Mutual funds trading strategy based on particle swarm optimization ☆

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ABSTRACT

Mutual funds have become the most popular products for diversity of investment, since they are able to disperse investment risks to the smallest degree. In selecting mutual funds, the past performance of funds plays a central role in the expectations of the future performance of funds. In 2008, the U.S. sub-prime broke out; numerous investors lost more than half of the capitals donated. Therefore, a good trading strategy is necessary. In this paper, a new funds trading strategy that combines turbulent particle swarm optimization (named TPSO) and mixed moving average techniques is presented and used to find the proper content of technical indicator parameters to achieve high profit and low risk on a mutual fund. The time interval of moving average of the proposed method is adjustable and the trading model could avoid and reduce loss by providing several good buy and sell points. We tested the proposed model using the historical prices of last 10 years and the experimental results show that the performance of the proposed model is far better than the best original performance.

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1. Introduction

There are many investment vehicles, such as mutual funds, deposits, stocks, real estate, foreign exchange, futures and options etc. They have their own advantages and disadvantages. For examples, deposits, it is safe, virtually no risk of loss, but relatively low value-added potential, inflation may erode the total income. Stocks have excellent potential for long-term value-added, higher price volatility, relatively high investment risk, and it takes time to gather information and study. Real estate, in terms of price increase likely to be alarming, but it needs much money. Many investors believe they do not have time or expertise to search for individual stocks. Instead, they like to choose one of the most popular investment vehicles to earn much profit and reduce risk.

A mutual fund, essentially, pool money, low risk, is a type of investment product that gathers assets from investors and invests them in stocks, bonds, real estate, futures, or money market instruments. It always buys a number of securities and then divides them into individual shares (Kaye, 2006). Today, there are mutual funds with all types of investment styles and with all sorts of securities. Most mutual funds can be divided into five major categories: equity funds, fixed income funds, hybrid funds (or balanced funds), international funds, and money market funds. In these styles, there are a wide range of funds and many derivations of them. Many mutual funds offer more than one class of shares. For example, a fund can offer "Class A", "Class B" and "Class C" shares, respectively. Each class will invest in the same pool (or investment portfolio) of securities and will have the same investment objectives and policies. But each class will have different shareholder services and/or distribution arrangements with different fees and expenses. These differences are supposed to reflect different costs involved in servicing investors in various classes; for example, one class may be bought through brokers with a front-end load (i.e. "Class A" and "Class B", and transaction fee included during buying), and another class may be sold directly to the public with no load but a "transaction fee" is included in the class's expenses (i.e. "Class C", and transaction fee included during selling).

In stock market, researchers focus on developing approaches to successfully forecast index values or stock prices (Atsalakis & Valavanis, 2009). The central idea to successful stock market

forecast is to achieve best results using historical data and the least complex stock market model (Atiya, Talaat, & Shaheen, 1997; Hsu, Hung, Yeh, & Liu, 2009; Tang, Xu, Wan, & Zhang, 1992; Tang et al., 2002). Many people have increasingly turned to technical analysis in recent years (Atiya et al., 1997; Baba & Kozaki, 1992; Dourra & Siy, 2002; Grudnitski & Osburn, 1993; Lam, 2001; Tang, Xu, Wan, & Zhang, 2002). They realize that security prices do not move randomly, rather they move in repeating and identifiable patterns. And they believe that all knowledge, regardless of type (fundamental, economic, political, psychological, or other), is already reflected in market prices. Technical analysis can be completed by the technical indicators. Technical indicators can help us to do analysis, statistics, early warning, and etc. Some technical indicators can be applied to stocks and mutual funds, for examples, MA (moving average), RSI (Relative Strength Indicator) and PSY (Psychological Line) and etc. But some technical indicators cannot be applied to mutual funds, for examples, DMI (Directional Movement Index), OBOS (Over Bought and Over Sold) and OBV (On Balance Volume) and etc. (Pring, 1991; Tsai, Yang, & Peng, 2009). In this paper, we proposed a new investment strategy based on mixed moving averages and turbulent particle swarm optimization techniques to find the proper parameters of technical indicators to achieve high profit and reduce risk when considering the transaction fee.

The remainder of this paper is organized as follows: Section 2 describes the moving average in trading strategies. Section 3 describes the particle swarm optimization (PSO). Section 4 discusses the details of the proposed new trading strategy method based on

mixed moving averages and TPSO. Section 5 discusses the experimental results obtained from the new proposed investment strategy. Finally, Section 6 summarizes the contribution of this paper and conclusions.

2. Moving average in trading strategies

In the financial market, technical analysis can be divided into three key areas: sentiment, flows-of-funds, and market structure indicators (Pring, 1991). Market structure indicators are one of the most commonly used by investors in financial markets. Professionals divide indicators into three groups: Trend-following indicators, Oscillators and Miscellaneous indicators. Trend-following indicators work best when markets are moving but give bad and dangerous signals when the markets are flat, such as MA (moving average). Oscillators catch turning points in flat but dangerous signals when the markets begin to trend, such as RSI (Relative Strength Indicator). Miscellaneous indicators such as PSY (Psychological Line) will provide special insights into mass psychology (Elder, 1993).

Moving average is a common tool in technical analysis. By definition, a simple moving average SMA^T is defined as follows:

$$SMA_k^T = \frac{1}{T} \sum_{t=k-T+1}^{k} Price_t, \tag{1}$$

where T is the time interval over which the average is calculated, k is the kth day currently being considered within the total number of days, and $Price_t$ is the historical price at day t. Suppose $T = 5$, we can use SMA^5 to represent 5-day simple moving average for all the days being considered. The 5-day moving average (i.e. SMA^5) of historical prices is shown in Fig. 1. It is easy to show that if the trend of historical price is positive, then for the kth day the moving average SMA_k^T will be below $Price_k$; otherwise, the trend is negative and SMA_k^T will be above $Price_k$. The former corresponds to the (bull) market and the latter corresponds to the falling (bear) market (Ellis & Parbery, 2005).

There are two variations of this general moving average technique; one is the fixed length moving average (named FLMA) and the other is the variable length moving average (named VLMA) (Gunasekarage & Power, 2001). In FLMA, there are many fixed SMA^T to be used in financial market normally, such as SMA^5, SMA^{20}, SMA^{60}, SMA^{120}, SMA^{240} and etc. corresponding to the week average, month average (i.e. 4 weeks average), season average, half-year average,

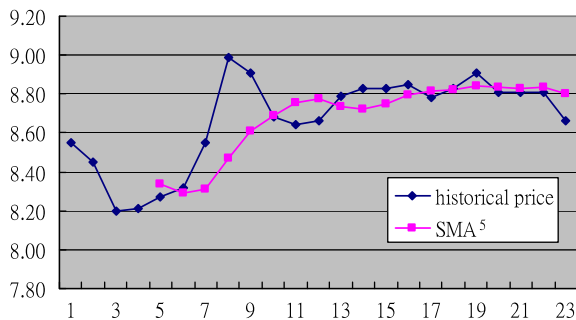
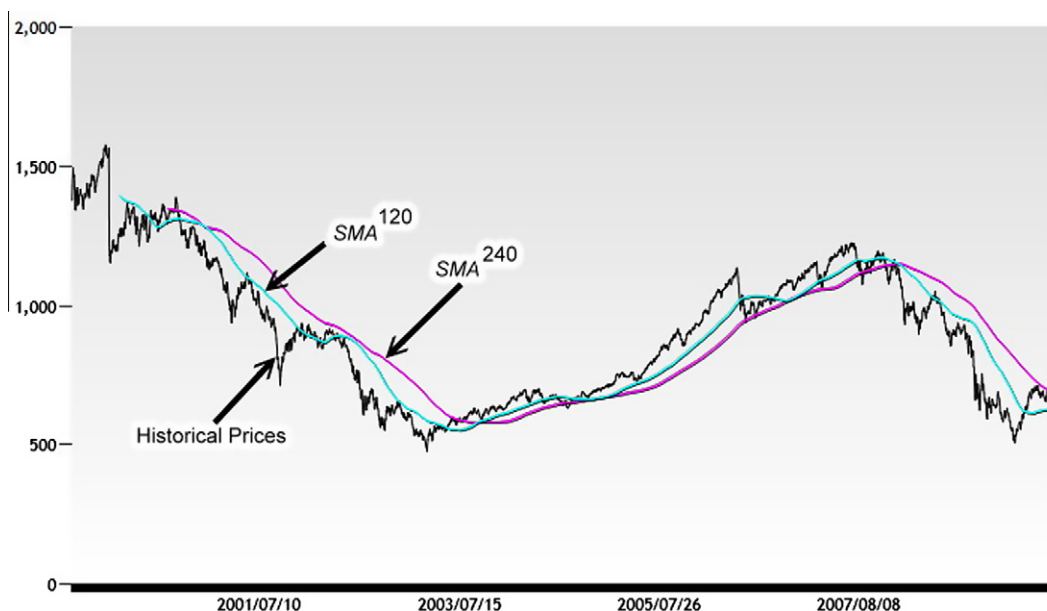**Fig. 1.** The 5-day moving average of historical prices.

Fig. 2. The moving averages SMA^{120} and SMA^{240} of "Falcon European Equity Fund" fund historical prices from January 4, 1999 to July 1, 2009.

year average and etc. They are important lines for decision-making and data analysis in finance. These moving averages are illustrated in Fig. 2 for the case of a typical financial time series, i.e. the evolution of "Falcon European Equity Fund" fund historical prices from January 4, 1999 to July 22, 2009. In Fig. 2, there are two different moving averages SMA^{T_1} and SMA^{T_2} characterized, respectively, by T_1 and T_2 intervals, where $T_1 = 120$ and $T_2 = 240$. If $Price_k$ increases for a long period before decreasing rapidly, SMA^{T_1} will cross SMA^{T_2} from above. This event is called a "death cross" in empirical finance. On the contrary, if SMA^{T_1} crosses SMA^{T_2} from below, the crossing point coincides with an upsurge of the $Price_k$. This event is called a "gold cross". In VLMA, there are no meaningful lengths like FLMA. In the trade strategy based on SMA, whether it is in FLMA or VLMA, the emphasis in this rule is on whether the short-length moving average is upper (or lower) than the long-length moving average which reveals that the most recent price is upper (or lower) than the longer term price level, and that the general trend in prices will be upward (or downward). In other words, buy when the short-length moving average crosses the long-length moving average from below and sell when the short-length moving average crosses the long-length moving average from above.

3. Particle swarm optimization

The particle swarm optimization (PSO) is a tool for handling optimization problems. It is one kind of evolutionary algorithms, which was inspired by swarm intelligence and theory in general such as bird flocking, fish schooling and even human social behavior (Kennedy, Eberhart, & Shi, 2001; Hsu, Horng, Fan, et al., 2010; Lin, Horng, Kao, Huang, et al., 2010). PSO consists of a swarm of particles that search for the best position with respect to the corresponding best solution for an optimization problem in the virtual search space. Every particle remembers its personal best position and it has been passed so far when it moves to another position.

Because of its fast convergence rate, simple computation and easy realization, PSO has extensive applications in optimization problem of continuous space. Kuo et al. (2009a) proposed the PSO and fuzzy time series to forecast enrollments. Mohemmed, Sahoo, and Geok (2008) proposed the PSO to solve the shortest path problem. Kuo et al. (2009b) proposed the hybrid PSO for the flow-shop scheduling. Hsu, Horng, Kao, et al. (2010) presented the temperature prediction and TAIFEX forecasting based on fuzzy relationships and MTPSO techniques. Kuo, Horng, Chen, et al. (2010) forecasted TAIFEX based on fuzzy time series and particle swarm optimization. Lin, Horng, Kao, Chen, et al. (2010) proposed an efficient job-shop scheduling algorithm based on particle swarm optimization. Kuo, Horng, Kao, et al. (2010) solved the traveling salesman problem using hybrid swarm intelligence algorithm.

3.1. Standard particle swarm optimization

Assuming that the search space is D-dimensional, the ith particle of the swarm is represented by the D-dimensional position vector $X_i = (x_{i1}, x_{i2}, \ldots, x_{iD})$ and the velocity vector is $V_i = (v_{i1}, v_{i2}, \ldots, v_{iD})$. After the evaluation of the fitness function, individual best position of the ith particle is recorded and represented as $P_i = (p_{i1}, p_{i2}, \ldots, p_{iD})$, and the best particle of the swarm is recorded and represented as P_g. Then, the next individual of particle's position and velocity will changed by the following equations:

$$V_i^{n+1} = w \cdot V_i^n + c_1 \cdot r_{i1}^n \cdot (P_i^n - X_i^n) + c_2 \cdot r_{i2}^n \cdot (P_g^n - X_i^n), \quad (2)$$

$$X_i^{n+1} = X_i^n + V_i^{n+1}, \quad (3)$$

where $i = 1, 2, \ldots, N$; N is the swarm's size; $n = 1, 2, \ldots, M$; M is the maximum number of iterations. The symbol w denotes the inertia weight.

Two symbols c_1 and c_2 denote the self confidence coefficient and the social confidence coefficient, respectively; r_{i1}^n and r_{i2}^n represent two different random numbers uniformly distributed within the range $[0, 1]$.

The whole running procedure of the standard PSO is described in Algorithm 1.

