南　　華　　大　　學

經濟學研究所

碩士論文

台灣股票型基金敏感度與經理人誘因之分析

– LA/AIDS 模型與 GME 估計法之運用

An Analysis of Sensitivity and Fund Manager’s Incentives

A LA/AIDS Model with an Application to Equity Funds in Taiwan

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Abstract

In this paper, we use a theoretical model, the Linear Approximated Almost Ideal Demand System (LA/AIDS), to reexamine the sensitivities of category equity funds with different risk-return profiles and the incentives offered to equity fund managers in Taiwan. By applying the Generalized Maximization Entropy (GME) method, expenditure elasticities indicate that an increase in expenditure have positive impacts on asset allocation, substitution elasticities show that Technology, Value and Special equity funds appear as complementary categories; moreover, General and Special equity funds appear as substitutes but serve as complements for M&S and OTC equity funds, own-price elasticities are all negative while the sign of cross-price elasticities are mixed. We also find that Technology, Value, Special and OTC equity fund managers have positive incentives to optimize their performances which help to explain the adoption of asset based schemes. However, managers of M&S and General equity fund managers have no incentives to optimize their performance under asset based scheme, thus we suggest the authorities to adopt the price based scheme.

Keywords: LA/AIDS model, GME method, sensitivity, incentive, category equity fund

Contents

1. Introduction

Mutual funds are one of the fastest growing financial intermediaries. The popularity is owing to numerous considerable advantages such as asset liquidity, asset diversification, professional portfolio management, investment information and advice, account reporting, and lower costs. The prevalent forms of management contract, like the United States, Canada and Taiwan, has been the asset-based scheme which regulates managers to receive a fixed percent of the fund size regardless of fund performance. However, because fund managers often have information advantages to develop their own remuneration rather than the wealth of investors, there exist problems of potentially acute moral hazard and adverse selection. Literatures on the mutual funds' operational efficiencies are relatively scant. Berkowitz and Kotowitz (1993) applied ARMA (1,2) to examine the incentives offered manager of Canadian equity mutual funds when their remuneration is based on the market value of the assets they manage. They found that the asset-based scheme provides strong incentives to managers to maximize fund performance owing to investors' expectations of positive serial correlation in the performance of mutual funds. Different from Berkowitz and Kotowitz's framework, Theodore (2002) uses the seemingly uncorrelated regressions (SUR) to consistently estimate the AIDS model for mutual fund classes with different risk-return profiles in Greek. The theoretically based AIDS model, originally developed by Deaton and Muellbauer (1980), simultaneously model all category equity funds and the interactions which benefits to the accuracy of estimating incentives as well as provides further sensitivity analysis. However, the limitation of SUR estimator is that it does not perform well while regressing in a small sample.

This paper attempts to investigate whether asset-based scheme contracts could provide incentives to prompt category equity fund managers to maximize fund returns. We design an AIDS model to reexamine the sensitivities of category equity funds with different risk-return profiles and the incentives offered to category equity fund managers. We further use the generalized maximum entropy (GME) approach to robustly estimate a system of equations with binding nonnegative constraints. The main advantages of the GME approach include that it is more efficient without strong parametric assumptions, more robust even if errors are not normal and exogenous variables are correlated, works well when the sample is small, covariates are highly correlated, or the design matrix is ill-conditioned. It also has a dual objective that permits a choice between estimation precision and category prediction and is easier to compute and use than the ML technique. Lence and Miller (1998a) proposed the GME approach to estimate multi-output production function and to recover input allocations simultaneously. By proceeding Monte Carlo simulations, they show that the GME estimator has better performance relative to the other estimators. Golan et al. (2001) show that the AIDS-GME estimator is consistent and asymptotically normal. Hence, the robust GME method allows us to consistently and efficiently estimate the category equity fund share system with non-negatively constraints and large numbers of goods without imposing any restrictions on the error terms.

The paper is organized as follows. Section 2 presents the classical AIDS model. By modifying some assumptions and model settings of the AIDS model by Theodore (2002), we build the LA/AIDS model for category equity funds. In section 3, we explain the robust GME approach of estimation. The variables within the model are specified and descriptions of the data are provided in section 4. By using the GME approach to analyze the system equations, we then gain important information from the empirical findings which are discussed in section 5. The sensitivity for category equity funds to changes in total fund sizes and category equity funds' prices as well as the managers' incentives toward maximization of investors' return can be examined. Finally, conclusions are made in section 6.

2. The linear approximate AIDS (LA/AIDS) model

Assume that utility functions are separable with regard to equity funds and the other products and services, the LA/AIDS model can be set as

$$w_i = (a_i - b_i \ln f) + \sum_{j=1}^{n} g_{i,j} \ln p_j + b_i \ln\left(\frac{m}{p^*}\right), \quad i = 1,\dots,n \tag{1}$$

$$\ln p^* = \sum_{i=1}^{n} w_i \ln p_i \tag{2}$$

In equation (1), w_i is the share variable, m denotes total equity fund sizes, p_j denotes the net value of category equity funds, and (m/p) is real total fund size. We adopt the Stone's geometric price index p^* which is presented in equation (2). Parameter a_i can be interpreted as the basic levels of fund shares for investors with prices, coefficients b_i represent the change in the ith category equity fund's share with respect to a change in real total fund sizes with prices held constant, and parameter f models the degree of collinearity among p_j. Green and Alston (1990) suggested that p may be approximately proportional to p^*, i.e., $p \cong fp^*$, when the net value of category equity funds are highly collinear.

