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The Temporal Characteristic of Closed-end Municipal Bond Fund Discounts/Premiums

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Abstract

The primary objective of this study is to investigate, identify and classify the characteristics of the temporal behavior of municipal bond closed-end fund discounts/premiums from a class of linear stochastic autoregressive-integrated-moving average (ARIMA(p, d, q)) models. The secondary objective is to examine the ability of the identified and classified models to forecast out-of-sample closed-end fund discounts/premiums. These objectives are consistent with those of earlier study on domestic equity closed-end funds. Comparisons of the forecasting abilities will be made between the classified ARIMA(p, d, q) and random walk models using mean absolute percent error metric (MAPE) as criterion. Classification results: for the monthly series our results show: out of 27 municipal bond closed-end funds, there are seven following random walk model, seven following ARIMA(1,0,0) model, three following ARIMA (1,1,0) model, four following ARIMA(0,1,1) model, two following ARIMA(1,0,2), one following each of ARIMA(1,0,1), ARIMA(2,1,0), ARIMA(2,0,0), and ARIMA(1,1,2) models. 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. 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.

Keywords: ARIMA, municipal bond closed-end fund, discount/premium, mean absolute percentage erro

1. Introduction

Both closed-end funds (CEF) and the more popular open-end funds (OEF) are investment companies who sets are diversified portfolio of publicly traded stocks and other securities that they own an damage.

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When a CEF is organized, a fixed number of shares are issued at an initial public offering (IPO). Those shares are then traded in the secondary market. An OEF, by contrast, issues additional share stoke achinvestor. Investors who desire to sell their open-end shares actually have their sharers deemed by the fund. While OEF shares are purchased and re deemed at their net asset values (NAVs), the price of a share of a CEF is set by the market and, as Dan Navarro(1999), the product manager of the Research Product Division of Wiesenberger, pointed out," Due to circumstances which have yet to be fully understood by the financial community and academia, most closed-end funds trade at discounts after their IPO. This phenomenon persists in spite of the fact that the net asset values of both types so fund sare readily determine able. This is the closed –end fund puzzle well-known in the finance literature. Brealey and Myers (2006) consider the puzzle as one of the" 10unsolved problems that's empire for productive research."(p.965).

While this puzzle has been extensively investigated in the literature for equity and no 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 shorts ale restriction, should generally baseline gat premiums. However, Pontiff offered no evidence to support his comment. Woan (2001b)' preliminary study and Woman 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 then do f2000, national municipal bond closed-end funds have the largest net assets of over$38billion followed by single state municipal bond closed-end funds with net assets around $14billion. In2000, these two types of funds posted average total returns of 16.7%and15.6%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 earlier research studies focus on identifying variables that could 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. Following Woan & Kline (2008) and Woan (2014) we will use a time-series approach in this study.

We focus on identifying the systematic paths, if they exist, fund discounts/premiums move over time, modeling the paths 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. In addition, the statistical pattern of discounts/premiums may also be useful in helping identify determinants of discounts/premiums. To forecast the discounts/premiums with reasonable accuracy, an accurate description of the stochastic process that generates discounts/premiums is required**.** Thus, the first objective of this paper is to build a parsimonious model to describe and classify the discount/premium-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 information in the series themselves 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 second objective is to assess the accuracy of forecasts of CEF's discounts/premiums derived from the 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 I, a brief review of the past studies related to closed-end fund discounts/premiums and the use of ARIMA (p, d, q) models in accounting literature is provided. Section II describes the data. Section III presents the time-series characteristics of the discounts/premiums and their classifications. Section IV presents the forecasting test results and section V presents the conclusion.

2. Literature Review and Justification for the Use of Arimamodel

An extensive review of earlier studies on CEF puzzle is provided by Woan & Kline (2003). These studies focused on identification of factors that could be used to explain the cross-sectional differences of discounts/premiums. 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. Woan and Kline's study identified nine of these variables accounted for approximately seventy percent of the cross-sectional national municipal bond closed-end fund discount/premium variance and five of these variables accounted for approximately fifty four percent of the single-state municipal bond fund discount/premium variances.

However, it is fair to say that overall the results from this area of research so far have been conflicting and inconsistent at best. ARIMA(p, d, q) models, by contrast, have enjoyed great success in the accounting literature. These linear stochastic 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. Thuswe 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.

3. Data

3.1 Data Source and Description

Twenty seven monthly NAV and discount data of twenty seven municipal bond closed-end funds (MBFs) from April 30, 2006 to April 30, 20013 were obtained from Lipper, a Thomson-Reuters Company. Weekly NAV and discount data for the same funds from January 13, 2012 to May17, 2013 were also obtained. The final sample includes seventy one weekly data. For model identification and classification purpose, all the data will be included; however, to be comparable to Woan (2014)'s study, only 54 weekly data for randomly selected eighteen funds will be used for the following reports unless otherwise indicated.

