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A STUDY ON TAIWAN'S BOND MARKET INTEGRITY AND MARKET TIMING ABILITY - BASED ON THE ARMAX-GARCH MODEL

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ABSTRACT

Due to the market's integrity and lack of liquidity of Taiwan's bond market, a bond manager finds it difficult to flexibly adjust portfolio allocation and systemic risk. No matter in the T-M model, T-M ARMAX-GARCH model, or H-M ARMAX-GARCH model, this study's results show that most bond funds do not have selective ability and significant systemic risk and timing ability, except for the H-M model. Hence, we recommend that Taiwan's bond market should develop more investment products, improve liquidity in the market, and enlarge the operating space of the fund manager.

Key Words: Bond fund, Timing ability, Selective ability, ARMAX-GARCH model
JEL classification: G20, C12, C13

MOTIVATION AND INTRODUCTION

Mutual funds in Taiwan are very popular investment products. In particular, bond funds are the largest types of domestic mutual funds in which the fund managers offer investors the advantages of diversification and professional risk assessment risk on both bond and stock investment. Taiwanese investors of bond funds are generally concerned with the performance that will affect their motivation for investing in the funds.

For a bond fund, the timing ability of a fund manager does affect its performance. Timing ability is the ability of the fund manager to use superior information about the future realizations of common factors that are affecting bond market returns. Therefore, market timing is an important investment strategy for mutual funds.
Earlier studies, such as Treynor and Mazuy (1966) and Henriksson and Merton (1981), are based on non-linear regressions of realized fund returns against contemporaneous market returns.[3] Lee and Rahman(1990) empirically examined market timing and selectivity performance of a sample of

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[3] This is also called return-based measures.

mutual funds. It uses a very simple regression technique to separate stock selection ability from timing ability. Litterman and Sheinkman (1991) indicated that a significant fraction of the potential performance of bond funds might be attributed to timing ability. As most mutual funds manager should have the ability of professional information for market timing, Aragon (2005) studied the timing ability of balanced funds for bond and stock indices. Jiang (2007) proposed and implemented new measures of market timing based on mutual fund holdings, finding that, on average, actively managed U.S. domestic equity funds have positive timing ability. Chen et al. (2010) also evaluated the ability of bond funds to "market time" nine common factors related to bond markets. Timing ability generates non-linearity in fund returns as a function of common factors, but there are several non-timing-related sources of non-linearity.The motivation for this study is twofold. First, we believe that the integrity of the bond market may affect the operating space of bond funds' investment. In order to understand bond funds and bond market participation, we examine the scale of the Taiwan bond market via the overall bonds' outstanding balances, which totaled over NT$5 trillion at the end of February 2009. The types of all outstanding bonds include government bonds, corporate bonds, financial bonds, beneficiary securities, and foreign bonds. In the bond markets, Taiwan government bonds account for 64%, corporate bonds 19%, financial bonds 14%, securitization beneficial securities 2%, and foreign bonds 1%. Most long-term holders of government bonds, such as the banking or insurance industry and bond funds, all mostly invest in corporate bonds. Second, the hypothesis of normal distribution in error term is not reasonable for the T-M model and H-M model. Hence, we extend the Treynor and Mazuy (1966) and Henriksson and Merton (1981) models and propose the T-M-ARMAX(1,0,0)-GARCH(1,1) model and the H-M-ARMAX(1,0,0)-GARCH(1,1) model to detect selective ability and timing ability. In our empirical study, we look at 32 bond funds and conclude that most bond funds do not have selective ability, significant systemic risk, and timing ability, except for the timing ability in the H-M model.

The remainder of the paper is organized as follows. Section 2 presents a brief review of Treynor and Mazuy (1966)'s quadratic model, Henriksson & Merton (1981)'s option model and the ARMAX-GARCH model. Section 3 provides the empirical results, followed by a conclusion and remarks.

BRIEF REVIEW OF MODELS

In our empirical study we employ the classical Treynor and Mazuy (1966) model (hereafter, TM model) and the Henriksson and Merton (1981) model (hereafter, T-M model) as benchmarks for detecting asset selectivity and market timing ability. Both models modify the unconditional one-factor capital asset pricing model (CAPM; Sharpe, 1964, and Lintner, 1965) by modeling the time-varying portfolio beta as a function of a market index excess return. The classical market-timing regression of Treynor and Mazuy (1966) is:

$$\gamma_{pt} = a_p + b_1 r_{mt} + b_2 r_{mt}^2 + \varepsilon_{pt}, \qquad (1)$$

where

γ_{pt} = the excess return on portfolio p over the risk-free rate during period t,

a_p = estimated selectivity performance; a_p >0 indicates selective ability,

b_1 = the portfolio's estimate of systematic risk,

r_{mt} = the excess return of the market portfolio over the risk-free rate during period t,

b_2 = estimated indicator of market-timing performance; b_2>0 indicates market-timing ability,

ε_{pt} = residual excess return on portfolio p during period t.