Throughout relaxing the assumption of constant preferences, LA/AIDS model can be extended to incorporate important information variables that are helpful to characterize preferences to vary with these exogenous variables. By applying "translation" method (see

Pollak and Wales, 1992) to introduce other crucial variables into the original AIDS specification, the incorporation of explanatory variables is realized through changing the equation (1) to be

$$w_{i,t} = \Pi_{i,t} + \sum_{j=1}^{n} g_{i,j} \ln p_{j,t} + b_i \ln\left(\frac{m_t}{p_t^*}\right) + e_{i,t}, \quad i = 1,...,n$$

$$\Pi_{i,t} = (a_i - b_i \ln f) + \sum_{j=1}^{n} \sum_{l=0}^{L} d_{i,j,l} \mathrm{PERF}_{j,t-l} \tag{3}$$

where $d_{i,j,l}$ are newly added parameters for estimation, and $\mathrm{PERF}_{j,t-l}$ denotes performance of j th category equity fund in period $t-l$. With the linear approximate model, a system of these share equations can be used to obtain all of the parameter estimates conditional on the given properties. The properties of theoretical demand functions are known as adding up, price homogeneity, Slutsky symmetry, concavity and monotonicity. To satisfy these properties, we impose the following restrictions in our model

Adding up

$$\sum_{i=1}^{n} (a_i - b_i \ln f) = 1$$

$$\sum_{i=1}^{n} d_{i,j,l} = \sum_{i=1}^{n} g_{i,j} = \sum_{i=1}^{n} b_i = 0, \quad l = 0,1,..., L, \; j = 1,2,...,n \tag{4}$$

Price homogeneity

$$\sum_{j=1}^{n} g_{i,j} = 0, \text{ for all } \; i = 1,2,...,n \tag{5}$$

Slutsky symmetry

$$g_{i,j} = g_{j,i}, \text{ for all } \; i, j = 1,2,...,n \tag{6}$$

3. The GME estimation approach

The GME approach of Golan et al., (1996) maximizes joint weighted average entropy of the parameters and the error terms as the objection function. It does not require any behavioral assumptions, but does accommodate non-sample information about plausible factor share allocations. In addition, the GME estimators permit incorporation of non-sample information on both the multinomial probabilities and the response parameters and it provides a basis for model diagnostics and information measures (see Soofi 1992). Consider the following matrix form in stead of equation (3)

$$\mathbf{W} = \mathbf{XB} + \mathbf{E} \tag{7}$$

where $\mathbf{W}$ is a $(T \times n)$ vector representing the equity funds' share. $\mathbf{X}$ is a $(T \times K)$ matrix included all intercept terms and regressors. $\mathbf{B} \equiv (\mathbf{b}_1', \ldots, \mathbf{b}_n')'$ is $(K \times n)$ coefficients matrix where $\mathbf{b}_i'$ is $(K \times 1)$ vector of unknown parameters. Similarly, $\mathbf{E} \equiv (\mathbf{e}_1', \ldots, \mathbf{e}_\mathbf{n}')'$ is $(T \times n)$ error term matrix and $\mathbf{e}_i'$ is $(T \times 1)$ vector of disturbances.

The principal assumption of GME is that a parameter $b_{i,k}$, a element of $\mathbf{b}_i'$, is regard as the mathematical expectation of some discrete support values $z_{i,k,r}$ in the support space $\mathbf{z}_{i,k} = (z_{i,k,1}, \ldots, z_{i,k,R})'$ such that $b_{i,k} = \sum_{r=1}^{R} p_{i,k,r} z_{i,k,r}$, where $p_{i,k,r} \geq 0$ are probabilities which satisfy $\sum_{r=1}^{R} p_{i,k,r} = 1$ for $i = 1, \ldots, n$, $k = 1, \ldots K$, $r = 1, \ldots R$. The vector $\mathbf{z}_{i,k}$ with dimension $R \geq 2$ is the discrete support spaces for each one of the K unknown parameters. Golan et al. (1996b) explain that wide bounds may be used without extreme risk consequences if prior information is minimal so as to ensure that our estimate of $\mathbf{z}_{i,k}$ contains the true $\mathbf{B}$. The element $z_{i,k,r}$ constitutes a priori information provided by the researcher, and $p_{i,k,r}$ is an unknown probability whose value must be determined by solving a maximum entropy problem. Another analogous assumption for the error term is assumed to be $e_{i,t} = \sum_{d=1}^{D} q_{i,t,d} v_{i,t,d}$, where $q_{i,t,d} \geq 0$ are probabilities which satisfy $\sum_{d=1}^{D} q_{i,t,d} = 1$ for $i = 1,\ldots,n$, $t = 1,\ldots,T$, $d = 1,\ldots,D$. $e_{i,t}$ of dimension $D \geq 2$ is regard as the mathematical expectation of some discrete support values $v_{i,t,d}$ in the support space $\mathbf{v}_{i,t} = (v_{i,t,1},\ldots,v_{i,t,D})'$, $i = 1,\ldots,n$, $t = 1,\ldots,T$, equally spaced and symmetric around zero. Likewise, $e_{i,t}$ of dimension $D \geq 2$ is regard as the mathematical expectation of some discrete support values $v_{i,t,d}$ in the support space $\mathbf{v}_{i,t} = (v_{i,t,1},\ldots,v_{i,t,D})'$, $i = 1,\ldots,n$, $t = 1,\ldots,T$, equally spaced and symmetric around zero. We adapt the "three-sigma rule" of Pukelsheim (1994) which Golan et al. (1996) recommend to establish bounds on the error components. That is, the lower bound is $\underline{\mathbf{v}} = -3s_{\mathbf{Y}}$ and the upper bound is $\overline{\mathbf{v}} = 3s_{\mathbf{Y}}$, where $s_{\mathbf{Y}}$ is the empirical standard deviation of the sample $\mathbf{Y}$