3.2 Summary Statistics

Table I presents the weekly summary cross-fund statistics for discounts. Thirty six out of fifty four weeks show statistically significant (.05 level) average premiums; only two weeks had average discounts. These two average discounts are not significantly from zero statistically. The discounts/premiums range from a minimum of -5.70 discounts to a maximum of 22.90 premium. The means range from -1.55discount 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 the 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 bonds which had average and median discounts.

Table 1: Cross-fund Means, Standard Deviations (std), Medians & Number of Funds traded at discount (nfd)

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 presents the summary statistics for individual 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 had both average and median discounts that were not significantly different from zero. Furthermore, the average premiums are generally larger with smaller standard deviations than those reported in Woan and Kline (2003).

Table 2: Individual Fund Means & Standard Deviations (Std)

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

Tabsle 2 (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

4. Time-Series Characteristics and Classification

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 desirable 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 Rubin feld pointed out, though "the Dickey-Fuller test is widely used, one should keep in mind that its power is limited." Instead, we will use the ARIMA's iterative process to determine because random walk corresponds to ARIMA (0,1,0).

For model identification purpose, following Box-Jenkins (1994) sample autocorrelations (ACs) and partial autocorrelations (PACs) up to sixteen lags were initially computed for each of the original eighteen funds to obtain a tentative model for each fund. The models are then fitted to the funds. And, the residual ACF and PACF were then computed to examine the adequacy of the models.

If a model is found to be 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 more improvement is possible, i.e., the ACs and PAs of the residuals are generally small and insignificant. Due to the voluminous data involved, the details are not reported here. Only the final models and their classification are reported in Table 3. From the table it is clear that only two funds behave as random walk ARIMA (0,1,0) and two as integrated first order moving average ARIMA(0,1,1).The overwhelming majority of the funds (11) follow ARIMA(1,0,0) (first order autoregressive). Interesting enough, Woan and Kline (2008) used average ACs and average PACs to obtain similar results for domestic equity close-end funds even though Woan and Kline 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 random walk. They found that ARIMA(1,0,0) and ARIMA (1,1,0) perform similarly in forecasting in terms of pooled MAPEs.

Table 3: Classification

ARIMA Models	(0,1,0)	(1,0,0)	(0,1,1)	(2,1,0)	(0,0,1)	(0,0,2)	(1,0,1)
Number of funds	2	11	2	0	1	1	1

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 observations. Table 5 presents the MAPEs of these absolute percent forecast errors from the models identified previously and the random walk model.

Table 4: Mapes Of One-Step Ahead Forecasts And Paired Sample T-Test

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 5: Median Of Apes Of One-Step Ahead Forecasts And Wilcoxon Signed Rank Test Results

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

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. Table 4presents the MAPEs of the absolute percent forecast errors from the models identified previously. The table shows remarkably similar forecasting MAPE results for random walk model and fund-specific ARIMA (p,d,q) models. Using the parametric Paired-Sample t-tests only week four produced statistically significant difference (.05 level) between the two. Table 5 presents the medians of the absolute percent forecast errors. Notice that from Tables4 and 5 both the means and the medians of the absolute percent forecast errors are larger than those reported in earlier studies. The results from the nonparametric Wilcoxon's signed rank tests produced no significant differences between forecast errors generated from fund-specific ARIMA (p, d, q) models and random walk. Likewise, the pooled forecasts produce no significant difference. It is clear from Tables 4 and5 that the distribution of the percent forecast errors are skewed with a few large errors since the means are much larger than the medians.

As a consequence, the nonparametric results should be more reliable. Thus, these findings are consistent with those for domestic funds reported by Woan (2014) and contradict those reported in Woan and Kline (2008)'s study which reported statistically significant differences.

6. Concluding Remarks

We have provided preliminary empirical evidence showing that parsimonious ARIMA models are capable of describing the historical patterns in the municipal bond closed-end fund discount/premium time series. Though both the means and median of the absolute percent errors are larger, these results are consistent with Woan and Kline (2008)'s and Woan (2014)'s findings for domestic equity closed-end funds. However, these models make use of the information in the series themselves to generate forecasts no better than the random walk model as measured by MAPEs. This last result is not consistent with those reported by Woan and Kline (2008) and might be due to difference in data from two 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). This implication is consistent with the results reported in Woan (2014).

Finally, as Woan and Kline (2008) pointed out, a caveat is in order. First, the iterative model-seeking procedure introduced by Box-Jenkins requires 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 MAPE, the difference in MAPE for the two were slight. Also, as Hanke and Wichern (2005) point out, typically ARIMA models are useful for short-term forecasts. Structural econometric modelscould 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 remains important.

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