Henriksson and Merton (1981) established the theoretical construction of the up/down model. To examine the market timing ability of portfolio managers, they proposed that the portfolio beta is cast as a binary variable, constrained to one value during up markets and another value during down markets. Assuming that securities are priced according to the CAPM, they run the following regression to test for timing ability.

$$\gamma_{pt} = a_p + b_1 r_{mt} + b_2 D r_{mt} + \varepsilon_{pt}, \qquad (2)$$

where D is a dummy variable; D=1 if the stock market index has excess return, and D=0 otherwise. The definitions of γ_{pt}, a_p, b_1, r_{mt}, b_2, and ε_{pt} are the same as equation (1).

The T-M ARMAX-GARCH model is as follows.[4]

$$\gamma_{pt} = a_p + b_1 r_{mt} + b_2 r_{mt}^2 + b_3 X_{,t-1} + \varepsilon_{p,t}, t = 1,2,\ldots T \qquad (3a)$$

$$\varepsilon_{p,t} = \sqrt{h_t} Z_t, Z_t \sim N(0,1)$$

(3b)

$$h_t = \sigma_t^2 = \omega + \alpha \varepsilon_{t-1}^2 + \beta h_{t-1} \qquad ,$$

(3c)

where X is the 10-year government bond rate, and b_3 is the coefficient of variable X.

The H-M ARMAX-GARCH model is as follows.

[4] Okoli(2012) employed the GARCH (1, 1) and VAR models to ascertain the relationship between volatilities in the monetary policy variables and volatilities in the stock market returns

$$\gamma_{pt} = a_p + b_1 r_{mt} + b_2 D r_{mt} + b_3 X_{,t-1} + \varepsilon_{pt}, t = 1,2,\ldots T \quad (4a)$$

$$\varepsilon_{pt} = \sqrt{h_t} Z_t, Z_t \sim N(0,1) \quad (4b)$$

$$h_t = \sigma_t^2 = \omega + \alpha \varepsilon_{t-1}^2 + \beta h_{t-1}, \quad (4c)$$

where the definitions of γ_{pt}, a_p, b_1, r_{mt}, D, b_2, and ε_{pt} are the same as equation (2), X is the 10-year government bond rate, and b_3 is the coefficient of variable X.

EMPIRICAL RESULT ANALYSIS

As described above, this article investigates the bond market integrity and market timing ability in Taiwan's bond market, and thus the dataset consists of bond funds issued in Taiwan. For the purpose of comparison, the sample period for the study covers ten years, from January 2001 to June 2010. Table 1 presents a total of 32 bond funds' name, trading code, and date of establishment. The data were obtained from the Taiwan Economic Journal (hence TEJ) database.

Table-1. Basic description of the bond funds

Code	Name of Bond Fund	Found. Date	Code	Name of Bond Fund	Found. Date
UI02	Union Bond	1999/9/30	DF02	The Forever Bond Fund	1996/10/15
TR02	Manulife Wan Li Bond Fund	1999/9/9	JF78	JF (Taiwan) First Bond Fund	1996/10/15
BR02	Primasia Paoyen Bond	1999/9/7	TS06	Shinkong Chi-Shin Fund	1996/9/3
TC18	IBT 1699 Bond Fund	1999/6/7	FP07	Fubon Chi-Hsiang Bond Fund	1996/6/14
CP12	PCA Well Pool Fund	1998/12/23	CA02	Capital Safe Income Bond Fund	1996/5/18
AP02	Manulife Wan Li Bond Fund	1998/11/5	ML04	Prudential Financial Bond Fund	1996/5/17
DS02	Truswell Bond Fund	1998/10/28	YC03	Hua Nan Phoenix Bond Fund	1996/2/6
AI03	PineBridge Taiwan Giant Fund	1998/9/7	CS03	Invesco ROC Bond Fund	1995/11/9
TC02	IBT Ta-Chong Bond Fund	1998/6/22	CI08	HSBC NTD Money Management Fund	1995/11/2
GC02	SinoPac Bond Fund	1998/6/19	IC27	ING Taiwan Bond Fund	1995/10/21