After reparameterizing both parameters and error term, we substitute these reparameterized terms into the LA/AIDS equation (3) and obtain

$$w_{i,t} = \sum_{k=1}^{K} X_{i,t,k} \sum_{r=1}^{R} p_{i,k,r} z_{i,k,r} + \sum_{i=1}^{D} q_{i,t,d} v_{i,t,d}, \quad i = 1,\ldots,n, \quad t = 1,\ldots,T \tag{8}$$

then the GME estimator by maximizing the joint entropies of the distributions of the parameters and the error terms can be stated as

$$\max H(\mathbf{p},\mathbf{q}) = -\sum_{i=1}^{n} \sum_{k=1}^{K} \sum_{r=1}^{R} p_{i,k,r} \ln(p_{i,k,r}) - \sum_{i=1}^{n} \sum_{t=1}^{T} \sum_{d=1}^{D} q_{i,t,d} \ln(q_{i,t,d}) \tag{9}$$

subject to

$$\sum_{r=1}^{R} p_{i,k,r} = 1, \quad i = 1,\ldots,n, \quad k = 1,\ldots K$$

$$\sum_{d=1}^{D} q_{i,t,d} = 1, \quad i = 1,\ldots,n, \quad t = 1,\ldots,T$$

$$\sum_{i=1}^{n} (a_i - b_i \ln f) = 1$$

$$\sum_{i=1}^{n} d_{i,j,l} = \sum_{i=1}^{n} g_{i,j} = \sum_{i=1}^{n} b_i = 0, \quad l = 0,1,\ldots,L, \; j = 1,2,\ldots,n$$

$$\sum_{j=1}^{n} g_{i,j} = 0, \text{ for all } \; i = 1,2,\ldots,n$$

$$g_{i,j} = g_{j,i}, \text{ for all } \; i, j = 1,2,\ldots,n$$

$$\sum_{i=1}^{n} \sum_{d=1}^{D} q_{i,t,d} v_{i,t,d} = 0$$

The objective function (9) is a dual objective function that places equal weights on both prediction and precision of estimates, while shrinking all the estimates to the center of their supports. The constraints are budget share equation (8), the GME adding-up conditions, and the other restrictions about the consumer theory. By applying the Lagrangian method and solving for the first order conditions, the unique optimal solution $\tilde{p}_{i,k,r}$ and $\tilde{q}_{i,t,d}$ can be derived and then the point estimates for the LA/AIDS coefficients, $\tilde{b}_{i,k} = \sum_{r=1}^{R} \tilde{p}_{i,k,r} z_{i,k,r}$ and $\tilde{e}_{i,t} = \sum_{d=1}^{D} \tilde{q}_{i,t,d} v_{i,t,d}$, can be derived as well.

4. Data sources and descriptive statistics

The monthly data included in this study are shares, prices and performances which are from the SITCA (Securities Investment and Consulting Association in Taiwan). The sample period spans from 2001: 2 to 2004: 2. Table 1 shows some basic information about the six equity fund classes in this study. These category equity funds are namely, Technology, Medium and small (M&S), Value, General, Special and Over the counter (OTC) equity fund, which consist of 21, 8, 3, 70, 3 and 9 funds in our sample. From table 1, we can find that the general equity fund is the dominant category in Taiwan equity fund market. Moreover, the technology equity funds are also very popular, since they share about 26% of the equity fund market. Besides, the others all possess less then 10% of the equity fund market.

The dependent variable $w_{i,t}$ represents the market share of investors' expenditure allocated to each class of the six equity funds, where i denotes the six equity fund classes. Since the share data are calculated as the ratio of size on the certain equity fund to all equity fund size, in order to approximate investors' share on each equity fund category, the size data of the respective equity fund class at the end of the month were needed. The size data represent the total net asset of investors which is allocated to each particular fund class. Table 2 gives some details and statistical values on the share data. From table 2, we can find that the share vary between 26.8 and 27.1% for technology equity funds, between 6.9 and 7.8% for M&S equity funds, between 1.9 and 2.0% for value equity funds, between 55.4 and 57.8% for general equity funds, between 0.75 and 0.8% for special equity funds, and between 5.5 and 7.0% for OTC equity funds. We can also observe that the share of general equity funds increase gradually, the share of OTC equity fund decrease and the other category funds are fluctuated over time. We also learn that these equity funds are not strongly deviated from their standard error.

The category equity fund shares are explained by changes in some independent variables. Classical AIDS model assumes that budget shares can be explained solely by price factors and the aggregate equity fund size. These are the logarithms of a price variable $\ln p_{i,t}$ in each equity fund class and the logarithm of real expenditure $\ln\left(m_t / p_t^*\right)$ allocated to these fund classes. However, other variables may be of importance in explaining equity fund demand.

The performance and its lagged value were initially included in the model, accounting for change in Taiwan investors preferences. Specifically, there are six price factors, a real total fund size factor, six performance factors and twelve performance lagged factors included in each one of the six fund class equations of the system. Hence, there are in total 25 independent variables in each equations of the system model.

Price variable $p_{i,t}$ denotes the net asset values (NAV) of each category equity fund. The data is obtained directly and help us to calculate the aggregate price index p. However, since the pieces of all category equity funds were found to be collinear, the Stone's price index p^* is applied to approximate the aggregate price index. By weighting average the prices data of single equity funds contained in each equity fund class, we can get the data of the Stone's price index p^*. The nominal expenditure m_i was calculated by summing the size in each of the six fund classes and the total real equity fund size m_t/p_t^* denotes that the total equity fund size is deflated by a NAV index p^*.