Algorithm 1. Standard PSO algorithm

1. initialize all particle positions X_i and velocities V_i, for $1 \leqslant i \leqslant N$, N is the swarm's size.
2. **while** the stop condition (the optimal solution is found or the maximal moving Mth step is reached) is not satisfied **do**
3.   **for** particle i, $(1 \leqslant i \leqslant N)$ **do**
4.   calculate the fitness value of particle i.
5.   update the personal best position P_i of particle i according to the fitness value.
6.   **end for**
7. update the global best position P_g of all particles P according to the fitness value.
8.   **for** particle i, $(1 \leqslant i \leqslant N)$ **do**
9.   move particle i to another position X_i according to Eqs. 2 and 3.
10.   **end for**
11. **end while**

3.2. Turbulent particle swarm optimization

In PSO model, the particle searches the solutions in the problem space with a range $[-V_{max}, V_{max}]$, and its moving range must be clamped in between the maximum velocity. Several theoretical studies have been done to analyse the trajectory of a single particle in PSO. The analysis of the behavior of the particle swarm model reveals that such premature convergence is mainly due to the decrease of velocity of particles in the search space that leads to a total implosion and ultimately fitness stagnation of the swarm (Abraham & Liu, 2009; Clerc & Kennedy, 2002; Liu & Abraham, 2005; Trelea, 2003). One of the main reasons for premature convergence of PSO is due to the stagnation of the particles exploration of a new search space. The method to drive those lazy particles (i.e. the particle velocity is small than the threshold), which can explore a better solution, is shown as follows:

$$V_i = \begin{cases} V_{max} & \text{if } V_i > V_{max}; \\ -V_{max} & \text{if } V_i < -V_{max}; \\ -V_{max} + 2 \times V_{max} \times rand() & \text{if } |V_i| < V_s; \\ V_i & \text{otherwise}, \end{cases} \quad (4)$$

where V_s is the minimum velocity threshold, a threshold parameter to limit the minimum of a particle velocity, $rand()$ is a uniformly distributed random number in the range $[0, 1]$. If V_s is large, it will shorten the oscillation period, and facilitates a global search. On the other hand, if V_s is small, it facilitates a local search.

4. The new proposed trading strategy model

Instead of using only one moving average, moving averages of differing lengths are used for trend determination. The major reason is to reduce the risk. When two moving averages are used, a buy signal is given when the short-length moving average crosses above the long-length moving average, and a sell signal occurs when long-length moving average crosses above short-length moving average. How long is the length for calculating the moving average? There is no magic answer. The best number of moving averages to use varies significantly from security and depends on the target of mutual fund. A new trading strategy method consisting of mixed moving average and TPSO is proposed in this paper. It can deal with the "how long"

question, and provides a good buy point (i.e. gold cross point) and a good sell point (i.e. death cross point).

4.1. Trading strategy

In mutual fund trading, it has many additional costs, such as transaction fee. Suppose trading too frequently, the additional transaction costs will then erode the capital. Therefore, a good trading strategy will enhance the profits and reduce the risk. As mentioned above, the best number of moving averages to use varies significantly from security and depends on the target of mutual fund; no specific rules can be applied to all funds. To make sure a good buy point and a good sell point, in this paper, we used eight moving averages in trading strategy, four to decide the buy point and the other four to decide the sell point. The trading strategy indicator is shown as follows:

$$signal_k = \begin{cases} buy, & if \left(SMA_k^{T_1} > SMA_k^{T_2}\right) and \left(SMA_k^{T_3} > SMA_k^{T_4}\right); \\ sell, & if \left(SMA_k^{T_5} < SMA_k^{T_6}\right) and \left(SMA_k^{T_7} < SMA_k^{T_8}\right); \\ hold, & otherwise, \end{cases}$$

(5)

where k is the relative position of the day currently being considered, and T_j is a positive integer and $T_j > 1$, for $1 \leqslant j \leqslant 8$. The buy and sell signals of the fund in trading model can be enhanced by

using Eq. (5). Then we can avoid the financial turmoil or turbulence, and reduce the investment loss. The transaction state diagram is shown in Fig. 3. In a bear market, when a buy signal is generated (i.e. $signal_k$ = buy) that indicates the bull market is coming and the general trend in prices will be upward. At this time, our model will start to buy good fund all capital (i.e. holding fund). On the contrary, in a bull market, when a sell signal is generated (i.e. $signal_k$ = sell) that indicates the bear market is coming and the general trend in prices will be downward. At this time, our model will redeem mutual fund (i.e. holding capital). The detailed procedure of the transaction in funds (for Class A or Class B) is described in Algorithm 2. In Algorithm 2, *Capital* represents holding capital, *State* represents the state in holding capital or in holding fund, *FundUnit* represents holding fund unit, *FundNet_k* represents the fund net in k position of date, *FundFee* represents the fund transaction fee.

Algorithm 2. The detailed procedure of the transaction in funds (for Class A or Class B)

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1. input eight time intervals T_j, for $1 \leqslant j \leqslant 8$.
2. initialize *Capital* = 1 and *State* = holding capital.
3. **for** k in historical price sorted by ascending date **do**.
4.   calculate moving averages $SMA_k^{T_j}$, for $1 \leqslant j \leqslant 8$.
5.   evaluate trading strategy indicator $signal_k$ according to Eq. (5).
6.   **if** (*State* = holding capital) **and** ($signal_k$ = buy) **then**
7.   holding fund $FundUnit = Capital/(FundNet_k^*(1 + FundFee))$.
8.   *State* = holding fund.
9.   **else if** (*State* = holding fund) **and** ($signal_k$ = sell) **then**
10.   holding capital *Capital* = $FundUnit * FundNet_k$.
11.   *State* = holding capital.
12.   **end if**
13. **end for**
14. **if** (*State* = holding fund) **then**
15.   *Capital* = $FundUnit * FundNet_{LastDate}$.
16. **end if**
17. **return** *Capital*.

Fig. 3. Transactions state diagram.

Fig. 4. The moving averages SMA^5 and SMA^{120} of "Falcon European Equity Fund" fund historical prices from February 25, 2002 to March 4, 2009 for deciding buy point and sell point.

For example, suppose there are eight moving averages, such as $T_1 = 5$, $T_2 = 120$, $T_3 = 60$, $T_4 = 200$, $T_5 = 5$, $T_6 = 120$, $T_7 = 60$ and $T_8 = 200$ of "Falcon European Equity Fund" fund historical prices from February 25, 2002 to March 4, 2009 which are illustrated in Figs. 4–6. In Fig. 4, there are two moving averages SMA^5 and SMA^{120}, three buy points (i.e. A, B and C) and two sell points (i.e. G and H). In Fig. 5, there are two moving averages SMA^{60} and SMA^{200}, two buy points (i.e. D and E) and one sell point (i.e. I). In Fig. 6, we use four moving averages SMA^5, SMA^{120}, SMA^{60} and SMA^{200}, and there is only one buy point (i.e. F) and two sell points (i.e. J and K). From Fig. 4, the two sell points are quite close to the two buy points, the transaction cost is quite high. For Fig. 5, the sell point is also close to the buy point. It has high transaction cost as in Fig. 4. Although there are two sell points in Fig. 6, however, it will be sold in point J according to Algorithm 2. Note that there are no buy points between point J and point K in Fig. 6. In this example, the benefits got from eight moving averages in Fig. 6 are better than those got from two moving averages in Figs. 4 and 5.

4.2. Mixed moving averages and TPSO algorithm

A moving average is commonly used with time series data to smooth out short-length fluctuations and highlight long-length trends or cycles. The threshold between short-length and long-length depends on the fund, and the parameters of the moving average will be set accordingly. PSO is an algorithm modeled on swarm intelligence that finds a solution to an optimization problem in a search space; as mentioned above, TPSO can further explore a better solution. In this section, we proposed a new model named as MMAPSO which consists of mixed moving averages and TPSO to find better transaction points for the trading strategy in mutual fund. A particle consists of eight moving averages, MMAPSO will find the best time interval of each moving average according to the fitness value (i.e. Capital) obtained from Algorithm 2. The detailed MMAPSO algorithm is described in Algorithm 3.

Algorithm 3. The MMAPSO algorithm

1. initialize all particle positions X_i (i.e. the time intervals of eight moving averages) and velocities V_i, for $1 \leqslant i \leqslant N$, N is the swarm's size.
2. **while** the stop condition (the optimal solution is found or the maximal moving Mth step is reached) is not satisfied **do**
3.   change the inertia weight w according to the number of iterations.
4.   **for** particle i, $(1 \leqslant i \leqslant N)$ **do**
5.   calculate the fitness value (i.e. profits $Capital$) of particle i according to Algorithm 2.
6.   update the personal best position P_i of particle i according to the fitness value.
7.   **end for**
8.   update the global best position P_g of all particles P according to the fitness value.
9.   **for** particle i, $(1 \leqslant i \leqslant N)$ **do**
10.   move particle i to another position X_i according to Eqs. (2)–(4).
11.   **end for**
12. **end while**

An example for illustrating the MMAPSO model for trading strategy is given in the following. In this example, we used "Falcon European Equity Fund" fund historical prices from January 4, 1999 to July 1, 2009 as shown in Fig. 2. Initially, the velocity threshold V_s corresponding to Eqs. (2)–(4) is set to 1, the range of $[-V_{max}, V_{max}]$ is set to $[-80, 80]$, both c_1 and c_2 are set to 2, and w is set to 1.4. Let the number of particles be 5. A particle is a vector consisting of 8 elements (i.e. T_j, where $1 \leqslant j \leqslant 8$) which define the eight moving averages. The randomized initial positions and initial velocities of all particles are listed in Tables 1 and 2, respectively.

Initially, the initial personal best positions are set as the initial positions of all particles. After all particles have got their own
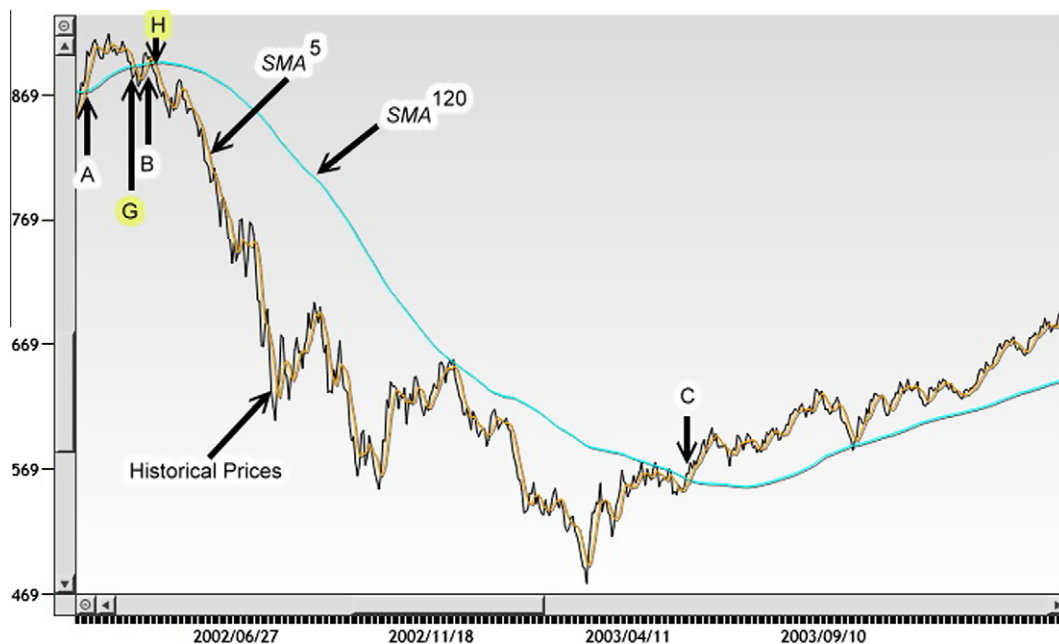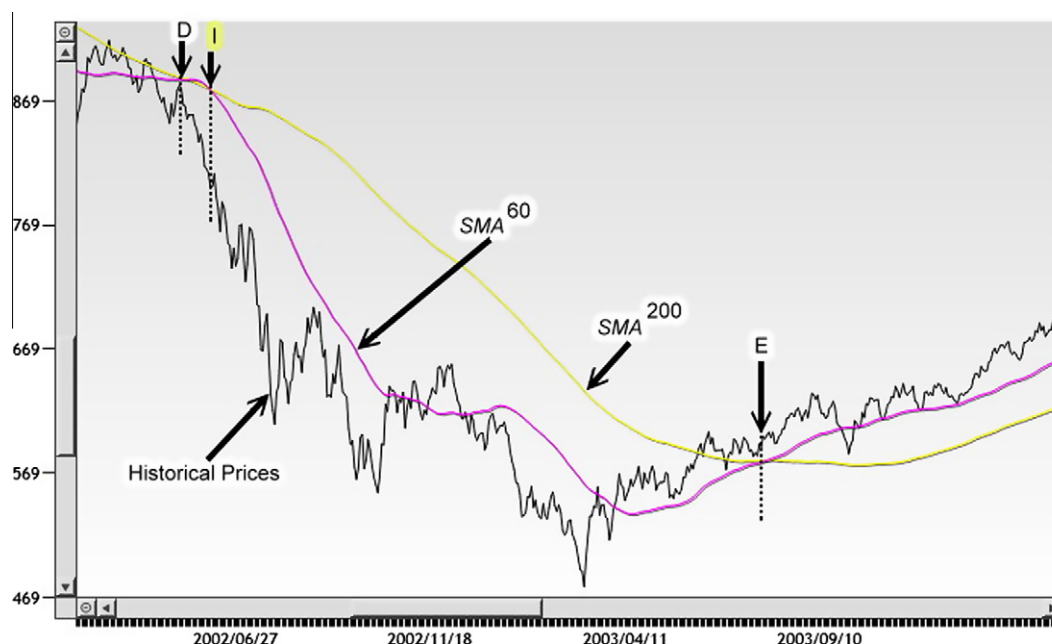

