from 7.44 to 13.04 with the means ranging from -9.90 to -6.26. The medians range from -12.5 to -10.35. Furthermore, the weekly proportions of number of discounts over number of premiums range from eighteen over two to sixteen over four. The table indicates that the number of funds with discounts outnumbered funds with premiums by more than four to one over the entire sample period. These data show clearly the distinction between how municipal bond funds and domestic equity funds were traded in the security market: predominantly premiums for municipal bond funds and discounts for domestic equity funds.

Table 1. Cross-Sectional means, standard deviations (std), medians & number of funds traded at discount (nfd) municipal bond funds

Week	1	2	3	4	5	6	7	8	9
mean	.38	1.75	2.42	3.44	4.14	2.09	3.13	4.52	4.32
std	5.09	5.70	5.73	5.72	5.47	5.09	4.79	4.93	5.44
median	-1.15	.2	1.25	2.2	3.25	1.05	2	3.8	2.85
nfd	12	7	8	3	3	6	3	2	3

Table 1 (continued)

Week	10	11	12	13	14	15	16	17	18
mean	-1.55	-.17	1.14	1.87	1.97	2.51	3.02	3.07	3.24
std	6.25	5.77	5.20	5.54	5.26	5.11	5.31	5.00	5.32
median	-3.4	-1.95	0	.35	.65	1.60	2	1.5	2
nfd	13	13	9	8	6	4	5	5	5

Table 1 (continued)

Week	19	20	21	22	23	24	25	26	27
mean	1.97	2.54	2.17	2.83	0.98	2.24	4.05	5.64	4.14
std	4.47	4.88	4.88	5.02	5.14	5.32	5.76	6.77	6.5
median	1.25	1.95	1.8	1.5	-0.2	0.3	1.6	2.45	1.15
nfd	5	5	7	6	11	7	3	0	3

Table 1 (continued)

Week	28	29	30	31	32	33	34	35	36
mean	3.43	4.04	4.26	3.6	4.58	2.69	2.44	2.74	4.52
std	5.71	5.48	5.81	5.3	5.22	5.07	5.04	5.59	5.42
median	0.7	2.05	2.45	2.6	2.65	1.15	0.95	0.7	2.45
nfd	5	3	2	4	1	6	8	5	0

Table 1 (continued)

Week	37	38	39	40	41	42	43	44	45
mean	4.36	4.68	4.88	4.16	4.36	4.69	3.91	4.7	2.68
std	5.65	5.32	5.6	4.65	4.48	4.75	4.26	4.93	3.69
median	2.2	2.75	2.95	3.1	3.5	3.15	3.15	3.05	1.7
nfd	1	0	0	1	1	0	0	0	4

Table 1 (continued)

Week	46	47	48	49	50	51	52	53	54
mean	4.01	3.96	1.49	3.02	2.59	1.59	5.05	5.2	3.73
std	4.65	4.46	4.56	4.74	5.12	4.93	5.56	5.32	5.54
median	2.8	2.8	-0.3	1.3	1.45	0.2	3.3	3.5	1.4
nfd	2	1	10	4	7	9	2	1	4

Table 2. Cross-sectional means, standard deviations (std), medians & number of funds traded at discount (nfd) domestic equity funds

Week	1	2	3	4	5	6	7	8	9
mean	-9.7	-9.9	-9.07	-8.81	-7.85	-7.94	-7.60	-7.26	-7.6
std	8.07	7.44	8.93	8.76	9.70	9.10	9.69	9.44	10.09
median	-12.3	-12.4	-12.3	-12.45	-11.45	-10.75	-10.50	-10.65	-11.35
nfd	18	18	18	18	18	18	17	17	17

Table 2 (continued)

Week	10	11	12	13	14	15	16	17	18
mean	-8.00	-8.09	-7.96	-7.22	-6.83	-6.93	-7.29	-6.33	-6.44
std	9.82	10.11	9.99	11.35	12.00	11.57	11.67	12.46	13.04
median	-12.5	-11.85	-12.6	-12.10	-12.15	-11.80	-12.15	-11.35	-11.75
nfd	17	17	17	17	17	18	18	18	18

Table 2 (continued)

Week	19	20	21	22	23	24	25	26	27
mean	-7.56	-7.47	-6.73	-7.325	-7.99	-7.25	-7.44	-6.26	-6.42
std	10.19	10.09	10.74	10.54	9.5	9.7	10.3	11.73	11.55
median	-11.6	-11.35	-11.1	-11.7	-11.4	-10.85	-11.9	-10.45	-10.6
nfd	16	17	16	17	17	17	17	16	17

Table 2 (continued)