Table 3 gives some statistical information about the calculated NAV and total real equity fund size. It can be found that the general equity fund is of the highest NAV, in other words, it serves to be the most expensive category equity fund in Taiwan. In contrast, the value equity fund is the cheapest category. The NAV are keeping growth only in M&S and special equity funds, while the others are frustrated over time. Finally, the total real size grows gradually as well. The performance data we applied is the Sharp's index. The basic statistical values are presented in Table 4. We can find that most of the performances are negative, which may result from the depression during these years.

Before preceding the other tests, the best lag length of the model should be firstly determined. The lag length of the performance is examined by the AIC and SBC statistics reported in table 5. Based on the findings in Table 5, we choose two periods as the lag length. Another important issue is whether the homogeneity and symmetry restrictions implied by the demand theory will hold. We first estimate the model without any prior restrictions being imposed, and then proceed to impose the price-homogeneity and price-symmetry constraints to do the test. Against the unrestricted model, the likelihood ratio statistics are used. The test statistics reported in Table 6 demonstrate that both restrictions are accepted at the 5% level of significance, and the null hypothesis is failed to reject in this case. This result indicates the investors' behaviors are consistent and follow the economic theory. The following empirical framework also applied these settings.

5. Empirical results

A system of six equations for each equity fund class is under our study. For econometric purpose, some settings must introduce before illustrating the empirical results. First of all, since theoretical restrictions can help to reduce the dimensionality of the problem and increase the degree of freedom in estimation, they should serve to increase the efficiency of the estimates. Hence, the estimated parameter coefficients from the homogeneity and symmetry restricted model are presented. Secondly, since the full set of share equations must sum to unity, the variance covariance matrix for the full system would be singular. Therefore, only five equations should be estimated and the parameters of the omitted equation may be calculated using the restrictions implied by the model. The omitted equation in this paper is the share of OTC equity fund. Finally, the support vectors in this paper are set wide enough in order to include all possible outcomes of the estimates. The support vector of log prices and lag performances of category equity funds are set with referring to the empirical findings of Theodore (2002) and Berkowitz and Kotowitz (1993). In Theodore (2002), the estimated coefficients on log prices of category equity funds were within the interval of $(-0.3,0.3)$ and the intercepts and coefficients on log expenditures were within the interval of $(-1,1)$. Therefore, we chose support vectors to be $(-30,30)$, which is 100 times wider than the interval $(-0.3,0.3)$ for the log price coefficients and $(-100,100)$ for the intercept and log expenditure coefficients. Similarly, the support vectors of lag performances are set as $(-230,230)$ based on the empirical finding in Berkowitz and Kotowitz (1993). Moreover, because all the dependent shares variables are positive decimals, the support vector for error terms is set as $\mathbf{v}=(-1,0,1)$.

The GME estimates presented in Table 7 are obtained by maximizing the joint entropy objective function subjected to the LA/AIDS model and restrictions of consumer-theory. From Table 7, most estimates are statistically significant at the 0.05 confidence level, having the expected signs with reasonable magnitude and displaying the following major features. As shown in Table 7, the log own prices are positively correlated with the share dependent variables of M&S, general and OTC equity fund categories, but are negatively correlated with the share dependent variables of technology, value and special equity fund categories. This empirical finding indicates that if the prices of category equity funds increase, investors tend to recover money by selling technology, value and special equity funds, but increase the money investment in M&S, general and OTC equity funds. Basically, the price of equity funds represents the purchase cost of investors as well as the value of equity funds. Therefore, investors would pay higher attention on the price costs of technology, value and special equity funds, and turn to care about the value rather than the price cost of M&S, general and OTC equity funds.

The cross price effects in Table 7 are very complicated. For the technology equity fund, the price increase of value and special equity funds leads to significant decreases of its share, but on the contrary, the price increase of M&S generates an opposite effect. Likewise, we can find that for the M&S equity fund, only the price increase of general equity fund lead to a significant decrease of its share. The increases in prices of technology, value and OTC result in a significant positive effect to its share. For the value equity fund, only the price increase of technology fund leads to a significant decrease of the share of value equity fund, and only the price increase of M&S generates a significant positive effect to its share. For the general equity fund, the price increases of M&S and OTC equity funds lead to significant decreases of its share, and only the price increase of special generates a significant positive effect to its share. For the special equity fund, only the price increase of technology equity fund leads to a significant decrease of its share, and only the price increase of general generates a significant positive effect to its share. For the OTC equity fund, only the price increase of general equity fund leads to a significant decrease of its share, and only the price increase of M&S generates a significant positive effect to its share. These estimates are important for calculating the cross price elasticities that can give a further explanation to the relationships of category equity funds. Leaving discussion of the estimated elasticities for the next section, several interesting comments can be drawn from the estimated coefficients.

Another interesting finding in Table 7 is that the M&S equity fund is the only positive correlated category with the real total fun size, with the value of 0.06065. Besides, the other categories are all negatively correlated with the real total fund size. This puzzling result reveals the fact that, ceteris paribus, with income increasing, investors will put a great deal more weight of the money to invest in M&S equity than other equity funds. Thus, except for M&S equity fund the shares of all category equity funds decrease when the real expenditures raise. Next section, we could attempt to draw further economic interpretation from these estimated parameters based on the implied elasticities.