Fig. 5. The moving averages SMA^{60} and SMA^{200} of "Falcon European Equity Fund" fund historical prices from February 25, 2002 to March 4, 2009 for deciding buy point and sell point.
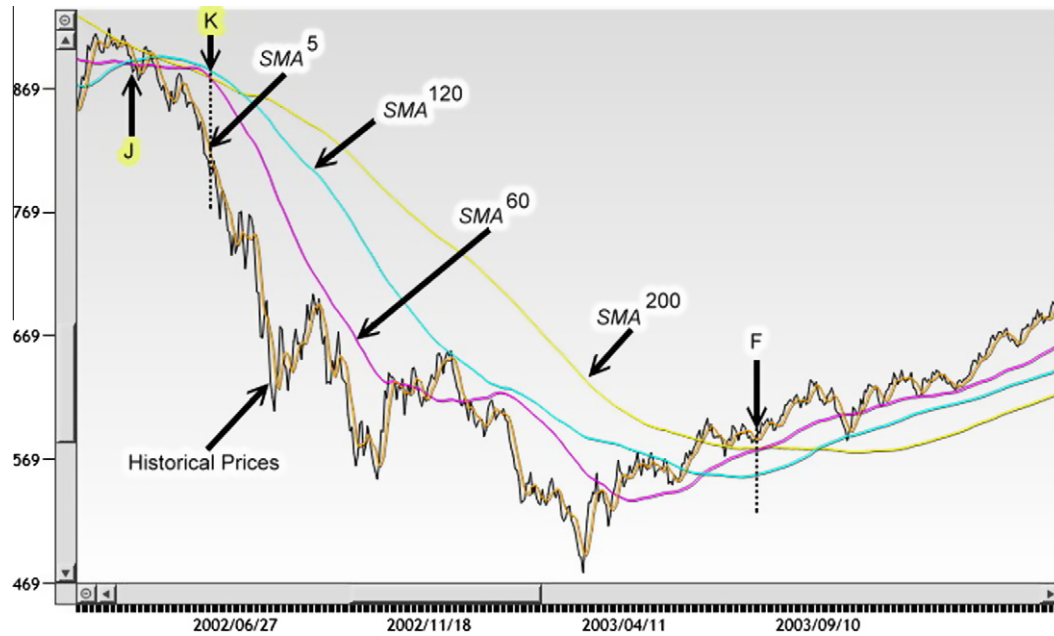
Fig. 6. The moving averages SMA^5, SMA^{120}, SMA^{60} and SMA^{200} of "Falcon European Equity Fund" fund historical prices from February 25, 2002 to March 4, 2009 for deciding buy point and sell point.

Table 1
The initial positions of particles 1–5.

	X_{T1}	X_{T2}	X_{T3}	X_{T4}	X_{T5}	X_{T6}	X_{T7}	X_{T8}	Fitness value
Particle 1	269	281	383	70	285	35	156	168	0.461064
Particle 2	168	155	75	56	321	227	236	302	0.586500
Particle 3	48	354	252	148	342	160	92	135	1.083124
Particle 4	233	77	20	113	356	224	22	115	0.588423
Particle 5	192	332	53	58	134	48	31	208	1.055764

Table 2
The initial velocities of particles 1–5.

	V_{T1}	V_{T2}	V_{T3}	V_{T4}	V_{T5}	V_{T6}	V_{T7}	V_{T8}
Particle 1	68	12	64	−50	−46	−20	16	79
Particle 2	50	−31	−10	35	−65	32	30	54
Particle 3	3	23	−1	57	−57	−34	−34	−16
Particle 4	59	18	35	27	45	−12	−41	−45
Particle 5	23	−39	−59	−60	7	−32	40	38

fitness values according to Algorithm 2, each particle updates its own personal best position so far according to its fitness value. The buy/sell points and fitness values by using eight moving averages in iteration 1 of each particle is shown in Table 5. The personal best positions of all particles so far are listed in Table 1. In Table 1, since the fitness value of particle 3 is the best among all five

particles so far, the global best position is then set to particle 3. Then the MMAPSO algorithm moves all particles to other positions according to Eqs. (2)–(4). The new position vector for particle 1 is shown in the following.

$$V_{T_1} = 1.4 \times (68) + 2 \times rand_1() \times (269 - 269) + 2 \times rand_2()$$
$$\times (48 - 269) = 82;$$
$$V_{T_2} = 1.4 \times (12) + 2 \times rand_1() \times (281 - 281) + 2 \times rand_2()$$
$$\times (354 - 281) = 24;$$
$$V_{T_3} = 1.4 \times (64) + 2 \times rand_1() \times (383 - 383) + 2 \times rand_2()$$
$$\times (252 - 383) = -20;$$
$$V_{T_4} = 1.4 \times (-50) + 2 \times rand_1() \times (70 - 70) + 2 \times rand_2()$$
$$\times (148 - 70) = 7;$$
$$V_{T_5} = 1.4 \times (-46) + 2 \times rand_1() \times (285 - 285) + 2 \times rand_2()$$
$$\times (342 - 285) = 57;$$
$$V_{T_6} = 1.4 \times (-20) + 2 \times rand_1() \times (35 - 35) + 2 \times rand_2()$$
$$\times (160 - 35) = 71;$$
$$V_{T_7} = 1.4 \times (16) + 2 \times rand_1() \times (156 - 156) + 2 \times rand_2()$$
$$\times (92 - 156) = -38;$$
$$V_{T_8} = 1.4 \times (79) + 2 \times rand_1() \times (168 - 168) + 2 \times rand_2()$$
$$\times (135 - 168) = 85;$$

(5)

Table 3
The second positions of particles 1–5.

	X_{T1}	X_{T2}	X_{T3}	X_{T4}	X_{T5}	X_{T6}	X_{T7}	X_{T8}	Fitness value
Particle 1	349	305	363	77	342	106	118	248	0.684368
Particle 2	230	116	69	115	241	210	156	294	0.806862
Particle 3	52	386	250	228	262	112	45	112	1.375216
Particle 4	313	139	80	161	399	193	68	58	0.765633
Particle 5	196	317	122	41	152	84	111	201	0.726889

Table 4
The second velocities of particles 1–5.

	V_{T1}	V_{T2}	V_{T3}	V_{T4}	V_{T5}	V_{T6}	V_{T7}	V_{T8}
Particle 1	80	24	−20	7	57	71	−38	80
Particle 2	62	−39	−6	59	−80	−17	−80	−8
Particle 3	4	32	−2	80	−80	−48	−47	−23
Particle 4	80	62	60	48	43	−31	46	−57
Particle 5	4	−15	69	−17	18	36	80	−7

$$
\begin{aligned}
X_{T_1} &= 269 + 80 = 349; (82 \text{ restricted to } 80 \text{ by Eq. (4))} \\
X_{T_2} &= 281 + 24 = 305; \\
X_{T_3} &= 383 + (-20) = 363; \\
X_{T_4} &= 70 + 7 = 77; \\
X_{T_5} &= 285 + 57 = 342; \\
X_{T_6} &= 35 + 71 = 106; \\
X_{T_7} &= 156 + (-38) = 118; \\
X_{T_8} &= 168 + 80 = 248; (85 \text{ restricted to } 80 \text{ by Eq. (4))}
\end{aligned} \tag{6}
$$

The velocity of particle 1 is calculated in Eq. (5) based on Eq. (2). Then the velocity vector is = {82, 24, −20, 7, 57, 71, −38, 85}, which is restricted to {80, 24, −20, 7, 57, 71, −38, 80} by Eq. (4). Then the new position vector of particle 1 is calculated in Eq. (6) based on Eq. (3). By this procedure, others can be updated similarly. The second positions and the corresponding new fitness values of all particles are listed in Table 3 and the second velocities are listed in Table 4.

By comparing the fitness values listed in Table 1 with those listed in Table 3, it is obviously that particles 1–4 reach better positions than their own personal best positions so far. The buy/sell points and fitness values using eight moving averages in iteration 2 of each particle are shown in Table 6. Also the new global best position for all particles is created by particle 3 as its fitness value is the best for all particles so far. The MMAPSO model repeats the above steps until the stop condition is satisfied.

5. Experimental results

In this section, we focus on the fund set up in Taiwan as the subject of study. The data set of our experiments is taken from cnYes.com (http://www.cnyes.com/) (cnYES.com, 2000). Let ROI (i.e. return on investment) represent the performance of a fund. To calculate the ROI of an investment, the net gain of an investment is divided by the cost of the investment; the result is expressed as a percentage or a ratio by the following notation:

$$
ROI = \frac{GainFromInvestment - CostOfInvestment}{CostOfInvestment}, \tag{7}
$$

where *GainFromInvestment* represents the final return of the investment (i.e. gain from investment), *CostOfInvestment* represents the beginning of the investment (i.e. cost of investment). For example, suppose we have \$1 at the beginning of the investment. The final return of the investment is \$2. Then the ROI is 1 (or 100%). In MMAPSO model, we set the initial capital to \$1.

Let $ROI_{oTraining}$ represent the original performance of a fund in training phase, $ROI_{oTesting}$ represent the original performance of a fund in testing phase and $ROI_{mTraining}$ represent the performance of a fund in MMAPSO training phase and $ROI_{mTesting}$ represent the performance of a fund in MMAPSO testing phase which are shown in Eqs. (8)–(11), respectively.

$$
ROI_{oTraining} = \frac{Net_{et} - Net_{st}}{Net_{st}}, \tag{8}
$$

$$
ROI_{oTesting} = \frac{Net_{es} - Net_{ss}}{Net_{ss}}, \tag{9}
$$

$$
ROI_{mTraining} = \frac{Capital_{et} - Capital_{st}}{Capital_{st}}, \tag{10}
$$

$$
ROI_{mTesting} = \frac{Capital_{es} - Capital_{ss}}{Capital_{ss}}, \tag{11}
$$

where Net_{st} represents the fund net in the start date of training phase, Net_{et} represents the fund net in the end date of training phase, Net_{ss} represents the fund net in the start date of testing phase, Net_{es} represents the fund net in the end date of testing phase, $Capital_{st}$ represents the capital in the start date of training phase by MMAPSO (i.e. 1), $Capital_{et}$ represents the capital in the end date of training phase by using MMAPSO, $Capital_{ss}$ represents the capital in the start date of testing phase by using MMAPSO (i.e. 1), $Capital_{es}$ represents the capital in the end date of testing phase by using MMAPSO.

The performance got from MMAPSO model is compared with the original performance of a fund. The essential parameters of MMAPSO model are set as follows. Let the number of particles be 50, the maximal number of move for each particle be 400, the value of inertial weight (i.e. x) be linearly decreased from 1.4 to 0.4, the self confidence coefficient (i.e. c_1) and the social confidence coefficient (i.e. c_2) both be 2, the velocity be limited (i.e. V_{max}) to [−80, 80], the minimum velocity threshold (i.e. V_s) be 1.

In Tables 7 and 8, there are approximately 38 mutual trust companies in Taiwan, which offer a total of 413 funds. Based on investment targets and regions, they are divided into 46 fund groups. We selected funds with class A or Class B, and trade date before July 1, 2008 in Taiwan. In this experiment, we tested this model to see if it is able to escape the 2008 financial crisis triggered by U.S. subprime crisis. We use one year historical data from July 2, 2007 to July 2, 2008 of the fund for training and use one year historical data from July 3, 2008 to July 1, 2009 for testing.

In this experiment, we ran MMAPSO algorithm for 10 times (i.e. R1, R2, . . . , R9 and R10). The ROI of the original and that of MMAPSO for the fund whose historical data ranging from July 2, 2007 to July 1, 2009 are shown in Tables 7 and 8. In Table 7, the performance of each fund on average has been improved more than the original about 17.66% in training phase and about 10.57% in testing phase. In Table 8, for example, there are 126 fund investment targets for the Taiwan stock. They are the most popular and invested, including "Taiwan Large-Cap Equity" and "Taiwan Small/Mid-Cap Equity". The average of $ROI_{oTraining}$ is −24.17% and that of $ROI_{oTesting}$ is −8.24%. After the training and testing by using MMAPSO, the average of $ROI_{mTraining}$ is improved to 0.97% and that of $ROI_{mTesting}$ is improved to 5.55%.

In Table 9 and Fig. 7, there are approximately 22 mutual trust companies in Taiwan, which offer a total of 115 funds from July 2, 1998 to July 1, 2009. We selected funds with class A or Class B. In this experiment, we tested this model to see if it is able to

Table 5
The buy/sell points and fitness values by using 8 moving averages in the iteration 1 of each particle.