FH02	Fuh-Hwa Bond Fund	1998/5/28	KY02	Polaris De-Li Bond Fund	1995/9/21
JS02	Jih Sun Bond Fund	1997/10/3	PS04	UPAMC James Bond Fund	1995/6/16
NC10	NITC Taiwan Bond Fund	1997/3/7	JF75	JF Taiwan Bond	1995/6/15
YT08	Yuanta Wan-Tai Bond Fund	1997/2/19	NC06	NITC Bond	1994/4/12
TI03	TIIM Bond Fund	1997/2/13	TS01	ShinKong High Yield	1994/1/31
CI10	HSBC NTD Money Management Fund 2	1996/10/17	0008	ING Taiwan Income Fund	1991/12/6

Note: Code represents the respective bond fund trading codes.

Table 2 reports the descriptive statistics of the bond funds' net asset value (hereafter, Nav), beta ratio, Jensen index, Treynor index, Sharpe index, and the rate of return. Here, Nav runs between NT$10.671 to NT$170.98, and the mean is NT$18.367. We can see a great gap between the bond funds. The mean Beta is lower than 0.1, which implies that when the market fell, the performance of bond funds is relatively defensive. As for the Jensen index, the value is between 0.121% to -0.187%, and the mean is -0.019%, which means that the excess return is lower than the market return. The Treynor index is between 912.00% to -968.00%, and the mean is 18.349%, which shows that the performance is higher than the Sharpe index - that is, it is possible that these bond funds' portfolios are not too dispersed. The Sharpe index is between 5.452% to -28.231%, and its mean is -3.627%, which explains that the rate of return cannot outperform the risk-free rate. The last column exhibits the return rate of bond funds, with a mean of 0.14%, which also indicates a high Kurtotsis. In addition, all of the Jarque-Berra (J-B) statistics reject the null hypotheses of normality distribution.

Table-2. Summary statistics of bond funds' performances

	Nav	Beta	Jensen index(%)	Treynor index(%)	Sharpe index(%)	Rate of return(%)
Mean	18.367	0.0004	-0.019	18.349	-3.627	0.1400
Std	25.810	0.001	0.0536	210.61	5.663	0.1000
Max	170.98	0.005	0.121	912.00	5.452	0.9450
Min	10.671	-0.004	-0.187	-968.00	-28.231	0.0030
Skewness	5.3876	0.754	0.308	-0.0786	-0.949	1.3060
Kurtotsis	27.185	4.756	-0.601	5.164	0.0780	5.2210
J-B	136824***	857***	119***	4262***	578***	1882***

Note: Std is standard deviation. P-value is the probability that the data come from the normal distribution, according to the Jarque –Berra(J-B) normality test.

Table 3 reports the results of the T-M model and T-M-ARMAX-GARCH model, and we find that selective ability almost indicates a significant negative relationship and that systemic risk is not significant, whereas market timing ability is significant in some of the funds via the first model. Selective ability almost has a significantly negative relationship, systemic risk and market timing ability are not significant for the funds, and most market timing abilities exhibit a negative relationship in the T-M-ARMAX-GARCH model. For comparison purposes, Table 4 presents the Mann-Whitney-Wilcoxon Test, whereby systemic risk and market timing ability are significant between the T-M model and the T-M ARMAX-GARCH model. In addition, b_3 is significantly positive to bond funds, which means the 10-year government bond rate does affect the bond funds significantly.