The most interesting economic parameters for policy analysis are the elasticities. The estimated model in this paper could be taken as a conditional demand system, which means that any elasticity must be interpreted as measuring the responsiveness of demand for equity fund with regard to changes in price or the other crucial independent variables for a given level of total fund sizes. In most cases, elasticities used in the past were based on subjective judgments and were not supported by empirical evidence. In recent years, some regression models have been estimated. Elasticities can then be calculated by simple formulas which convert the parameter estimates to be elasticities. The price and expenditure elasticities are computed to examine the effect of price changes and expenditure changes on consumption patterns. However, four alternative formulas for price elasticities using LA/AIDS parameter estimates have appeared in the previous literature. Thus, different values can be obtained for AIDS elasticities when the LA/AIDS parameter estimates are substituted in various elasticity expressions. The differences can be represented in terms of different expressions for the elasticity of the price index with respect to the j th price. Green and Alston (1990) applied the Monte Carlo studies to analyze these formulas, and found that some of previously reported approaches to compute elasticities are theoretically incorrect. With the degree of multicollinearity increases, accuracy decreases for all of the formulas, and especially for theoretically incorrect formulas. Green and Alston also proposed the correct formula; however, it is far difficult to calculate. Chalfant (1987) used which provides a very good approximation to the formula of Green and Alston. Since the approximation specification helps to simplify the calculation of elasticities without loss of accuracy, the formula of the expenditure, substitution and uncompensated own and cross-price elasticities which are developed by Chalfant is applied in this paper as discussed below

Expenditure elasticities

$$h_i = 1 + \frac{b_i}{w_i} \tag{10}$$

Marshallian price elasticities (uncompensated price elasticities)

$$h_{i,i}^{U} = -1 + \frac{g_{i,i}}{w_i} - b_i \tag{11}$$

$$h_{i,j}^{U} = \frac{g_{i,j}}{w_i} - \left(\frac{w_j}{w_i}\right) b_i \tag{12}$$

Hicksian price elasticities (compensated price elasticities)

$$h_{i,i}^{C} = -1 + \frac{g_{i,i} + w_i^2}{w_i} \tag{13}$$

$$h_{i,j}^{C} = \frac{g_{i,j} + w_i w_j}{w_i} \tag{14}$$

Elasticities of substitution

$$h_{i,j} = 1 + \frac{g_{i,j}}{w_i w_j}, \quad i \neq j \tag{15}$$

Some important characteristics about these elasticity formulas are described as follows. First, the expenditure elasticities in equation (10) are the same for either model specification of the price index. Second, the compensated price elasticities and elasticities of substitution can then be obtained by manipulating the Slutsky equation (i.e. $h^{C}_{i,j} = h^{U}_{i,j} + w_j h_i$, $h^{C}_{i,j} = w_j h_{i,j}$). Finally, equation (15) is important because the usual definitions of complementary and substitute goods are based on the sign of $h_{i,j}$. Follow above settings, the elasticities are calculated from the estimates of both homogeneity and symmetry restricted model as well. The illustration starts with the estimated expenditure elasticities presented in Table 8. According to the relevant standard error values, expenditure elasticities of all category equity funds are positive and considerably different from zero. Such result implies that equity funds are normal products for investors. Only the M&S category equity fund is found to be more expenditure elastic, with the value of 1.81632. The other expenditure elasticities of technology, value, general, special and OTC equity funds are found to be below unity, with values of 0.97894, 0.50920, 0.99776, 0.34054 and 0.38568. From the equity fund expenditure point of view, expenditure increases for M&S category is more than proportional when total equity fund expenditure rises, but the others are less than proportional. Therefore, M&S category can be considered as luxury goods for investors, and the other equity funds are found to be necessities.

Moreover, the estimated expenditure elasticities can also provide an indication of Taiwan investors' preference which affected by their risk aversion (or taking) attitudes. For instance, an increase in total investment by 1% would result in a more than proportionate share of the M&S category, as this asset class was found to be the most expenditure elastic. However, an increase in investor's expenditure would have a moderate impact on the share of technology, value, general, special and OTC equity fund categories. It may be related with the higher returns of the M&S stock, as well as the fact that M&S funds are addressed toward the market segment with a higher risk-taking profile. Therefore, this category can be characterized by high volatility in case of shifting market conditions. That is, investors of M&S equity fund often take the frequent inflows and outflows of short term investment horizon into account to rebalance the risk level between cash and other investment instruments. On the contrary, the other equity fund categories are targeted to the more conservative medium to lower range of the risk aversion (or taking) attitudes and this is also supported by the lower estimated expenditure elasticities. In other words, most of investors are conservative and have lower range of the risk aversion (or taking) attitudes. Above findings is useful and reinforced when combined with the conclusions obtained by Goetzmann and Kumar (2002). By examining the portfolio structure and characteristics of a large number of investment accounts, Goetzmann and Kumar (2002) found that despite investors' awareness of the diversification benefits, low-income and nonprofessional investors hold the least diversified portfolios, whereas young and active investors hold under-diversified portfolios.

The substitution elasticities also help to investigate the interactions among different categories about investors. Intuitively, investors may consider some categories of equity funds as substitutes, since equity funds are given highly liquidity, easy access to entry and exit in any equity fund class. The substitution elasticities also reveal the fact that investors may move from a moderate to a higher risk-return level and vice versa, depending on market expectations and trends. In other words, investors may substitute an "overvalued" category by switching their assets towards "undervalued" categories instead, on the expectation of higher return. But complementarity also seems realistic, because investors may construct asset portfolio combinations with a blend of more than one category to aim at a more efficient diversification and dispersion of risk. In Table 8, the substitutability and complementarity among categories are indicated by positive and negative substitution elasticities. It shows explicit complementary relationships exist between technology, value and special equity funds. These categories appear as complementary asset classes, and it is possibly by investors who prefer asset portfolio combinations. These detected complementarity effects can be justified on the basis of portfolio diversification (fund of funds approach) in order to increase risk dispersion and reduce return volatility. Presumably, these assets respond differently both to the shocks from macroeconomic and microeconomic and the shifts in economic cycles. Therefore, constructing a portfolio with a blend of complement categories can be contributive to hedge the returns of portfolio against adversely shifting market conditions. Beside the complementarity between technology, value and special equity funds, there exists some more interesting but complicated substitution and complementary relationships in our finding. For general and special equity funds, although both categories appear as substitutes, they both serve as complements for M&S and OTC equity funds. The finding implies that if investors invest in M&S or OTC equity fund, he or she may also choose one of general or special equity funds to combine, but not both.