Particle 1				Particle 2				Particle 3				Particle 4				Particle 5			
Date	FundNet	FundUnit	Capital	Date	FundNet	FundUnit	Capital	Date	FundNet	FundUnit	Capital	Date	FundNet	FundUnit	Capital	Date	FundNet	FundUnit	Capital
1-Mar-2001	1066.1	0.000920		29-Nov-2000	1210.95	0.000809606		22-Oct-2003	628.49	0.001560		7-Jun-2001	1088.25	0.000901		22-Dec-2003	633.23	0.001548	
25-Aug-2003	621.55	0	0.5715812	29-Jan-2004	675.12		0.5465811	21-Jul-2004	653.36		1.019187	28-May-2004	667.47		0.601316	5-Sep-2007	1160.55		1.796810
3-Nov-2003	630.02	0.000889		4-Oct-2004	684.92	0.000782		13-Dec-2006	1088.25	0.000918		11-Oct-2004	688.04	0.000857		23-Oct-2007	1157.78	0.001522	
5-Oct-2004	690.21	0	0.6139099	23-Apr-2007	1177.73		0.921426	17-Oct-2007	1179.65		1.083124	14-Jun-2006	945.73		0.810319	2-Jun-2009	693.89		1.055764
30-Jan-2008	995.21	0.000605		28-Dec-2007	1137.89	0.000794						22-May-2008	1029.29	0.000772					
				2-Apr-2008	974.63		0.773748												
				3-Apr-2008	986.06	0.000769													
1-Jul-2009	683.22		0.461064	1-Jul-2009	683.22		0.586500	1-Jul-2009	683.22		1.083124	1-Jul-2009	683.22		0.588423	1-Jul-2009	683.22		1.055764

Table 6
The buy/sell points and fitness values by using 8 moving averages in the iteration 2 of each particle.

Particle 1				Particle 2				Particle 3				Particle 4				Particle 5			
Date	FundNet	FundUnit	Capital	Date	FundNet	FundUnit	Capital	Date	FundNet	FundUnit	Capital	Date	FundNet	FundUnit	Capital	Date	FundNet	FundUnit	Capital
1-Feb-2001	1173.82	0.000835		23-Oct-2000	1247.07	0.000786		27-Nov-2003	631.94	0.001551		27-Feb-2002	864.49	0.00113407		23-Jun-2004	671.69	0.001460	
2-Jan-2008	699.32		0.944386	5-Dec-2000	699.32		0.929567	21-Jun-2004	679.95		1.054875	29-Jan-2004	675.12		0.765633	29-Nov-2004	699.32		1.020721
15-May-2008	971.67	0.000898		30-Jul-2001	971.67	0.000945		11-Feb-2005	741.62	0.001395						29-Jun-2006	971.67	0.001030	
				9-Aug-2002	1085.81		0.628035	29-Jun-2006	971.67		1.354996					15-Nov-2006	1085.81		1.118258
				23-Jun-2003	1149.86	0.001031		8-Mar-2007	1095.67	0.001212						3-Sep-2007	1149.86	0.000953	
				12-Feb-2008			0.994243	31-Aug-2007	1134.26		1.375216								
				1-Jul-2008		0.001058													
1-Jul-2009	683.22		0.684368	1-Jul-2009	683.22		0.806862	1-Jul-2009	683.22		1.375216	1-Jul-2009	683.22		0.765633	1-Jul-2009	683.22		0.726889

Table 7
Results comparison of the *ROIs* of the original (i.e., *ROI*oTraining and *ROI*oTesting) and MMAPSO (i.e., *ROI*mTraining and *ROI*mTesting) from July 2, 2007 to July 1, 2009.

	$ROI_{oTraining}$		$ROI_{oTesting}$		$ROI_{mTraining}$		$ROI_{mTesting}$	
	Maximum (%)	Average (%)	Maximum (%)	Average (%)	Maximum (%)	Average (%)	Maximum (%)	Average (%)
R1	21.47	−16.01	17.32	−8.59	19.50	1.69	31.27	2.04
R2					19.50	1.68	31.27	1.94
R3					19.50	1.69	31.27	2.09
R4					19.50	1.42	31.27	2.07
R5					19.50	1.67	31.27	2.10
R6					19.50	1.68	31.27	1.92
R7					19.50	1.68	31.27	1.84
R8					19.50	1.70	31.27	1.76
R9					19.50	1.70	31.27	1.92
R10					19.50	1.55	31.27	2.10
Average					19.50	1.65	31.27	1.98

Table 8
Results comparison for the *ROIs* of the original and MMAPSO of fund groups from July 2, 2007 to July 1, 2009.

| Fund group	$ROI_{oTraining}$		$ROI_{oTesting}$		$ROI_{mTraining}$		$ROI_{mTesting}$		Number of funds
	Maximum (%)	Average (%)	Maximum (%)	Average (%)	Maximum (%)	Average (%)	Maximum (%)	Average (%)	
1 Taiwan Large-Cap Equity	−5.68	−21.83	17.32	−6.37	6.37	1.02	31.27	6.14	15
2 Other Asia–Pacific Equity	−19.23	−19.23	−8.20	−8.20	8.92	8.92	5.70	5.70	1
3 Taiwan Small/Mid-Cap Equity	21.47	−26.52	10.36	−10.12	19.50	0.93	24.51	4.96	111
4 Malaysia Equity	−22.39	−22.39	−5.67	−5.67	8.46	8.46	4.79	4.31	1
5 Greater China Equity	−2.59	−18.33	0.62	−9.01	7.83	1.33	17.44	4.15	6
6 Sector Equity Technology	−17.44	−29.15	3.56	−11.04	7.81	0.58	18.83	3.43	34
7 TWD Aggressive Balanced	16.77	−8.83	10.47	−5.59	12.49	1.80	19.24	1.36	40
8 Asia–Pacific with Japan Equity	−14.26	−19.82	−2.68	−10.05	7.56	4.07	4.28	0.92	9
9 Global Large-Cap Value Equity	−22.25	−22.55	−9.62	−15.82	2.10	0.72	4.48	0.90	3
10 India Equity	−18.52	−18.52	6.95	6.95	4.56	4.56	4.81	0.79	1
11 Taiwan Bond	1.76	1.43	8.05	1.17	4.23	2.25	4.57	0.73	51
12 Dollar Global Bond	1.73	−2.86	13.97	4.29	10.11	3.16	10.43	0.63	20
13 Dollar Diversified Bond	1.88	−3.52	9.50	5.36	8.88	2.49	4.27	0.53	7
14 Dollar Moderate Balanced	−5.70	−10.86	10.39	−4.45	6.08	1.03	6.69	0.35	14
15 Sector Equity Infrastructure	−8.04	−17.31	−11.50	−18.23	2.66	0.58	1.97	0.33	6
16 Dollar Cautious Balanced	1.38	−6.31	4.75	−0.32	4.39	2.70	3.21	0.28	4
17 Sector Equity Real Estate Indirect	−24.33	−32.59	−22.88	−27.64	0.31	−3.15	0.00	0.00	8
18 Europe Large-Cap Blend Equity	−16.25	−16.67	−21.81	−26.98	6.03	4.50	0.00	0.00	3
19 Sector Equity Natural Resources	16.44	16.44	−33.56	−33.56	18.42	18.42	0.00	0.00	1
20 Dollar Government Bond	−8.95	−8.95	−7.28	−7.28	0.00	0.00	0.00	0.00	1
21 Euro Moderate Balanced	−7.87	−7.87	−12.88	−12.88	0.00	0.00	0.00	0.00	1
22 Europe Large-Cap Value Equity	−22.35	−22.35	−21.73	−21.73	0.08	0.08	0.00	0.00	1
23 Sector Equity Energy	−4.34	−4.34	−32.48	−32.48	0.00	0.00	0.00	0.00	1
24 Sector Equity Ecology	−7.80	−7.80	−33.96	−33.96	5.31	5.31	0.00	0.00	1
25 U.S. Large-Cap Blend Equity	−26.24	−26.24	−23.64	−23.64	0.00	0.00	0.00	0.00	1
26 Europe Large-Cap Growth Equity	−6.64	−6.64	−29.07	−29.07	0.56	0.56	0.00	0.00	1
27 Japan Large-Cap Equity	−14.35	−21.80	−4.98	−16.93	0.27	0.04	0.00	−0.04	6
28 TWD Cautious Balanced	5.48	−5.77	4.88	−7.83	3.09	0.69	5.39	−0.21	10
29 Asia–Pacific ex-Japan Equity	−4.28	−15.82	−12.50	−18.64	15.47	6.03	3.39	−0.27	7
30 Target Date 2015+	−2.28	−7.85	5.24	−4.47	0.69	0.41	4.41	−0.34	3
31 Global Large-Cap Blend Equity	−3.30	−13.71	11.32	−11.12	9.34	2.26	6.87	−0.57	7
32 Sector Equity Real Estate Indirect – Asia	−26.59	−32.06	−18.68	−26.55	10.47	4.00	0.00	−1.00	5
33 Sector Equity Communications	−18.24	−19.21	−15.33	−15.43	1.72	0.86	0.00	−1.28	2
34 Latin America Equity	−3.59	−3.59	−26.04	−26.04	4.87	4.87	0.00	−1.39	1
35 European Bond	−2.05	−2.61	2.80	2.26	0.00	0.00	0.00	−1.40	2
36 Sector Equity Consumer Goods and Services	−23.77	−24.20	−10.48	−16.24	0.00	0.00	0.00	−1.54	3
37 Emerging Markets Equity	5.16	−4.04	−11.81	−22.79	9.72	5.86	8.05	−1.64	6
38 BRIC Equity	5.23	5.23	−28.70	−28.70	13.59	13.59	0.00	−1.75	1
39 Asia Balanced	8.54	−6.61	−4.53	−11.30	6.28	1.59	0.39	−1.92	5
40 Global Large-Cap Growth Equity	7.06	−14.93	−15.29	−17.52	5.95	3.48	0.38	−1.93	3
41 TWD Money Market	−1.69	−1.69	−1.13	−1.13	0.00	0.00	0.00	−2.21	1
42 Sector Equity Health Care	−10.80	−12.46	−11.41	−13.72	0.00	0.00	0.00	−2.91	2
43 Dollar Aggressive Balanced	−11.92	−13.16	−19.41	−22.99	0.00	0.00	0.00	−4.62	2
44 Global Equity Small/Mid Cap	−15.69	−15.69	−21.08	−21.08	4.22	4.22	−5.44	−6.14	1
45 Canada Equity	−10.91	−10.91	−10.84	−10.84	0.00	0.00	−5.95	−6.49	1
46 Sector Equity Biotechnology	−8.41	−12.62	−4.87	−9.54	0.00	0.00	0.00	−7.61	3

avoid the financial turmoil or turbulence, and reduce the investment loss in recent 10 years. We use one year historical data for training and use the next year historical data for testing. For example, we use historical data of the fund from July 2, 1998 to July 2, 1999 for training and use historical data from July 3, 1999 to July 3, 2000 for testing.

Table 9
Results comparison for the *ROIs* of the original and MMAPSO of fund groups in recent 10 years.

Training period		Testing period		$ROI_{oTraining}$ (%)	$ROI_{oTesting}$ (%)	$ROI_{mTraining}$ (%)	$ROI_{mTesting}$ (%)
July 2, 1998	July 2, 1999	July 3, 1999	July 3, 2000	14.51	13.22	46.49	12.88
July 2, 1999	July 3, 2000	July 4, 2000	July 2, 2001	13.18	−26.01	40.31	6.18
July 3, 2000	July 2, 2001	July 3, 2001	July 1, 2002	−27.17	−2.02	20.50	25.16
July 2, 2001	July 1, 2002	July 2, 2002	July 1, 2003	−3.00	0.36	50.27	24.16
July 1, 2002	July 1, 2003	July 2, 2003	July 1, 2004	0.17	11.93	40.24	25.25
July 1, 2003	July 1, 2004	July 2, 2004	July 1, 2005	13.33	8.19	50.32	22.68
July 1, 2004	July 1, 2005	July 2, 2005	July 3, 2006	7.27	18.77	33.53	12.24
July 1, 2005	July 3, 2006	July 4, 2006	July 2, 2007	19.60	32.85	26.90	−0.61
July 3, 2006	July 2, 2007	July 3, 2007	July 2, 2008	33.46	−20.72	10.90	−8.87
July 2, 2007	July 2, 2008	July 3, 2008	July 1, 2009	−19.87	−7.95	1.67	3.82
Total				51.48	28.63	321.14	122.87
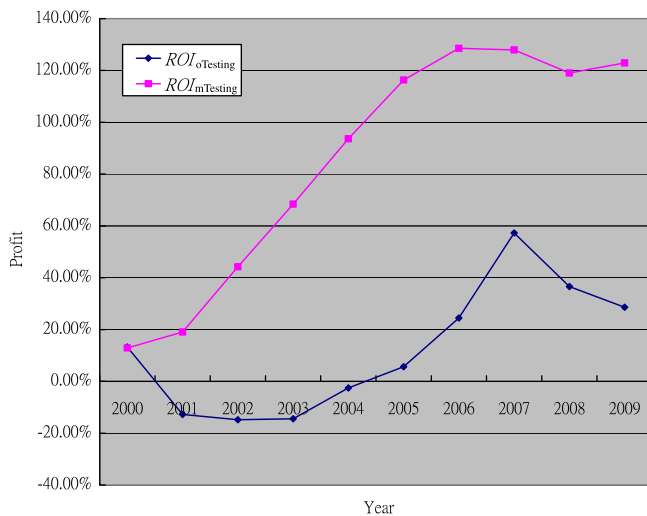
Fig. 7. Profit curve of the *ROIs* of the original and MMAPSO for the fund groups in recent 10 years.

In this experiment, we ran and averaged the MMAPSO algorithm for 10 times. The *ROIs* of the original and MMAPSO for the fund in recent 10 years are shown in Table 9. In Table 9, the performance of each fund on average has been improved more than the original about 94.25% in testing phase. Profit curve of the *ROIs* of the original and MMAPSO for the fund in recent 10 years is shown in Fig. 7. As shown in Fig. 7, the *ROI* of the original could lead to possible flattening or even slump of profit curve, and the proposed method could improve profitability and reduce losses quite a much.