Week	28	29	30	31	32	33	34	35	36
mean	-6.725	-7.635	-7.78	-7.5	-7.55	-7.45	-6.865	-7.435	-7.35
std	10.33	9.59	9.99	10.46	10.72	10.73	11.63	11.81	11.89
median	-9.95	-11.2	-11.25	-10.7	-10.75	-10.95	-10.35	-11.35	-11.45
nfd	16	17	18	18	17	17	17	17	17

Table 2 (continued)

Week	37	38	39	40	41	42	43	44	45
mean	-6.78	-6	-6.2	-5.83	-5.83	-7.07	-8.9	-6.69	-8.96
std	11.98	11.99	13.27	12.90	11.04	11.08	10.54	10.61	9.87
median	10.45	-9.95	-10.5	-10.5	-9.95	-9.7	-9.05	-10.55	-9.87
nfd	17	17	17	16	18	17	16	17	17

Table 2 (continued)

Week	46	47	48	49	50	51	52	53	54
mean	-8.73	-8.2	-8.9	-9.11	-9.05	-9.54	-8.72	-7.63	-7.4
std	8.38	9.06	8.94	8.35	7.82	6.96	7.9	8.97	8.7
median	-11.85	-11.7	-12.4	-11.9	-11.6	-11.15	-11.15	-10.6	-10.2
nfd	17	17	17	17	17	18	18	17	17

Table 3 presents the summary statistics for individual municipal bond fund discounts/premiums. Of the eighteen funds in the sample, three funds traded at premium over the entire fifty-four weeks. Thirteen funds had average and median premiums and the remaining four had both average and median discounts with only one significantly (α=5%) different from zero. Furthermore, the average premiums are generally larger with smaller standard deviations than those reported in Woan and Kline (2003). Thirteen have significant average premiums. For the DEQ funds, Table 4 shows that, of the eighteen DEQ funds in the sample, only one fund traded at premium over the entire fifty-four weeks. This fund is only one with significant average and median premiums. Furthermore, the discount means/medians reported here are generally much larger with smaller standard deviations than those reported in Woan and Kline (2008). Fourteen funds were trading at discounts over the entire fifty-four weeks. Sixrteen funds have significant mean/median discounts and one fund has insignificant (α = 5%) mean/median premium. These results are consistent with expectations for municipal bond funds mostly trading at premiums and equity funds mostly trading at discounts.

Table 3. Individual fund means & standard deviations (std), medians and number of discounts (nfd) municipal bond funds

fund	1	2	3	4	5	6	7	8	9
mean	3.59	-.21	3.35	-.66	1.90	1.08	3.00	-.54	-.43
std	3.17	2.42	2.36	2.32	3.78	1.44	2.71	2.26	1.98
median	3.4	-0.35	2.35	-0.3	0.8	1.05	2.5	-0.55	-0.2
nfd	8	30	1	31	20	12	7	30	29

Table 3 (continued)

fund	10	11	12	13	14	15	16	17	18
mean	1.79	0.46	-0.48	1.18	3.28	2.4	8.3	19.08	9.3
std	1.89	1.68	2.45	1.68	2.12	1.87	3.04	2.1	2.89
median	2	0.7	-0.7	1.15	3.55	2.8	8.15	19.05	9.25
nfd	7	15	32	9	5	7	0	0	0

Table 4. Individual fund means & standard deviations (std), medians and number of discounts (nfd) domestic equity funds

fund	1	2	3	4	5	6	7	8	9
mean	-14.14	-10.36	-20.94	-8.27	-5.95	18.44	-10.09	.48	-14.65
std	.72	1.36	1.31	.65	2.00	5.17	1.71	2.04	.65
median	-14.1	-10.25	-21.15	-8.3	-6.1	18.05	-10.1	0.75	-14.6
nfd	54	54	54	54	54	0	54	16	54

Table 4 (continued)

fund	10	11	12	13	14	15	16	17	18
mean	-4.56	-11.03	-2.98	-11.71	-12.54	-12.61	-11.16	-14.37	-11.55
std	2.67	1.83	2.64	1.16	1.10	.77	1.18	.43	1.07
median	-4.5	-11.55	-3.05	-11.85	-12.65	12.65	-11.2	-14.4	-11.65
nfd	53	54	48	54	54	54	54	54	54

4. Temporal Behavior

Due to their mean-reverting characteristic (Brickley & Schallheim, 1985; Pontiff, 1995), discount/premium time series are expected to be stationary over the long run. However, over the short run, it is possible that discount/premium time series could exhibit nonstationary behavior. In particular, like other stock prices, they could potentially follow a random walk with perhaps a short-run drift. If this is indeed the case, then there will be no model that can be used to outperform the market. Consequently, it is important for us to perform some sort of statistical test of the random walk hypothesis on the discount/premium series. Though the well-known Dickey—Fuller test (Pindyck & Rubinfeld, 1998) is available for this purpose, it will not be used since Pindyck and Rubinfeld pointed out, though "the Dickey-Fuller test is widely used, one should keep in mind that its power is limited." Instead, we will let the ARIMA model to determine because random walk corresponds to ARIMA (0, 1, 0).