The Marshallian uncompensated elasticities measures the price effect on demand which takes the income effect into account, whereas the Hicksian compensated elasticities measures the price impact assuming that the income effect holds constant. The uncompensated price elasticities yield interesting policy implications as to the investor preferences toward specific asset classes and their risk-return profiles. Table 9 reports the Marshallian uncompensated and Hicksian compensated own-price elasticities derived from the estimates of homogeneity and symmetry restricted model. As expected, these own-price elasticities are negative and significantly different from zero. The uncompensated own-price elasticities have negative signs means that changes in own price have inverse impacts on quantities demanded. It also implies that all categories are consistent with the law of demand. In addition, the uncompensated own-price elasticities of M&S, general and OTC equity funds are found to be less than unity, while technology, value and special equity funds are more elastic. This result also shows that investors' reactions to the changes of equity fund price vary considerably among different categories.

Different with the uncompensated own-price elasticity, compensated own-price elasticity represents the effect of price fluctuations. An adverse price effect of compensated own-price elasticity may erode the advantage of a higher share due to an increase in investors' expenditure, but a consistently robust performance may contribute to absorb the adverse price impact. This finding has significant implications to the equity fund managers. Therefore, it is quite important to the size of category equity funds, particular to the value and special equity fund categories, with the higher own-price compensated elasticity values of -1.17167 and -1.43665. Relatively, price changes have a lower impact on the technology, M&S, general and OTC equity funds, of own-price elasticities values of -0.82660, -0.70472, -0.07549 and -0.02077. It was also found that if investors move upwards their underlying risk scale, the price effects on size of category equity funds are increasingly robust. In other words, price shifts may also provide signals about the shifts of investors' risk aversion.

Table 10 reports the Marshallian uncompensated and Hicksian compensated cross-price elasticities for each type of equity funds. Same as own-price elasticities, these values are estimated from the homogeneity and symmetry restricted model as well. Most of the elasticities are statistically insignificantly different form zero at the 0.05 level on the basis of asymptotic t-tests. Overall, the price factor appears to have a considerable impact on portfolio allocation to category equity funds with different risk-return characteristics and can lead to reallocation between the asset classes.

In order to investigate the incentives of these market responses, the estimates of performance variable showed in Table 7 are used to calculate how management fees are affected by the improved short-term performance with the asset-based system. The case of Technology equity funds is applied here to explain the calculation of the incentives. Specifically, a temporary improvement of 1 percentage point in Technology equity fund's performance, holding other variables as constant, leads to an increase of about 13.56 percent in market share at current year, 7.895 percent after one year and -2.251 percent after two years. These increases may reflect the fact that significant proportions of dividends are automatically reinvested as well as the increased sales due to the effect of past returns. And in the following year, the increased performance will further increase the expectations of future performance of investors and hence increase the fund sales. Therefore, the long-run change in market share as a result of a one-time increase in performance $\left(\Delta PERF_{j,t-l}\right)$ is calculated as

$$\Delta PERF_{j,t-l} \sum_{l=0}^{2} d_{i,j,l}$$

Since the estimated coefficients measure the proportionate change in real total fund size as well as changes in market shares, it follows that a one-percentage-point increase in performance is to increase real total fund size by approximately 0.13556+0.07895 -0.02251=19.2 percent. Similarly, the values of the other category equity funds are calculated and reported in Table 11. These results reveal the incentive of managers of category equity funds to our specification and estimation of the model. For example, the annual average management fee of technology fund is about 1.5 percent of real total fund size, so the management remuneration due to a 1 percent point increase in the fund's performance is approximately 28.8 percent of the marginal profit. This figure clearly represents a very substantial incentive that urges the manager to maximize the performance. We can also find that Value, Special and OTC equity fund managers are of positive incentive index of 0.273, 2.328 and 12.552 percent. However, the incentive index of M&S and General equity funds are negative, with the value of -4.052 and -31.288. In addition, based on the management fees in Table 11, the changes of management remunerations of these categories are approximately -6.6432, 0.4368, -46.932, 3.6084 and 19.4556 percent. Therefore, relative to executive compensation scheme in private industry, Technology, Value, Special and OTC equity fund managers appear to receive significant rewards, which increase with their tenure in the fund. But managers of M&S and General equity funds seem to have no incentives to optimize their performance. Because such result reveals the fact that if all category equity funds' managers engage in optimizing performance, investors will prefer to increase their investments in Technology, Value, Special and OTC equity funds. One important finding here is that investors' behavior may base on different benchmarks. Comparing with the own price effects that had been emphasized, we find investors focus on performance of technology, value, special and OTC equity funds, but on price of M&S, General and OTC equity funds. Positive incentives reinforce the asset based scheme which is adopted currently in Taiwan and the United States, but such remuneration is not suitable for the categories with negative incentives. We suggest the authorities to adopt the price based scheme rather than asset based one in M&S, General equity fund categories.