6. Conclusions

In this paper, we proposed a mixed moving averages and turbulent particle swarm optimization algorithm (named MMAPSO) for mutual fund trading based on particle swarm optimization. The proposed method consists of multiple moving averages and turbulent strategy for improving trading profit. We used the MMAPSO technique to adjust the intervals of multiple moving averages to fit the fund characteristics. Then the trading model could avoid and reduce loss by providing good buy and sell points. In the experiment, we tested the proposed model to see if it can escape the 2008 financial crisis triggered by U.S. subprime crisis and avoid the financial turmoil or turbulence in recent 10 years. The experimental results show that the MMAPSO model can achieve high profit and reduce risk when considering the transaction fee.

Appendix A

Fund name	Fund group	$ROI_{oTraining}$ (%)	$ROI_{oTesting}$ (%)	$ROI_{mTraining}$ (%)	$ROI_{mTesting}$ maximum (%)	$ROI_{mTesting}$ average (%)
TIIM Concept	Taiwan Large-Cap Equity	−30.63	17.32	0.00	31.27	31.27
ING Taiwan Growth	Taiwan Small/Mid-Cap Equity	−14.72	0.76	0.00	24.51	22.06
Jih Sun Jih Sun	Taiwan Large-Cap Equity	−28.50	12.23	0.63	20.13	20.13
ING Taiwan Aggressive Growth Selec	Taiwan Small/Mid-Cap Equity	−15.91	−0.39	0.00	23.29	18.91
Jih Sun High Tech	Sector Equity Technology	−30.40	2.79	0.00	18.83	18.83
Capital OTC	Taiwan Small/Mid-Cap Equity	−31.46	2.77	0.36	20.22	18.20
Yuanta OTC Equity Fund	Taiwan Small/Mid-Cap Equity	−42.85	−4.16	0.02	17.51	17.51
Reliance Digital	Sector Equity Technology	−29.22	−0.28	0.00	16.26	16.26
Fubon Elite Fund	Taiwan Small/Mid-Cap Equity	−35.89	−1.31	2.90	15.82	15.82

Appendix A (*continued*)

Fund name	Fund group	$ROI_{oTraining}$ (%)	$ROI_{oTesting}$ (%)	$ROI_{mTraining}$ (%)	$ROI_{mTesting}$ maximum (%)	$ROI_{mTesting}$ average (%)
INVESCO Mainstream Equity Fund	Taiwan Small/Mid-Cap Equity	−20.32	−0.20	0.00	15.07	15.07
Yuanta Duo Duo Equity Fund	Taiwan Small/Mid-Cap Equity	−35.52	4.72	0.00	14.94	14.94
Yuanta DUO FU EQUITY FUND	Taiwan Small/Mid-Cap Equity	−32.56	4.80	0.00	14.91	14.91
NITC OTC Fund	Taiwan Small/Mid-Cap Equity	−32.46	−3.74	0.00	14.81	14.81
Jih Sun Small Cap	Taiwan Small/Mid-Cap Equity	−34.74	−2.48	0.00	16.51	14.68
PCA OTC	Taiwan Small/Mid-Cap Equity	−37.17	−3.28	0.85	15.39	13.85
IBT 2000 Hi-Tech	Sector Equity Technology	−27.33	2.82	0.00	13.60	13.60
Jih Sun Neo Taiwan Enterprises	Taiwan Small/Mid-Cap Equity	−26.24	−0.13	1.26	13.53	13.53
Yuanta BUFFETT EQUITY FUND	Taiwan Small/Mid-Cap Equity	−22.24	6.00	0.00	13.44	13.44
Cathay Technology	Sector Equity Technology	−21.78	−2.41	0.00	16.08	13.23
TIIM Da Li	Taiwan Small/Mid-Cap Equity	−32.07	0.39	0.00	16.19	12.95
JF (TW) New Technology	Sector Equity Technology	−28.55	3.56	0.00	12.72	12.72
ING Taiwan Superior Equity	Taiwan Small/Mid-Cap Equity	−14.87	−3.34	0.00	12.68	12.68
ING Taiwan Growth Selection	Taiwan Small/Mid-Cap Equity	−13.69	−3.62	1.16	14.04	12.64
Fuh Hwa Digital Economy	Sector Equity Technology	−17.44	−2.95	0.00	12.37	12.37
Cathay Dragon Fund	Taiwan Small/Mid-Cap Equity	−19.26	−1.31	0.00	11.86	11.86
Yuanta DUO YUAN EQUITY FUND	Taiwan Small/Mid-Cap Equity	−25.65	10.36	4.62	13.16	11.85
Fuh Hwa High Growth	Taiwan Small/Mid-Cap Equity	−19.47	−3.52	0.00	11.84	11.84
Manulife Fund	Taiwan Small/Mid-Cap Equity	−27.04	−1.51	0.00	11.70	11.70
MEGA TOP20 FUND	Taiwan Small/Mid-Cap Equity	−34.82	3.10	1.22	11.70	11.70
TIIM OTC	Taiwan Small/Mid-Cap Equity	−32.51	−3.01	0.00	11.52	11.48
Fubon Taiwan Heart	Taiwan Small/Mid-Cap Equity	−30.43	−5.35	0.00	11.26	11.26
MEGA FIRST	Taiwan Small/Mid-Cap Equity	−41.52	0.71	0.00	11.16	11.16
MEGA BALANCED FUND	TWD Aggressive Balanced	−13.49	4.92	0.00	11.09	11.09
Capital Strategin Growth	Taiwan Small/Mid-Cap Equity	−22.23	−13.99	1.17	10.87	10.87
SinoPac Hi Tech	Sector Equity Technology	−24.11	−9.89	0.00	10.86	10.86
SinoPac Pilot Fund	Sector Equity Technology	−26.90	−10.24	0.00	10.61	10.61
JF (TW) Taiwan Fund	Taiwan Large-Cap Equity	−34.95	3.28	2.20	10.34	10.34
Manulife II Fund	Taiwan Small/Mid-Cap Equity	−21.43	−2.24	0.00	11.22	10.10
Yuanta Intl Trd Eq	Taiwan Small/Mid-Cap Equity	−24.78	−0.81	1.76	11.18	10.06
Cathay Greater China	Greater China Equity	−15.59	−10.42	0.00	11.18	10.06
Allianz Glb Investors Taiwan Tech	Sector Equity Technology	−28.30	−0.46	0.00	9.81	9.81
JF (TW) Growth	Taiwan Large-Cap Equity	−20.85	2.98	1.75	10.49	9.75
INVESCO Capital Appreciation	Taiwan Small/Mid-Cap Equity	−12.28	−9.47	2.13	14.83	9.39
HSBC Taiwan Blue Chips	Taiwan Large-Cap Equity	−8.73	−3.62	2.10	10.38	9.34
Fubon Precision	Taiwan Small/Mid-Cap	−31.05	−12.13	0.00	9.31	9.31

Appendix A (*continued*)

Fund name	Fund group	$ROI_{oTraining}$ (%)	$ROI_{oTesting}$ (%)	$ROI_{mTraining}$ (%)	$ROI_{mTesting}$ maximum (%)	$ROI_{mTesting}$ average (%)
	Equity					
Yuanta MAINSTREAM EQUITY FUND	Taiwan Small/Mid-Cap Equity	−33.24	−0.13	0.00	10.30	9.27
Yuanta Win–Win BALANCED FUND	TWD Aggressive Balanced	−20.12	10.01	0.00	9.26	9.26
NITC High-Tech	Taiwan Small/Mid-Cap Equity	−27.08	−5.22	1.07	11.03	9.25
IBT New Taiwan Equity Fund	Taiwan Small/Mid-Cap Equity	−15.29	4.68	5.20	10.05	9.05
Jih Sun Top Five	Taiwan Small/Mid-Cap Equity	−25.45	−2.48	0.00	8.50	8.50
Capital Strategin Alpha	Taiwan Small/Mid-Cap Equity	−19.36	−5.76	0.00	8.49	8.49
Cathay Small	Taiwan Small/Mid-Cap Equity	−20.30	−9.86	0.00	8.31	8.31
ShinKong OTC	Taiwan Small/Mid-Cap Equity	−45.78	−16.42	0.00	9.18	8.26
NITC Flagship Fund	Taiwan Large-Cap Equity	−28.70	−6.26	0.07	8.18	8.18
Fubon Supreme	Taiwan Small/Mid-Cap Equity	−19.84	−13.22	0.00	7.53	7.53
Prudential Financial OTC	Taiwan Small/Mid-Cap Equity	−36.33	−9.76	0.00	8.34	7.50
ING Taiwan China Focus	Taiwan Small/Mid-Cap Equity	−6.83	−16.44	8.65	7.47	7.47
Fuh Hwa Global Fixed Inc FOFs	Dollar Global Bond	−4.03	13.97	9.25	10.43	7.44
President All Weather	Taiwan Small/Mid-Cap Equity	−39.24	−7.04	0.29	8.24	7.42
NITC Fuyuan	Taiwan Small/Mid-Cap Equity	−42.36	−5.99	0.00	7.40	7.40
Polaris Global Emerging Market	Emerging Markets Equity	−10.29	−11.81	7.37	8.05	7.24
Capital Small and Medium Cap.	Taiwan Small/Mid-Cap Equity	−29.39	−9.87	0.61	6.58	6.58
Truswell IC	Sector Equity Technology	−24.12	−11.98	0.00	6.52	6.52
JF (TW) Micro	Taiwan Small/Mid-Cap Equity	−11.26	−4.47	0.00	13.00	6.48
UNION Knowledge Industry	Taiwan Small/Mid-Cap Equity	−37.04	0.00	0.75	7.11	6.40
Deutsche Far Eastern DWS Technology	Sector Equity Technology	−27.67	−5.85	0.00	6.70	6.03
Fubon Taiwan Phoenix	Taiwan Small/Mid-Cap Equity	−33.34	−14.38	2.12	5.95	5.95
ING Singapore	Other Asia–Pacific Equity	−19.23	−8.20	8.92	5.70	5.70
UNION China	Greater China Equity	−33.46	−1.72	0.00	5.65	5.65
Franklin Temp First TW First	Taiwan Small/Mid-Cap Equity	−25.43	−10.71	1.06	6.21	5.59
UNION Technology	Sector Equity Technology	−28.96	−0.18	0.00	6.47	5.33
Cathay Assets Allct Neutral	TWD Aggressive Balanced	−5.21	0.97	2.12	5.47	5.33
Cathay Superior Balanced	TWD Cautious Balanced	−6.26	1.10	0.75	5.39	5.22
IBT China Fund	Greater China Equity	−4.67	0.62	7.83	17.44	5.19
Truswell Global Balanced	Dollar Moderate Balanced	−19.61	10.39	0.36	6.69	4.94
Hua Nan Glb Sh-Term Fix Inc	Dollar Global Bond	1.73	7.82	10.11	6.10	4.88
President Quality Growth	Taiwan Small/Mid-Cap Equity	−10.56	−10.69	7.15	4.83	4.83
THE RSIT IVY FUND	TWD Aggressive Balanced	−15.83	−0.58	0.00	5.95	4.73
ING Taiwan Small Cap	Taiwan Small/Mid-Cap Equity	−24.41	−8.68	0.00	5.82	4.66
Fuh Hwa Life Goal Balance	TWD Aggressive Balanced	−2.58	9.59	12.17	13.54	4.60
SinoPac Hi ROE	TWD Aggressive Balanced	−1.92	5.81	7.33	13.24	4.58

Appendix A (*continued*)