For model identification purpose, sample autocorrelations (ACs) and partial autocorrelations (PACs) up to twenty-four lags were initially computed for each of the original forty-seven funds to obtain a tentative model for each fund. The models are then fitted to the funds. And, the residual ACF and PACF are then computed to examine the adequacy of the models. If a model is found inadequate, the residual ACs and PACs are used to revise the model and the revised models are fitted to the funds again to obtain improved models. This process is repeated until no further improvement is possible, i.e., the ACs and PACs of the residuals are generally small and insignificant (α=5%). Due to the voluminous data involved, the details are not reported here. Only the final models and their classification are reported in Table 5 for domestic equity funds and TABLE 6 for the municipal bond funds. From the tables it is clear that only six out of the combined funds behave as random walk and the overwhelming majority of both funds follow either ARIMA (1,0,0) (first order autoregressive) or ARIMA (0,1,1) (integrated first order moving average) model. Interesting enough, Woan and Kline (2008) used average ACs and average PACs to obtain similar results even though they chose ARIMA (1, 1, 0) over ARIMA (0, 1, 1) as one of their two potential premier models because ARIMA (0, 1, 1) produced MAPEs similar to those produced by random walk. They found that ARIMA (1, 0, 0) and ARIMA (1, 1, 0) perform similarly in forecasting in terms of pooled MAPEs. Table 5 showed that domestic equity funds follow mostly first differenced first order moving average model followed by first order autoregressive model. Twelve DEQ funds are nonstationary and require first order differencing. Furthermore, fourteen follow moving average model. Table 6 shows that most municipal bond funds follow first order autoregressive model. Clearly, closed-end municipal bond funds behave somewhat simpler than domestic equity funds which exhibit more complex temporal characteristics.

Table 5. Temporal behavior domestic equity closed-end funds

ARIMA Models	(0,1,0)	(1,0,0)	(0,1,1)	(0,1,2)	(2,1,0)	(1,0,1)	(0,0,1)	(0,0,2)	(0,1,3)
Number of funds	1	6	8	0	2	0	1	1	1

Table 6. Temporal behavior municipal bond closed-end funds

ARIMA Models	(0,1,0)	(1,0,0)	(0,1,1)	(0,1,2)	(2,1,0)	(1,0,1)	(0,0,1)	(0,0,2)	(0,1,3)
Number of funds	5	13	5	1	2	1	0	0	0

5. Forecasting Ability and Predictability

In this section, we examine the forecasting ability of the previously identified models and hence, the predictability of the discounts/premiums. To assess the forecasting performance of the identified models, we will use forecast results from random-walk model as benchmark since stock prices generally follow a random walk. Furthermore, we will use the widely used mean absolute percent error (MAPE) as criterion for assessing the forecasting performance.

One-step ahead weekly forecasts are generated for each model identified. First, we use the first fifty weeks' data to estimate the parameters of these models and use the resultant models to forecast the fifty-first week's discounts/premiums which, together with the actual observed discounts/premiums, enable us to obtain the absolute percent forecast error for each of the eighteen funds. Next, we use the first fifty one weeks' data to estimate the parameters of the models and use these models to forecast the fifty-second week's discounts/premiums which, together with the actual observed discounts/premiums, enable us to obtain the absolute percent forecast error for each of the eighteen funds. Repeating this procedure until we obtain the absolute percent forecast errors from the fifty-fourth week's observation. Tables 6 through 9 presents the MAPEs of these absolute percent forecast errors from the models identified previously and the random walk model. Following the accounting literature (Lorek, Schaefer and Willinger, 1993), percent forecast errors exceeding 100 percent are truncated to 100 percent before the MAPEs were computed. There were close to thirty percent truncations ((21 out of 72) for municipal bond funds reflect both large mean and median APEs for all four weeks' one-step ahead forecasts. These results at first blush seem to be in conflict with the intuition that municipal bond funds, with their fixed cash flows should be more predictable. However, the data are from depressing recessionary period from 2011 to 2012 with high degree of uncertainty. The domestic equity funds fare much better with only two truncations for each model which reflect the much smaller mean and median APEs for domestic equity funds.