6. Concluding remarks

For the purpose of examining the sensitivities of category equity funds and investigating the incentives of fund managers given the asset based scheme, the linear approximated Almost Ideal Demand System model is applied as a framework to analyze all category equity funds with different risk-return profiles. By translating methods, the LA/AIDS model is expanded through specifying the intercept as a linear function of performances variables to incorporate the contributions of managers. From the LR tests, the homogeneity and symmetry assumption imposed by economic theory are accepted. The GME method is employed to estimate the share equations for six types of category equity funds using time series data. The obtained results provide interesting insights about the preference of Taiwan investors for equity funds.

Taking into account the risk aversed attitudes of investors, the factors that affect investors in allocating money to Technology, M&S, Value, General, Special and OTC equity funds are identified. The parameter estimates and resulting elasticity coefficients are in general plausible which confirm the strong influence of changes in budget expenditure and prices on the money allocation of equity fund investors. Although investors exhibit different patterns of preferences, an increase in expenditure is expected to have a positive impact on asset allocation which implies that equity funds are normal products. The M&S category can be considered as a luxury good which is more volatile and risky, and the other equity funds are found to be necessities which are less volatile and conservative.

We find that explicit complementary relationships exist between Technology, Value and Special equity funds which reveal the fact those investors who invest in Technology, Value and Special equity funds may prefer asset portfolio combinations. However, although General and Special equity funds appear as substitutes, they both serve as complements for M&S and OTC equity funds. The investors of these categories may also choose one of general or special equity funds to combine, but not both. The own-price elasticities are all negative means that changes in own price have inverse impacts on the quantities demanded, which satisfies the law of demand. We also found that investors' reactions to the changes of equity fund price vary considerably among different categories and the volatility will reinforce by the effect of uncompensated own-price elasticities. However, the cross-price elasticities are mixed with positive and negative signs.

While the regularities in Taiwan have contributed to a management fee structure that supplies a very weak direct link between performance and the remuneration of managers, a stronger link through the effect of current and past performance on future sales of the Technology, Value, Special and OTC equity fund managers. By comparing with the own price effects, we find that investors focus on performance of Technology, Value, Special and OTC equity funds, and the prices of M&S, General and OTC equity funds. The relatively positive incentives associated with this indirect link may also help to explain the adoption rate of asset based schemes in the United States, but negative incentives suggest the price based scheme to managers of M&S and General equity funds.

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Table 1.

The equity fund classes in Taiwan: Feb, 2004

Equity Fund Class	Numbers	Assets (million NTD)	Share (%)
Technology	21	51987.8054	26.26
M&S	8	13603.0547	6.87
Value	3	3982.2705	2.01
General	70	114092.6867	57.63
Special	3	1696.7164	0.86
OTC	9	12599.5101	6.37
Total	114	197962.0438	100

Source: SITCA (Securities Investment & Consulting Association).

Table 2.

Statistical description of the shares of classified equity funds

	2001		2002		2003	
Equity Fund Class	Mean (%)	S.D.	Mean (%)	S.D.	Mean (%)	S.D.
Technology	27.1649	0.2858	26.8567	0.6867	26.8706	0.8575
M&S	7.5229	0.2656	7.8131	0.3420	6.9468	0.0936
Value	2.0377	0.1513	1.9390	0.1119	1.9868	0.1891
General	55.4381	0.5206	56.0792	1.3197	57.8228	0.5217
Special	0.8051	0.0601	0.75808	0.0334	0.8021	0.0429
OTC	7.0313	0.2900	6.5539	0.4328	5.5710	0.3259

Source: SITCA (Securities Investment & Consulting Association).

Table 3.

Statistical description of net value and real total size

	2001		2002		2003	
Equity Fund Class	Mean	S.D.	Mean	S.D.	Mean	S.D.
Net Asset Value (NTD)						
Technology	13.5867	2.6208	14.2540	2.0056	14.0556	2.0900
M&S	10.5080	1.6812	10.8193	1.4746	11.3391	2.0599
Value	6.4769	2.0376	6.3756	0.5415	6.9777	0.9801
General	14.6873	2.5241	15.8955	2.0010	15.4342	2.3314
Special	8.3275	1.4080	8.5944	1.1004	8.8658	1.2394
OTC	8.6392	1.6820	10.1702	1.3192	9.5484	1.6685
Total Real Fund Size (million NTD)	10.4103	0.2018	10.9196	0.2124	11.2116	0.1493

Source: SITCA (Securities Investment & Consulting Association).

Table 4.

Statistical description of the performances and the lagged values

	Level		Lag 1 period		Lag 2 period	
Equity Fund Class	Mean	S.D.	Mean	S.D.	Mean	S.D.
Performance						
Technology	-0.0627	0.3175	-0.0893	0.3010	-0.1081	0.2913
M&S	-0.0369	0.2991	-0.0648	0.2774	-0.0828	0.2662
Value	0.0083	0.2551	-0.0204	0.2436	-0.0400	0.2446
General	-0.0318	0.2744	-0.0578	0.2544	-0.0744	0.2477
Special	0.0055	0.2890	-0.0240	0.2607	-0.0424	0.2492
OTC	-0.0510	0.3306	-0.0770	0.3073	-0.0947	0.2974

Source: SITCA (Securities Investment & Consulting Association).

Table 5.

Tests about the lag length of performance in the model

	Lag length	Technology	M&S	Value	General	Special	OTC
AIC	1	-9.0863	-9.6543	-12.613	-8.4942	-13.834	-10.315
	2	-9.5030*	-9.9476*	-13.033*	-8.7666*	-14.005*	-11.587*
	3	-9.3023	-9.2548	-12.983	-8.5294	-13.648	-10.692
SBC	1	-8.1976	-8.7655	-11.725	-7.6054	-12.945*	-9.427
	2	-8.3476*	-8.7922*	-11.877*	-7.6112*	-12.850	-10.431*
	3	-8.1682	-8.6751	-11.783	-7.6108	-12.872	-10.263

Note: * denotes the test statistic is significant.