Fund name	Fund group	$ROI_{oTraining}$ (%)	$ROI_{oTesting}$ (%)	$ROI_{mTraining}$ (%)	$ROI_{mTesting}$ maximum (%)	$ROI_{mTesting}$ average (%)
President Optima	Taiwan Small/Mid-Cap Equity	−19.99	−13.52	0.00	4.52	4.52
Capital Steady Growth	Taiwan Small/Mid-Cap Equity	−27.99	−20.07	0.00	4.33	4.33
NITC Malaysia	Malaysia Equity	−22.39	−5.67	8.46	4.79	4.31
HSBC Pacific Stars	Asia–Pacific with Japan Equity	−14.87	−6.95	3.24	4.28	4.28
NITC Greater China	Greater China Equity	−25.49	−14.69	0.00	4.26	4.26
Polaris Taiwan Mid-Cap 100 Trk	Taiwan Small/Mid-Cap Equity	−23.09	−13.56	0.03	11.67	4.25
Fubon Aggresive Growth	Taiwan Small/Mid-Cap Equity	−28.31	−16.61	0.00	4.21	4.21
Prudential Financial Asia-Pac	Asia–Pacific with Japan Equity	−20.58	−9.99	2.39	4.12	4.12
SinoPac Balance Fund	TWD Aggressive Balanced	−1.58	−11.55	0.00	4.12	4.12
Cathay High Div Balanced	TWD Aggressive Balanced	−4.94	0.42	0.00	4.56	4.11
TIIM Action	Taiwan Small/Mid-Cap Equity	−34.63	−8.14	0.00	5.03	4.02
Capital Stable Value	TWD Aggressive Balanced	−10.67	−2.27	0.94	3.94	3.94
EnTrust Long Win Balance Fund	TWD Aggressive Balanced	−17.60	−5.16	0.31	4.36	3.92
Prudential Financial Maxima	Taiwan Small/Mid-Cap Equity	−27.56	−9.66	0.00	3.74	3.74
Truswell Global Fixed Income FOFs	Dollar Global Bond	−0.81	10.77	8.50	6.05	3.73
ING Taiwan High Tech Selection	Sector Equity Technology	−29.83	−12.91	0.00	4.08	3.67
Polaris Global ETFs	Global Large-Cap Blend Equity	−3.30	11.32	9.34	6.87	3.58
Prudential Financial Balanced	TWD Aggressive Balanced	−5.78	−3.58	0.12	4.43	3.55
Yuanta HI-TECH EQUITY FUND	Sector Equity Technology	−33.00	−7.84	0.00	3.52	3.52
INVESCO Taiwan Select Growth	Taiwan Small/Mid-Cap Equity	−30.77	−13.79	0.00	3.51	3.51
JF (TW) Balanced	TWD Aggressive Balanced	−7.20	−0.38	0.00	3.47	3.47
IBT Ta Chong Equity Fund	Taiwan Small/Mid-Cap Equity	−29.63	−11.54	0.00	3.47	3.47
MEGA NEW EMERGING ENTERPRISE FUND	Taiwan Small/Mid-Cap Equity	−32.19	−15.81	0.00	3.81	3.43
Fuh Hwa Fund	Taiwan Small/Mid-Cap Equity	−20.48	−12.59	0.00	3.41	3.41
Cathay Glb Aggressive FOFs	Dollar Moderate Balanced	−10.93	−6.62	0.55	3.62	3.26
Fuh Hwa Global Bond	Dollar Diversified Bond	1.88	8.16	8.88	4.27	3.21
Yuanta Asia Pacific Growth Fund	Asia–Pacific with Japan Equity	−18.64	−2.68	7.23	3.17	3.17
Cathay Cathay	Taiwan Small/Mid-Cap Equity	−13.40	−9.21	0.81	3.16	3.16
Taishin Taishin Fund	Taiwan Small/Mid-Cap Equity	−42.80	−7.29	1.35	3.51	3.15
Prudential Financial Sm	Taiwan Small/Mid-Cap Equity	−27.93	−11.22	0.00	3.08	3.08
President Asia Pacific	Asia–Pacific with Japan Equity	−19.51	−4.90	5.82	2.89	2.89
Allianz Glb Inv Target 2020	Target Date 2015+	−7.13	−5.07	0.69	3.19	2.87
Prudential Fin Glb Fix In Sel	Dollar Global Bond	−4.50	8.16	5.04	3.71	2.86
ING Asia Pacific High Dividend Fund	Asia–Pacific ex-Japan Equity	−22.95	−12.97	4.77	2.85	2.85
Hua Nan Global Henry	Dollar Global Bond	−1.32	5.34	6.75	4.77	2.84
TIIM Prime-Balance	TWD Aggressive Balanced	−23.22	−6.44	0.00	3.09	2.79

Appendix A (*continued*)

Fund name	Fund group	$ROI_{oTraining}$ (%)	$ROI_{oTesting}$ (%)	$ROI_{mTraining}$ (%)	$ROI_{mTesting}$ maximum (%)	$ROI_{mTesting}$ average (%)
Prudential Financial High Tech	Sector Equity Technology	−32.49	−13.49	0.00	2.74	2.74
Franklin Templeton Global Equity	Global Large-Cap Value Equity	−22.67	−9.62	0.00	4.48	2.69
INVESCO Balance Fund	TWD Aggressive Balanced	−18.25	−6.49	0.82	5.07	2.66
Prudential Financial High Gth	Taiwan Small/Mid-Cap Equity	−20.74	−14.91	0.00	2.59	2.59
AIG Giant	Taiwan Large-Cap Equity	−19.85	−15.87	0.00	2.52	2.52
President Long Ma	Taiwan Small/Mid-Cap Equity	−31.44	−12.60	2.99	3.49	2.49
Fubon Internet	Taiwan Small/Mid-Cap Equity	−17.65	−10.73	0.00	2.44	2.44
Fubon Technology	Sector Equity Technology	−19.62	−7.58	0.00	2.43	2.43
Capital Multi-Income Alloc	Dollar Global Bond	−5.85	8.35	5.11	4.39	2.39
Capital Marathon	Taiwan Small/Mid-Cap Equity	−28.59	−8.68	0.00	2.63	2.36
JF (TW) Smaller Company	Taiwan Small/Mid-Cap Equity	−36.65	−17.16	0.00	2.35	2.35
Reliance Small	Taiwan Small/Mid-Cap Equity	−27.88	−14.61	0.80	3.32	2.33
Manulife Classical Fund	TWD Aggressive Balanced	−12.72	−1.98	0.00	4.26	2.27
NITC Greater China Balanced	TWD Aggressive Balanced	−12.06	−4.78	0.00	2.27	2.27
Polaris Fu-Li Strategic Inc	Taiwan Bond	0.84	3.26	3.31	2.27	2.27
ING Global Bond Port	Dollar Global Bond	−2.80	7.37	4.63	4.12	2.26
Fubon Fubon Fund	Taiwan Small/Mid-Cap Equity	−36.54	−14.67	0.00	3.20	2.16
Polaris 2001	Taiwan Small/Mid-Cap Equity	−17.02	−1.45	0.00	2.11	2.11
Polaris TW Wthg Index	Taiwan Large-Cap Equity	−17.59	−12.71	0.00	2.27	2.04
KGI Pan-Asia Taiwan Enterprises Fun	Asia–Pacific ex-Japan Equity	−28.68	−17.76	0.32	3.39	2.04
ING Taiwan High Dividend	Taiwan Small/Mid-Cap Equity	8.98	−3.27	15.87	9.73	2.04
Polaris Silicon	Sector Equity Technology	−30.13	−5.52	0.00	1.99	1.99
President Infrastructure	Sector Equity Infrastructure	−12.57	−15.15	2.66	1.97	1.97
Capital High Tech	Sector Equity Technology	−40.38	−10.99	0.00	1.97	1.97
ING Taiwan Balanced	TWD Aggressive Balanced	−0.57	10.47	12.49	19.24	1.93
UNION Yo-Li Bond	Taiwan Bond	−2.25	8.05	4.23	4.57	1.92
Jih Sun Mortgage Bk Securities	Dollar Diversified Bond	−6.10	9.50	2.67	2.78	1.90
HSBC Taiwan Success	Taiwan Large-Cap Equity	−16.44	−6.23	0.00	1.88	1.88
Paradigm Small Capital Fund	Taiwan Small/Mid-Cap Equity	−46.77	−21.85	0.00	2.02	1.82
Franklin Templeton Glb Bd FOFs-A-ACC	Dollar Global Bond	−3.89	6.75	4.35	5.39	1.73
Polaris High-Performance	Taiwan Small/Mid-Cap Equity	−39.95	−11.82	1.03	1.91	1.72
Cathay Glb Balance FOFs	Dollar Moderate Balanced	−13.58	−3.17	0.38	1.67	1.67
ShinKong National Dev	Taiwan Small/Mid-Cap Equity	−41.21	−15.73	0.00	4.19	1.65
Taishin Mainstream	Taiwan Small/Mid-Cap Equity	−32.54	−11.03	0.27	4.04	1.62
Truswell Stable Growth	TWD Aggressive Balanced	−10.31	−2.00	0.00	2.18	1.61
ING Taiwan High Tech	Sector Equity Technology	−24.55	−11.10	0.00	1.77	1.59
Fubon Champion	Taiwan Small/Mid-Cap Equity	−32.90	−13.03	0.68	4.04	1.55
AIG US Dual Core Inc-A-ACC	Dollar Global Bond	−0.50	11.46	7.16	5.24	1.54
Franklin Templeton Glb Bd FOFs-B-INC	Dollar Global Bond	−7.54	3.10	0.00	2.15	1.50
ShinKong Great China	Taiwan Small/Mid-Cap	−34.26	−15.60	0.00	1.67	1.50

Appendix A (*continued*)

Fund name	Fund group	$ROI_{oTraining}$ (%)	$ROI_{oTesting}$ (%)	$ROI_{mTraining}$ (%)	$ROI_{mTesting}$ maximum (%)	$ROI_{mTesting}$ average (%)
	Equity					
UPAMC GREAT CHINA Fund	Greater China Equity	−2.59	−4.12	0.13	4.90	1.47
ING Taiwan Dynmc Bal Asset Alloc	TWD Aggressive Balanced	−6.53	−4.67	0.00	2.54	1.46
Cathay Glb Conservative FOF	Dollar Diversified Bond	−6.21	6.13	0.11	1.45	1.45
Prudential Financial N Century	Taiwan Small/Mid-Cap Equity	−32.37	−13.99	0.00	1.44	1.44
ShinKong Yuan Hwa	Taiwan Small/Mid-Cap Equity	−21.00	−18.25	0.00	1.70	1.36
PCA Global Bond Fund of Fund	Dollar Diversified Bond	−2.57	4.45	2.76	2.72	1.34
UNION Bond	Taiwan Bond	1.63	1.17	2.84	1.18	1.18
Fuh Hwa You Li	Taiwan Bond	1.71	1.17	2.91	1.17	1.17
ShinKong Innovative Tech	Sector Equity Technology	−39.96	−9.91	0.00	1.28	1.16
Cathay Bond	Taiwan Bond	1.61	1.14	2.77	1.14	1.14
PCA Balanced	TWD Aggressive Balanced	−5.59	−8.88	0.00	1.12	1.12
Prudential Financial Em Mkt Select	Emerging Markets Equity	−7.64	−20.43	9.72	1.23	1.11
Central Diamond Bond	Taiwan Bond	1.66	1.09	2.78	1.09	1.09
Jih Sun Bond	Taiwan Bond	1.52	1.08	2.63	1.09	1.09
ShinKong Fu Kuei	Taiwan Small/Mid-Cap Equity	−47.13	−19.76	0.08	1.09	1.09
TIIM Bond	Taiwan Bond	0.64	1.09	1.74	1.09	1.09
Prudential Financial Return	Taiwan Bond	1.34	2.09	2.61	1.08	1.08
Ontario Fortune Fund	Taiwan Bond	1.03	1.08	2.13	1.08	1.08
PCA WELL POOL FUND	Taiwan Bond	1.73	1.08	2.82	1.08	1.08
Fuh Hwa Asia Pacific Equity Fd	Asia–Pacific with Japan Equity	−14.26	−10.58	4.29	1.78	1.07
Prudential Financial Bond	Taiwan Bond	1.62	1.04	2.68	1.04	1.04
Hua Nan Kirin Bond	Taiwan Bond	1.66	1.04	2.72	1.04	1.04
NITC Taiwan Bond	Taiwan Bond	1.68	1.03	2.74	1.04	1.04
Taishin Lucky Fund	Taiwan Bond	1.68	1.04	2.74	1.04	1.04
EnTrust Phoenix Bond Fund	Taiwan Bond	1.68	1.03	2.73	1.03	1.03
NITC Bond	Taiwan Bond	1.65	1.02	2.69	1.03	1.03
Fuh Hwa Bond	Taiwan Bond	1.70	1.00	2.73	1.00	1.00
Taishin Global ETFs Fund	Dollar Moderate Balanced	−8.54	−4.29	6.08	1.00	1.00
ING Taiwan Select Bond	Taiwan Bond	1.64	1.00	2.65	1.00	1.00
Paradigm Ping An Fund	Taiwan Bond	1.40	1.00	2.42	1.00	1.00
KGI Victory	Taiwan Bond	1.37	0.99	2.38	0.99	0.99
TLAM B.B.Bond Fd	Taiwan Bond	1.55	0.98	2.56	0.98	0.98
Capital Safe Income	Taiwan Bond	1.65	0.98	2.65	0.98	0.98
Polaris De Li	Taiwan Bond	1.75	0.98	2.75	0.98	0.98
ShinKong Chi Shin	Taiwan Bond	1.59	0.97	2.58	0.97	0.97
Deutsche Far Eastern DWS TW Bond	Taiwan Bond	1.63	0.96	2.61	0.97	0.97
ING Taiwan Income	Taiwan Bond	1.68	0.97	2.67	0.97	0.97
Manulife Wan Li Bond Fund	Taiwan Bond	1.64	0.96	2.62	0.96	0.96
ING Taiwan Bond	Taiwan Bond	1.68	0.95	2.65	0.95	0.95
Schroder NEW ERA Bd	Taiwan Bond	1.64	0.94	2.59	0.94	0.94
ShinKong High Yield	Taiwan Bond	1.61	0.93	2.57	0.93	0.93
Allianz Global Investors Taiwan Bd	Taiwan Bond	1.62	0.91	2.56	0.92	0.92
Fubon Chi-Hsiang Fund	Taiwan Bond	1.35	0.91	2.29	0.92	0.92
TLAM Solomon Bond Fd	Taiwan Bond	1.61	1.01	2.64	1.01	0.91
AIG Bond	Taiwan Bond	1.53	0.90	2.44	0.90	0.90
HSBC NTD Money Management	Taiwan Bond	1.64	0.90	2.55	0.90	0.90
NITC Taiwan Fortune	Taiwan Small/Mid-Cap Equity	−33.33	−22.17	0.00	1.05	0.84
HSBC NTD Money	Taiwan Bond	1.65	0.83	2.51	0.84	0.84

Appendix A (*continued*)