Table 7. MAPEs of one-step ahead forecasts and paired sample t-test domestic equity funds

Week	1	2	3	4	Pooled
Random walk	.142	.139	.159	.101	.135
ARIMA	.161	.123	.160	.121	.141
Significance	.117	.363	.928	.179	.688

Table 8. Medians of APEs of one-step ahead forecasts and Wilcoxon signed rank test results domestic equity funds

Week	1	2	3	4	Pooled
Random Walk	.037	.064	.081	.044	.052
ARIMA	.042	.058	.068	.055	.057
Significance	.048	.557	.586	.089	.208

Table 9. MAPEs of one-step ahead forecasts and paired sample t-test municipal bond funds

Week	1	2	3	4	Pooled
Random walk	0.51	0.74	0.34	0.65	0.56
ARIMA	0.57	0.66	0.39	0.53	0.50
Significance	0.12	0.32	0.31	0.03	0.09

Table 10. Medians of one-step ahead forecasts and Wilcoxon signed rank test results municipal bond funds

Week	1	2	3	4	Pooled
Random walk	0.41	0.91	0.2	0.89	0.51
ARIMA	0.44	0.81	0.3	0.56	0.38
Significance	.21	.11	.24	.09	0.37

For the domestic equity funds, Table 7 and Table 8 show reasonable forecasting results with no mean or median APES exceeding 16%. The random walk performs slightly better for the weekly MAPEs including the pooled percent forecast errors. It is clear from tables that the distribution of the percent forecast errors are skewed with few large errors since the means are much larger than the medians. This skew distribution of forecast errors calls for nonparametric statistical approach for forecasting performance assessment purpose. Thus, in addition to the traditional paired t-test, Wilcoxon signed rank test, a nonparametric two sample test for related samples is also employed. For the four weekly forecasts the tests produced only one marginally significant (5%) result for week 1. For the pooled forecasts the median for random walk and ARIMA are about the same. Thus, the findings here contradict those in Woan and Kline (2008).

Table 9 and Table 10 show the forecasting results for municipal bond funds. These tables show unusually large mean and median absolute percent forecasting errors (APEs) for the four-week holdout sample with most exceeding 50%. Both the ARIMA and the random walk models failed to provide credible forecasts. All except for the fourth week's paired t-test show no significant (α=5%) difference between the mean and median APEs produced by fund-specific ARIMA models and the random walk models. At first blush, it might seem that ARIMA models are not adequate for the municipal bond funds for forecasting purpose. This perception is misleading because these data were generated during the highly inflationary period which caused high uncertainty even for the fixed cash flow securities.

6. Conclusion Remarks

The weekly time-series of discounts/premiums show that the temporal characteristics of the domestic equity funds are different from those for municipal bond funds. Furthermore, the forecast results fo domestic equity funds are much more credible than those for municipal bond funds. Even though the results reported here are not as clear-cut as those reported in Woan and Kline (2008) for domestic equity funds, we have provided additional empirical evidence showing that parsimonious ARIMA models are capable of describing the historical patterns in the closed-end fund discount/premium time series. However, these models make use of only the historical information in the series to generate forecasts no better than the random walk model as measured by mean and median APEs. These results are not consistent with those reported by Woan and Kline (2008) and might be due to difference in data from two drastically different economic environments. Anyway, the result here implies that historical discounts/premiums provide information that may not be used to outperform the market, contradicting statements made by Thompson (1978), Pontiff (1996) and Woan and Kline (2008).

Finally, as Woan and Kline (2008) point out, a caveat is in order. First, the iterative model-seeking procedure introduced by Box-Jenkins require judgment and experience. Different models could explain the sample ACF and PACF equally well since they do not match closely any particular theoretical ACF and PACF in the short run. Second, ARIMA models make use of historical patterns of the time-series to extrapolate into the future as forecasts. As the historical pattern changes, different model will be required. As a result, the models identified from the data used here should not be applied to data sets from different time period indiscriminately. Third, no improvement of the forecasts generated from ARIMA models over those obtained from random walk model in this sample. As Woan and Kline (2008) noted, even though they found that fund-specific ARIMA model outperform random walk model in forecast accuracy as measured by MAPEs, the difference in MAPEs for the two were slight. Forth, the data used here come from an unusual recessionary time period; the applicability of the results to other time periods is questionable at best. Also, as Hanke and Wichern (2005) point out, typically ARIMA models are useful for short-term forecasts and structural econometric model will provide better forecast over the longer term. A transfer function model, a combination of time-series ARIMA models and econometric structural equation models, can provide the best of both worlds for forecasting and causal explanation simultaneously. Thus, to unravel the closed-end fund puzzle, further research in the area of identifying determinants of discounts/premiums is still of great importance.

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