Table-3. The T-M model and T-M ARMAX-GARCH model results

	Code	T-M model			T-M ARMAX GARCH model		
		Selective ability	Systemic risk	Timing ability	Selective Ability	Systemic risk	Timing Ability
1	TR02	-0.0009***	0.0001	0.0000	-3.9767***	-9.5441***	0.0001***
2	BR02	-0.0012***	0.0003	0.0000	-4.4519***	-1.0685***	8.7202
3	CP12	-0.0011***	0.0004	-0.0000	-2.9796***	-7.1510***	3.3991***
4	AP02	-0.0015***	0.0007***	-0.0001	-2.7260***	-6.5424***	-6.7187
5	DS02	-0.0010	0.0001	0.0001	-4.7148***	-1.1315***	0.0001
6	AI03	-0.0016***	0.0008	-0.0001	-1.7061***	-4.0946***	-6.8973
7	GC02	-0.0011***	0.0003	-0.0000	-2.6887***	-6.4528***	4.0466
8	FH02	-0.0015***	0.0008***	-0.0001	-3.0960***	-7.4305***	-2.8089
9	JS02	-0.0010***	0.0004	-0.0000	-3.7139***	-8.9134***	5.8871***
10	NC10	-0.0012***	0.0005***	-0.0000	-3.5270***	-8.4648***	2.8737
11	YT08	-0.0012***	0.0004**	-0.0000	-3.6748***	-8.8195***	4.2381
12	TI03	-0.0006	-0.0001	0.0001	-5.1186***	-1.2285***	0.0002
13	CI10	-0.0013***	0.0005***	-0.0000	1.5394***	-3.6946***	-7.0233***
14	UI02	-0.0010***	0.0003	0.0000	-3.4026***	-8.1662***	5.6980
15	DF02	-0.0009***	0.0002	0.0000	-4.6248***	-1.1100***	0.0000
16	JF78	-0.0011***	0.0004**	-0.0000	-2.2636***	-5.4328***	1.8063***
17	TS06	-0.0011***	0.0004	-0.0000	-2.7429***	6.5829***	4.3505
18	FP07	-0.0011***	0.0004	-0.0000	-2.7827***	-6.6785***	3.0081
19	CA02	-0.0016***	0.0009***	-0.0001	-2.5757***	-6.1816***	-4.9331***
20	ML04	-0.0010***	0.0004	-0.0000	-2.5801***	-6.1923***	2.9941
21	YC03	-0.0015***	0.0007**	-0.0000	-4.1957***	-1.0070***	3.1405***
22	CS03	-0.0011***	0.0004**	-0.0000	-2.2463***	-5.3912***	1.7638
23	CI08	-0.0013***	0.0005**	-0.0000	-1.8836***	-4.5206***	-2.4612***

	Code	T-M model			T-M ARMAX GARCH model		
		Selective ability	Systemic risk	Timing ability	Selective Ability	Systemic risk	Timing Ability
24	IC27	-0.0011***	0.0003	-0.0000	-2.0264***	-4.8633***	3.0594***
25	KY02	-0.0012***	0.0004	-0.0000	-3.6982***	-3.6982***	5.9720***
26	PS04	-0.0012***	0.0005	-0.0000	-2.7596***	-6.6231***	2.8587***
27	JF75	-0.0011***	0.0004	-0.0000	-3.2018***	-7.6844***	4.5238
28	NC06	-0.0011***	0.0004**	-0.0000	-2.8309***	-6.7942***	2.4990***
29	TS01	-0.0013***	0.0005**	-0.0000	-2.7926***	-6.7022***	2.0547
30	0008	-0.0015***	0.0007**	-0.0000	-3.4299***	-8.2317***	8.6745
31	TT21	-0.0010***	0.0004	-0.0000	-3.4639***	-8.3133***	4.6174
32	TT15	-0.0009***	0.0003	-0.0000	-3.0103***	-7.2247***	3.3874***

Table-4. Mann-Whitney-Wilcoxon test on the T-M and T-M ARMAX-GARCH models

Models	**The T-M model's selective ability**	**The T-M model's systemic risk**	**The T-M model's timing ability**
The T-M ARMAX GARCH model's selective ability	0.2605		
The T-M ARMAX-GARCH model's systemic risk		0.0090***	
The T-M ARMAX-GARCH model's timing ability			0.0026***

Note: 1. P-value is according to the T-M model and the T-M-ARMAX-GARCH model results.

2. *** denotes significant at the 1% significance level.

Table 5 reports the results of the H-M model and the H-M-ARMAX-GARCH model. Selective ability almost always has a significant negative relationship, and systemic risk and market timing ability are significant in some of the funds via the first model. We further find that selective ability almost indicates a significantly negative relationship, and most market timing abilities and systemic risk also have a negative relationship in the second model. Table 6 shows the Mann-Whitney-Wilcoxon test results. Selective ability, systemic risk, and market timing ability between the H-M model and the H-M ARMAX-GARCH model are not significant. Here, b_3 is positive significantly to bond funds.