Fund name	Fund group	$ROI_{oTraining}$ (%)	$ROI_{oTesting}$ (%)	$ROI_{mTraining}$ (%)	$ROI_{mTesting}$ maximum (%)	$ROI_{mTesting}$ average (%)
Management II						
SinoPac Bond	Taiwan Bond	1.41	0.82	2.25	0.82	0.82
Prudential Financial JapanKorea	Asia–Pacific with Japan Equity	−24.18	−15.69	0.45	0.82	0.82
INVESCO R.O.C. Bond Fund	Taiwan Bond	1.56	0.80	2.38	0.80	0.80
Taishin Hi Divid Yld Balanced	TWD Aggressive Balanced	−14.07	−0.22	0.00	0.80	0.80
PCA India Equity	India Equity	−18.52	6.95	4.56	4.81	0.79
Fuh Hwa Global Balanced	Dollar Moderate Balanced	−5.70	2.25	1.92	0.76	0.76
Schroder Glb Bd FoF	Dollar Global Bond	−3.20	4.90	1.21	1.12	0.73
Allianz Glb Inv Target 2015	Target Date 2015+	−2.28	5.24	0.53	4.41	0.70
Fidelity Taiwan Growth	Taiwan Large-Cap Equity	−5.68	−11.05	6.37	0.67	0.67
Polaris Small-Medium Fund	Taiwan Small/Mid-Cap Equity	−27.63	−17.65	0.00	0.73	0.66
Paradigm Technology	Sector Equity Technology	−25.20	−16.19	0.00	0.65	0.65
AIG Flagship Glb Bal FOF	Dollar Moderate Balanced	−8.57	−6.83	1.07	0.65	0.65
SinoPac Glb Bal FOFs	Dollar Cautious Balanced	−18.67	−2.10	1.13	0.62	0.62
NITC Global Taiwan Enterprise	Taiwan Large-Cap Equity	−26.47	−12.96	0.96	0.62	0.62
President Pentium	Taiwan Small/Mid-Cap Equity	−18.84	−13.56	3.47	0.59	0.59
JF (TW) Asia	Asia–Pacific ex-Japan Equity	−13.17	−14.28	15.47	3.15	0.55
Prudential Fin Glb Bal Selec	TWD Cautious Balanced	−8.14	−3.21	0.00	0.52	0.52
HSBC Taiwan Growth	Taiwan Small/Mid-Cap Equity	−21.20	−14.78	0.00	0.49	0.49
Fidelity Taiwan Balance FOFs	Dollar Moderate Balanced	−9.00	−11.01	1.74	0.59	0.47
NITC Small Cap	Taiwan Small/Mid-Cap Equity	−30.02	−20.06	0.00	0.47	0.43
INVESCO Taiwan Technology Fund	Sector Equity Technology	−31.12	−14.70	0.00	0.52	0.42
MEGA GLOBAL FUND	Global Large-Cap Growth Equity	7.06	−15.30	4.48	0.38	0.38
ING Global Balanced	Dollar Cautious Balanced	−1.13	4.75	4.39	3.21	0.37
IBT 1699 Bond	Taiwan Bond	1.67	1.35	2.04	0.36	0.36
PCA Essence	Taiwan Small/Mid-Cap Equity	−30.48	−15.42	0.20	0.34	0.34
JF (Taiwan) Pacific Balanced	Asia Balanced	−10.36	−4.53	0.00	0.27	0.27
Truswell Bond	Taiwan Bond	0.48	0.27	0.75	0.27	0.27
Capital Asset Manager Income	TWD Aggressive Balanced	−3.87	−9.38	0.00	0.64	0.26
Paradigm Global Portfolio Fund	Dollar Moderate Balanced	−14.49	10.31	0.00	3.26	0.26
Fubon Value	Taiwan Small/Mid-Cap Equity	−14.55	−13.55	2.86	2.47	0.26
PCA High Tech	Taiwan Small/Mid-Cap Equity	−30.71	−14.94	0.00	0.24	0.16
Fuh Hwa Olympic Global	TWD Cautious Balanced	−3.09	4.88	3.09	2.55	0.14
JPMF (TW) Global Balanced	Dollar Cautious Balanced	1.38	1.87	4.05	1.17	0.12
Truswell Hua-Win Bond	Taiwan Bond	0.27	0.08	0.36	0.08	0.08
THE FOREVER FUND	Taiwan Bond	1.29	1.08	1.38	0.08	0.08
HSBC Taiwan Safe and Rich	TWD Aggressive Balanced	−11.54	−7.40	3.82	0.06	0.06
President James Bond	Taiwan Bond	1.69	1.06	1.76	0.06	0.06
AIG Flagship Glb Conserv FOFs	Dollar Diversified Bond	−0.38	−1.04	0.00	0.04	0.04
Yuanta Global Asset Sec Bal Inc-ACC	Dollar Diversified Bond	−2.98	7.74	3.01	1.64	0.03
TLAM Apollo Fd	Taiwan Small/Mid-Cap Equity	−31.74	−10.79	0.00	0.01	0.01
Fubon Fu Bao	TWD Aggressive Balanced	−11.93	−19.60	0.00	0.00	0.00
HSBC New Japan FOFs	Japan Large-Cap Equity	−23.01	−11.31	0.27	0.00	0.00
SinoPac Strategic Alloc	TWD Aggressive Balanced	−12.25	−7.71	0.00	0.00	0.00

Appendix A (*continued*)

Fund name	Fund group	$ROI_{oTraining}$ (%)	$ROI_{oTesting}$ (%)	$ROI_{mTraining}$ (%)	$ROI_{mTesting}$ maximum (%)	$ROI_{mTesting}$ average (%)
Balanc						
PCA Quality-Quantity	TWD Cautious Balanced	−10.30	−6.40	0.03	0.00	0.00
PCA European	Europe Large-Cap Blend Equity	−16.25	−29.84	5.57	0.00	0.00
Allianz Glb inv Glb Eco Trends	Sector Equity Ecology	−7.80	−33.96	5.31	0.00	0.00
HSBC European Star FOF	Europe Large-Cap Blend Equity	−17.25	−21.81	6.03	0.00	0.00
HSBC Trinity Balanced	TWD Aggressive Balanced	−1.82	−7.57	0.00	0.00	0.00
TIIM Asian Real Estate Div-A-ACC	Sector Equity Real Estate Indirect - Asia	−26.59	−24.29	9.36	0.00	0.00
Jih Sun Upstream	Taiwan Small/Mid-Cap Equity	−19.70	−26.08	0.00	0.00	0.00
Primasia Asia Pioneer Fund	Asia–Pacific ex-Japan Equity	−12.18	−31.09	0.00	0.00	0.00
Fubon Global REIT	Sector Equity Real Estate Indirect	−30.90	−34.14	0.00	0.00	0.00
Yuanta GLOBAL GROWTH EQUITY FUND	Global Large-Cap Growth Equity	−20.89	−21.97	5.95	0.00	0.00
Yuanta Global Realty	Sector Equity Infrastructure	−26.73	−11.50	0.00	0.00	0.00
PCA Balance III	TWD Cautious Balanced	−7.58	−19.74	0.00	0.00	0.00
PCA Balance II	TWD Aggressive Balanced	−6.02	−18.24	0.00	0.00	0.00
PCA ASIA PACIFIC REITs-A	Sector Equity Real Estate Indirect - Asia	−32.02	−29.65	0.00	0.00	0.00
PCA ASIA PACIFIC REITs-B	Sector Equity Real Estate Indirect - Asia	−33.36	−29.71	0.00	0.00	0.00
Yuanta European Growth Fund	Europe Large-Cap Growth Equity	−6.64	−29.07	0.56	0.00	0.00
PCA US Hi-Tech	Sector Equity Technology	−23.21	−14.01	1.65	0.00	0.00
ING Global REITs	Sector Equity Real Estate Indirect	−24.33	−25.13	0.31	0.00	0.00
Yuanta GLOBAL ASSET ALLOCATION FUND	TWD Cautious Balanced	−4.54	−7.76	2.47	0.00	0.00
HSBC Glb Themes FoFs	Global Large-Cap Blend Equity	−13.37	−15.00	0.00	0.00	0.00
SinoPac World Bd Selection	Dollar Global Bond	−1.21	−7.29	0.00	0.00	0.00
ING Japan	Japan Large-Cap Equity	−22.53	−24.40	0.00	0.00	0.00
ING Global Biotech	Sector Equity Biotechnology	−20.85	−4.87	0.00	0.00	0.00
Yuanta GLOBAL TELECOMMUNICATION FUN	Sector Equity Communications	−20.18	−15.33	1.72	0.00	0.00
TLAM Global Selection Fund	TWD Cautious Balanced	−8.72	−13.08	0.00	0.00	0.00
Allianz Glb Inv Glb Div Quan Fund	Dollar Moderate Balanced	−8.32	−7.78	0.00	0.00	0.00
Primasia Money Market Fund	Taiwan Bond	1.27	0.40	0.00	0.00	0.00
ING Europe High Dividend	Europe Large-Cap Value Equity	−22.35	−21.73	0.08	0.00	0.00
Yuanta Global Realty	Sector Equity Infrastructure	−28.76	−14.25	0.00	0.00	0.00
Capital Global REIT Balanced-A	Sector Equity Real Estate Indirect	−32.14	−24.52	−1.48	0.00	0.00
Hua Nan Global Luxury Goods	Sector Equity Consumer Goods and Services	−23.77	−20.63	0.00	0.00	0.00
Hua Nan Glb Infrast-A-ACC	Sector Equity Infrastructure	−8.04	−23.95	0.00	0.00	0.00
JF (TW) Japan New Generation	Japan Large-Cap Equity	−26.18	−22.99	0.00	0.00	0.00
Hua Nan Glb Infrast-B-INC	Sector Equity Infrastructure	−9.97	−25.62	0.82	0.00	0.00
NITC Europe Dynamic Blanced	Euro Moderate Balanced	−7.87	−12.88	0.00	0.00	0.00
JF (Taiwan) Japan Brilliance	Japan Large-Cap Equity	−19.73	−4.98	0.00	0.00	0.00
UBS Asian Real Estate Securities Fd	Sector Equity Real Estate Indirect – Asia	−36.57	−18.68	0.19	0.00	0.00

Appendix A (*continued*)

Fund name	Fund group	$ROI_{oTraining}$ (%)	$ROI_{oTesting}$ (%)	$ROI_{mTraining}$ (%)	$ROI_{mTesting}$ maximum (%)	$ROI_{mTesting}$ average (%)
SKIT STRATEGY BAL FUND Series 2	Dollar Government Bond	−8.95	−7.28	0.00	0.00	0.00
SKIT Strategy Balanced Fund	TWD Cautious Balanced	−9.41	−4.90	0.00	0.00	0.00
Capital Global REIT Balanced-B	Sector Equity Real Estate Indirect	−33.03	−26.79	−1.83	0.00	0.00
ING Global Equity	Global Large-Cap Value Equity	−22.73	−18.17	2.10	0.00	0.00
Deutsche Far Eastern Glb Mat	Sector Equity Natural Resources	16.44	−33.56	18.42	0.00	0.00
Fidelity Excnt Navig Glb FOFs	TWD Aggressive Balanced	−19.64	−29.70	11.31	0.00	0.00
Paradigm Glb Resources Hi Yld	Sector Equity Energy	−4.34	−32.48	0.00	0.00	0.00
ShinKong Japan Active	Japan Large-Cap Equity	−14.35	−26.65	0.00	0.00	0.00
INVESCO Glb Health Sciences	Sector Equity Health Care	−10.80	−11.41	0.00	0.00	0.00
Polaris Global REITs-B	Sector Equity Real Estate Indirect	−33.55	−32.61	0.00	0.00	0.00
NITC Global REITs Fund-B-INC	Sector Equity Real Estate Indirect	−38.96	−26.16	−14.25	0.00	0.00
Polaris Global REITs-A-Acc	Sector Equity Real Estate Indirect	−30.45	−28.93	0.00	0.00	0.00
NITC Global REITs Fund-A-ACC	Sector Equity Real Estate Indirect	−37.38	−22.88	−7.97	0.00	0.00
Cathay Global Infrastructure Fund	Sector Equity Infrastructure	−17.82	−18.91	0.00	0.00	0.00
JPMF (TW) Greater Europe	Europe Large-Cap Blend Equity	−16.52	−29.30	1.90	0.00	0.00
JPMF (TW) Global Dynamic	Global Large-Cap Blend Equity	−20.12	−22.91	2.02	0.00	0.00
ING Global High Dividend	Global Large-Cap Value Equity	−22.25	−19.68	0.06	0.00	0.00
NITC Strategy Balanced Fund	TWD Aggressive Balanced	−1.86	−10.16	0.00	0.00	0.00
JPMF (TW) New America Fund	U.S. Large-Cap Blend Equity	−26.24	−23.64	0.00	0.00	0.00
JF (TW) Wealth Management	Dollar Cautious Balanced	−6.81	−5.79	1.25	0.00	0.00
Yuanta WAN TAI BOND FUND	Taiwan Bond	1.76	1.00	1.76	0.00	0.00
AIG Global Medallion FOFs	TWD Aggressive Balanced	−10.43	−10.93	0.00	−0.03	−0.03
Paradigm Taiwan Fund	Taiwan Large-Cap Equity	−20.32	−20.40	0.00	0.00	−0.04
HSBC Taiwan Phoenix	Taiwan Small/Mid-Cap Equity	−16.82	−11.96	1.11	2.71	−0.07
Fuh Hwa Heirloon Balanced II	TWD Aggressive Balanced	−11.39	−10.22	0.00	1.96	−0.12
UPAMC Glb FI Selection	Dollar Global Bond	−4.06	−2.28	0.00	0.00	−0.15
DAH-FA FUND	Taiwan Small/Mid-Cap Equity	−22.19	−19.85	0.00	−0.15	−0.15
Paradigm Life Style Fund	Sector Equity Consumer Goods and Services	−24.69	−10.48	0.00	0.00	−0.19
Capital Multi-Asset Alloc	TWD Aggressive Balanced	−8.47	−10.31	0.00	−0.23	−0.23
HSBC Global Fd Of Bond Fds	Dollar Global Bond	−0.10	0.37	0.85	−0.24	−0.24
Prudential Financial Jpn Eq	Japan Large-Cap Equity	−24.97	−11.23	0.00	0.00	−0.24
JPM (Taiwan) Eurpean Bond-B-INC	European Bond	−3.18	1.72	0.00	0.00	−0.30
HSBC Taiwan Mid	Taiwan Small/Mid-Cap Equity	−25.13	−18.17	0.12	0.00	−0.34
UPAMC SMALL AND MEDIUM CAP Fund	Taiwan Small/Mid-Cap Equity	−40.40	−17.17	0.00	−0.40	−0.40
Prudential Financial TW Ent	Taiwan Small/Mid-Cap Equity	−29.69	−14.99	0.00	−0.55	−0.55
Shin Kong SKIT ECB Balanced	Asia Balanced	−5.50	−7.56	0.00	0.00	−0.56
IBT Bond	Taiwan Bond	1.74	1.33	1.08	−0.65	−0.65

Appendix A (*continued*)

Fund name	Fund group	$ROI_{oTraining}$ (%)	$ROI_{oTesting}$ (%)	$ROI_{mTraining}$ (%)	$ROI_{mTesting}$ maximum (%)	$ROI_{mTesting}$ average (%)
Capital Asset Allocation	TWD Aggressive Balanced	−5.73	−8.72	0.00	−0.66	−0.66
HSBC Global Balanced Select	Dollar Moderate Balanced	−12.54	−2.65	0.00	−0.72	−0.72
SinoPac Twin-core Global Int Fd	Dollar Moderate Balanced	−7.12	−15.74	1.35	0.00	−0.78
Mega High Tech	Sector Equity Technology	−35.55	−12.92	0.00	0.00	−0.80
THE RSIT ENHANCED BOND	Taiwan Bond	1.65	1.12	0.78	−0.86	−0.86
INVESCO Global Technology Fund	Sector Equity Technology	−27.07	−12.61	2.55	0.00	−0.89
HSBC Taiwan Electronics	Sector Equity Technology	−30.33	−10.67	0.43	−0.94	−0.94
ING Global Balanced Port	Dollar Moderate Balanced	−14.19	−8.90	0.93	−0.95	−0.95
Polaris De-Bao Fund	Taiwan Bond	1.75	0.97	0.72	−1.01	−1.01
JF (TW) First Bond	Taiwan Bond	1.64	0.96	0.61	−1.01	−1.01
Deutsche Far EasternDWS TW Flagship	Taiwan Large-Cap Equity	−28.44	−12.10	0.00	0.00	−1.02
JF (TW) Bond	Taiwan Bond	1.63	0.95	0.60	−1.03	−1.03
New Light Fortune Balanced	TWD Aggressive Balanced	−15.07	−4.14	0.00	−1.08	−1.08
Allianz Glb Inv Glb Quant Bal	Dollar Moderate Balanced	−6.87	0.00	0.00	0.00	−1.09
PCA Export	Taiwan Small/Mid-Cap Equity	−27.35	−20.51	0.00	0.00	−1.11
PCA Global Equity Fund of Fund	Global Large-Cap Blend Equity	−14.89	−9.48	4.46	−1.21	−1.21
Yuanta EXCELLENCE EQUITY FUND	Taiwan Small/Mid-Cap Equity	−32.14	−13.48	0.00	−1.26	−1.26
HSBC Taiwan Opportunity Fund	Taiwan Small/Mid-Cap Equity	−24.05	−9.79	1.79	−1.28	−1.28
TIIM Asia Win–Win	Asia–Pacific ex-Japan Equity	−10.43	−17.80	12.44	0.00	−1.28
JF (TW) Value Growth	Taiwan Large-Cap Equity	−22.53	−14.60	1.20	−1.33	−1.33
AIG Latin America	Latin America Equity	−3.59	−26.04	4.87	0.00	−1.39
PCA E-Tech	Sector Equity Technology	−31.67	−13.09	0.17	−1.50	−1.50
Shinkong Champion Fd of Fds	Asia Balanced	−18.05	−16.38	0.00	−1.51	−1.51
IBT Asia-Amer Sh Duration Bd	Dollar Global Bond	−3.36	−1.22	0.18	1.63	−1.54
JPM (Taiwan) Global Focus Fund	Global Large-Cap Blend Equity	−23.94	−15.51	0.00	0.00	−1.66
Truswell Taiwan A-Plus Fund	Greater China Equity	−28.20	−23.73	0.00	0.00	−1.73
HSBC BRIC	BRIC Equity	5.23	−28.70	13.59	0.00	−1.75
IBT Glb Growth Port	Global Large-Cap Blend Equity	−9.07	−8.04	0.00	−1.87	−1.87
PCA Asia–Pacific Hi Yld Eq	Asia–Pacific ex-Japan Equity	−19.07	−12.50	5.35	−1.96	−1.96
PCA Small Capital	Taiwan Small/Mid-Cap Equity	−31.17	−17.96	0.33	−2.04	−2.04
Truswell Eastern Key Fund	Asia–Pacific with Japan Equity	−24.04	−10.05	7.56	0.00	−2.07
Prudential Financial First	Taiwan Small/Mid-Cap Equity	−29.12	−11.09	0.00	−2.09	−2.09
Cathay Glb Money Market	TWD Money Market	−1.69	−1.13	0.00	0.00	−2.21
Fubon Taiwan Technology Tracker Fd	Sector Equity Technology	−23.95	−17.95	1.90	0.00	−2.23
President Tung Hsin	Taiwan Small/Mid-Cap Equity	−32.72	−27.50	0.00	−0.03	−2.26
SinoPac Fund	Taiwan Small/Mid-Cap Equity	21.39	−4.23	19.50	3.41	−2.26
JF (TW) Eastern Technology	Sector Equity Technology	−20.56	−15.79	7.81	−2.30	−2.30
IBT Diamond Balanced	TWD Aggressive Balanced	−13.68	−8.26	0.00	0.00	−2.31
Polaris TW Top 50 Tracker	Taiwan Large-Cap Equity	−17.78	−15.55	0.01	0.21	−2.32
Mega Citizen Fund	Taiwan Small/Mid-Cap Equity	−34.85	−15.19	0.15	−2.34	−2.34
JPM (Taiwan) Eurpean Bond-A-ACC	European Bond	−2.05	2.80	0.00	0.00	−2.51
Fuh Hwa Heirloon Balanced	TWD Aggressive Balanced	−2.71	−8.97	0.00	0.00	−2.54

Appendix A (*continued*)

Fund name	Fund group	$ROI_{oTraining}$ (%)	$ROI_{oTesting}$ (%)	$ROI_{mTraining}$ (%)	$ROI_{mTesting}$ maximum (%)	$ROI_{mTesting}$ average (%)
JPMF (TW) Glb Communication	Sector Equity Communications	−18.24	−15.53	0.00	−2.57	−2.57
Fuh Hwa Asia Pacific Bal	Asia Balanced	−7.69	−10.77	1.66	−2.58	−2.58
Manulife Glb Fund of Bd Funds	Dollar Global Bond	−1.46	0.96	0.00	−1.08	−2.58
Reliance Wealth Bond	Dollar Global Bond	−0.13	−1.32	0.00	−1.36	−2.65
Polaris Global ETF Growth Fund	Global Large-Cap Blend Equity	−11.27	−18.21	0.00	−2.81	−2.81
NITC Transpac	Asia–Pacific with Japan Equity	−27.90	−15.21	1.71	−2.84	−2.84
Capital Emerging Mkts	Emerging Markets Equity	5.16	−27.71	3.39	0.00	−2.89
Union Quantitative Balanced	TWD Cautious Balanced	−5.14	−15.62	0.60	0.00	−3.03
Allianz Global Investors Taiwan	Taiwan Small/Mid-Cap Equity	−22.37	−13.86	0.00	−2.68	−3.07
Polaris Win–Win New Balanced	TWD Aggressive Balanced	5.66	1.85	8.77	1.00	−3.08
Allianz Asian Pacific Dyn Strg	Asia–Pacific with Japan Equity	−14.39	−14.39	3.96	−3.17	−3.17
MEGA SECURED VALUE FUND	TWD Aggressive Balanced	−14.61	−10.81	0.00	−3.34	−3.34
AIG Flagship Glb Growth FOF	TWD Aggressive Balanced	−14.44	−15.86	1.50	−3.52	−3.52
JPM (TW) Glb Emg Mkts	Emerging Markets Equity	−3.92	−27.11	6.56	0.00	−3.55
NITC Wonderful	Taiwan Small/Mid-Cap Equity	−22.01	−24.78	0.00	0.00	−3.67
Cathay Global Bond	Dollar Global Bond	−7.01	−2.53	0.00	0.00	−3.81
NITC Asian Technology	Sector Equity Technology	−25.75	−21.42	4.39	0.00	−3.90
Allianz Global Investors Global Bd	Dollar Global Bond	−1.87	4.23	0.03	−1.32	−4.05
SKIT ASIA EQUITY FUND	Asia–Pacific ex-Japan Equity	−4.28	−24.05	3.89	0.00	−4.09
ING Global Dynamic Port	Dollar Aggressive Balanced	−14.41	−19.41	0.00	−4.20	−4.20
Primasia Baoli Fund	Taiwan Small/Mid-Cap Equity	−35.80	−12.15	0.00	−4.29	−4.29
Yuanta Global Asset Sec Bal Inc-INC	Dollar Diversified Bond	−8.32	2.58	0.00	−3.65	−4.30
Fuh Hwa OMNI	Taiwan Small/Mid-Cap Equity	−14.46	−10.73	0.00	0.00	−4.32
AIG US Dual Core Inc-B-INC	Dollar Global Bond	−5.22	6.82	0.00	−1.46	−4.37
SinoPac Luxury and Lifesty	Sector Equity Consumer Goods and Services	−24.16	−17.60	0.00	0.00	−4.43
EnTrust Vision Tech Fund	Sector Equity Technology	−34.66	−24.50	0.00	0.00	−4.58
KGI Pioneer	Taiwan Small/Mid-Cap Equity	−27.71	−23.14	0.00	−2.69	−4.58
Allianz Glb Inv Target 2030	Target Date 2015+	−14.13	−13.59	0.00	−4.59	−4.59
Prudential Financial Glb Sel	Dollar Moderate Balanced	−12.66	−18.31	0.00	−4.61	−4.61
Fuh Hwa Aegis	TWD Cautious Balanced	5.48	−13.54	0.00	−2.91	−4.97
TIIM Asian Real Estate Div-B-INC	Sector Equity Real Estate Indirect - Asia	−31.74	−30.42	10.47	−3.46	−4.99
Prudential Financial Euro Selection	Dollar Aggressive Balanced	−11.92	−26.57	0.00	0.00	−5.04
HSBC Glb Em Mkts Equity Fund	Emerging Markets Equity	−0.24	−26.54	6.04	0.00	−5.13
Capital Asia Pac Mega-Trend	Asia Balanced	8.54	−17.28	6.28	0.39	−5.24
EnTrust Yung Chong Fund	Taiwan Small/Mid-Cap Equity	−24.68	−21.24	0.00	0.00	−5.68
MEGA Life Science Fund	Sector Equity Health Care	−14.11	−16.02	0.00	−3.71	−5.82
Primasia Hi-Tech Fund	Sector Equity Technology	−34.89	−28.02	0.00	0.00	−5.92
SinoPac Sm and Mid Cap	Taiwan Small/Mid-Cap Equity	21.47	−11.67	10.68	6.02	−6.03
Prudential Fin Glb Sm	Global Equity Small/Mid Cap	−15.69	−21.08	4.22	−5.44	−6.14
ING Global Luxury Brands	Global Large-Cap Growth	−30.95	−15.29	0.00	−6.17	−6.17

Appendix A (*continued*)

Fund name	Fund group	$ROI_{oTraining}$ (%)	$ROI_{oTesting}$ (%)	$ROI_{mTraining}$ (%)	$ROI_{mTesting}$ maximum (%)	$ROI_{mTesting}$ average (%)
	Equity					
IBT NAmerica Inc Trust	Canada Equity	−10.91	−10.84	0.00	−5.95	−6.49
Allianz Global Emg Mkts	Emerging Markets Equity	−7.34	−23.12	2.08	−6.62	−6.62
Trustwell Taiwan Small-Cap Fund	Taiwan Small/Mid-Cap Equity	−35.09	−28.04	−5.45	0.00	−6.87
Ontario High-Tech Fund	Sector Equity Technology	−37.60	−20.26	0.00	−6.14	−7.96
Prud Financial Glb BioHlth	Sector Equity Biotechnology	−8.41	−7.97	0.00	0.00	−8.38
Fuh Hwa Small Capital	Taiwan Small/Mid-Cap Equity	−18.03	−15.80	0.00	−3.38	−8.66
SinoPac Balance 2 Fund	TWD Aggressive Balanced	16.77	−10.57	10.30	7.63	−8.79
Taishin Tech	Sector Equity Technology	−44.72	−38.74	0.70	−8.75	−8.80
Allianz Glb Investors Glb Biotech	Sector Equity Biotechnology	−8.61	−15.80	0.00	0.00	−14.46
	Average	−16.01	−8.59	1.65	2.95	1.98

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