Table-5. The H-M model and H-M ARMAX-GARCH model results

	Code	H-M model			H-M ARMAX-GARCH model		
		Selective ability	Systemic risk	Timing ability	Selective ability	Systemic risk	Timing ability
1	TR02	-0.0012***	0.0003***	0.0003***	-2.5631***	-6.1514***	0.0004***
2	BR02	-0.0013	0.0004	0.0001	-3.0098***	-7.2236***	0.0001***
3	CP12	-0.0010	0.0003	0.0002	-2.6672***	-6.4012***	0.0002***
4	AP02	-0.0012	0.0004	0.0002	-3.161***	-7.5863***	0.0002***
5	DS02	-0.0015***	0.0004***	0.0002	-2.3337***	-5.6009***	0.0002***
6	AI03	-0.0009***	0.0003***	0.0002	-3.2916***	-7.9000***	0.0002***
7	GC02	-0.0011***	0.0003***	0.0001	-2.1612***	-5.1869***	0.0001
8	FH02	-0.0011***	0.0004***	0.0002	-3.4759***	-8.3422***	0.0002***
9	JS02	-0.0010***	0.0003***	0.0002***	-3.0184***	-7.2441***	0.0003***
10	NC10	-0.0011***	0.0004***	0.0002**	-3.2857***	-7.8858***	-2.2837
11	YT08	-0.0011***	0.0003***	0.0001***	-3.1443***	-7.5463***	0.0002
12	TI03	-0.0013***	0.0004***	0.0004***	-2.5546***	-6.1311***	0.0004
13	CI10	-0.0010***	0.0003***	0.0001	-1.8294***	-4.3906***	0.0001
14	UI02	-0.0010***	0.0003***	0.0003***	-2.7735***	-6.6565***	0.0003
15	DF02	-0.0012***	0.0004***	0.0003***	-2.9931***	-7.1833***	0.0003***
16	JF78	-0.0010***	0.0003***	0.0001***	-2.1559***	-5.1741***	0.0001***
17	TS06	-0.0010***	0.0003***	0.0002***	-2.2428***	-5.3826***	0.0002
18	FP07	-0.0010***	0.0003***	0.0002	-2.5393***	-6.0943***	0.0002***
19	CA02	-0.0010***	0.0004***	0.0001	-3.6793***	-8.8303***	0.0001
20	ML04	-0.0010***	0.0003***	0.0002***	-2.2992***	-5.5182***	0.0002
21	YC03	-0.0012***	0.0004***	0.0003***	-4.0414***	-9.6993***	0.0003
22	CS03	-0.0010***	0.0003***	0.0001	-2.0394***	-4.8945***	7.6581***
23	CI08	-0.0010***	0.0003***	0.0001	-2.0857***	-5.0057***	0.0001***
24	IC27	-0.0011***	0.0003***	0.0001	-1.6546***	-3.9712***	0.0001
25	KY02	-0.0012***	0.0004***	0.0002***	-2.9581***	-7.0994***	0.0002***
26	PS04	-0.0011***	0.0004***	0.0002***	-2.5432***	-6.1036***	0.0002
27	JF75	-0.0011***	0.0003***	0.0002***	-2.6263***	-6.3030***	0.0001
28	NC06	-0.0010***	0.0003***	0.0002***	-2.6668***	6.4003***	0.0002
29	TS01	-0.0011***	0.0004***	0.0002***	-2.6753***	-6.4207***	0.0002***
30	0008	-0.0012***	0.0004***	0.0001	-3.4738***	-8.3372***	0.0001***
31	TT21	-0.0010***	0.0003***	0.0003***	-3.0782***	-7.3876***	0.0003***
32	TT15	-0.0009***	0.0003***	0.0003***	-2.5545***	-6.1307***	0.0003***

Table-6. Mann-Whitney-Wilcoxon test for H-M and H-M-ARMAX-GARCH models

Models	**The H-M model's selective ability**	**The H-M model's systemic risk**	**The H-M model's timing ability**
The H-M ARMAX-GARCH model's selective ability	0.3351		
The H-M ARMAX-GARCH model's systemic risk		0.3351	
The H-M ARMAX-GARCH model's timing ability			0.4174

Note: 1. P-value is according to the H-M model and the H-M-ARMAX-GARCH model results.

2. *** denotes significant at the 1% significance level.

CONCLUSION AND REMARKS

This paper investigates the bond market integrity and market timing ability in Taiwan's bond market via four models: T-M model, H-M model, T-M-ARMAX-GARCH model, and H-M-ARMAX-GARCH model. The results show that no matter in the T-M model, T-M ARMAX-GARCH model, or H-M ARMAX-GARCH model, bond funds do not have selective ability, significant systemic risk, and market timing ability except for the H-M model.

Due to the market integrity and lack of liquidity in Taiwan's bond market, bond managers are finding it difficult to flexibly adjust their portfolio allocation and systemic risk. In other words, Taiwan's bond market does not have enough scale and liquidity, and it lacks a reasonable evaluation of corporate bonds, financial bonds, and structured bonds by rating agencies. Thus, we recommend that the bond market should develop more investment products and greatly improve liquidity in order to provide a good operating space for the fund managers.

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