Table 6.

Likelihood ratio test of homogeneity and symmetry

Model	Log L	LR	D.F	Critical value
Unrestricted	1147.260	----	----	----
Homogeneity	1140.662	6.598	5	11.071
Symmetry	1131.594	15.666	10	18.307
Homogeneity and symmetry	1127.138	20.122	15	24.996

Note: * denotes the test statistic is significant under 0.05 confidence level.

Table 7.

Empirical estimates of the AIDS Mutual Demand System

	Category Equity Funds					
Variables	Technology	M&S	Value	General	Special	OTC
Intercept	0.41585	-1.28708**	0.24109	0.50930	0.11709	1.00376**
Net Value						
$\ln P_{1,t}$	-0.02581*	0.05793**	-0.00959**	-0.01660	-0.01043*	0.00450
$\ln P_{2,t}$	0.05793**	0.01642*	0.01034**	-0.11608**	-0.00849	0.03988**
$\ln P_{3,t}$	-0.00959**	0.01034**	-0.00378**	0.00358	-0.00252	0.00196
$\ln P_{4,t}$	-0.01660	-0.11608**	0.00358	0.20295**	0.02759**	-0.10143**
$\ln P_{5,t}$	-0.01043*	-0.00849	-0.00252	0.02759**	-0.00348*	-0.00267
$\ln P_{6,t}$	0.00450	0.03988**	0.00196	-0.10143**	-0.00267	0.05777**
Real Total Fund Size	-0.00579	0.06065**	-0.00968	-0.00127	-0.00517	-0.03874**
Performance in t						
$PERF_{1,t}$	0.13556**	-0.05164**	-0.00036	-0.07320**	0.00812	-0.01848*
$PERF_{2,t}$	-0.09052**	0.00612*	-0.02142**	0.14041**	0.00481	-0.03940**
$PERF_{3,t}$	-0.02506**	-0.00415	0.00657*	0.03087**	-0.00452	-0.00372
$PERF_{4,t}$	0.03886	0.09142**	0.00502	-0.20454**	-0.02587**	0.09511**
$PERF_{5,t}$	-0.02071	-0.04880**	-0.00515	0.07960**	0.01586**	-0.02080**
$PERF_{6,t}$	-0.04907**	0.00652	0.01358**	0.03989**	0.00006	-0.01098*
Performance in $t-1$						
$PERF_{1,t-1}$	0.07895**	0.02781	-0.00557	-0.10239**	-0.00098	0.00217
$PERF_{2,t-1}$	0.02186	-0.00366*	0.00490	-0.01239	-0.00047	-0.01025
$PERF_{3,t-1}$	-0.02027	-0.01815	-0.00001*	0.07282**	0.00472	-0.03910**
$PERF_{4,t-1}$	0.05631*	-0.02264	-0.00638	-0.08105**	0.01126	0.04249**
$PERF_{5,t-1}$	-0.06362**	0.00180	0.00586	0.07379**	-0.00928*	-0.00855
$PERF_{6,t-1}$	-0.06376**	0.00385	0.00043	0.05156**	-0.00544	0.01337**
Performance in $t-2$						
$PERF_{1,t-2}$	-0.02251*	0.05588**	-0.01850**	-0.01893	-0.00822	0.01228
$PERF_{2,t-2}$	0.02767	-0.04398**	-0.00499	0.02673	0.01149*	-0.01691**
$PERF_{3,t-2}$	-0.01324	0.01498	-0.00383*	0.01461	-0.00311	-0.00941
$PERF_{4,t-2}$	-0.05876**	0.05606*	0.01525	-0.02729*	-0.01970*	0.03444**
$PERF_{5,t-2}$	0.04402**	-0.08558**	0.01777**	0.03923	0.01670**	-0.03214**
$PERF_{6,t-2}$	0.01437	0.00646	-0.00352	-0.02208*	0.00249	0.00228*

Note: ** and * individually denotes the parameter which is significant under 0.05 and 0.1 confidence level.

Table 8.

Calculated expenditure and substitution elasticities

	Category Mutual Funds					
Substitution Elasticities	Technology	M&S	Value	General	Special	OTC
Technology	----	3.89592*	-0.80412*	0.89101*	-3.94265*	1.26482*
M&S	3.89592*	----	8.05247*	-1.76119*	-13.57455*	9.51201*
Value	-0.80412*	8.05247*	----	1.32065*	-15.27764*	2.57541*
General	0.89101*	-1.76119*	1.32065*	----	7.22030*	-1.84307*
Special	-3.94265*	-13.57455*	-15.27764*	7.22030*	----	-4.39664*
OTC	1.26482*	9.51201*	2.57541*	-1.84307*	-4.39664*	----
Expenditure Elasticities	0.97849*	1.81632*	0.50920*	0.99776*	0.34054*	0.38565*

Table 9.

Calculated own-price elasticities

	Category Mutual Funds					
Own-price Elasticities	Technology	M&S	Value	General	Special	OTC
Marshallian Uncompensated						
Technology	-1.09006*	----	----	----	----	----
M&S	----	-0.83967*	----	----	----	----
Value	----	----	-1.18171*	----	----	----
General	----	----	----	-0.64005*	----	----
Special	----	----	----	----	-1.43932*	----
OTC	----	----	----	----	----	-0.04508*
Hicksian Compensated						
Technology	-0.82660*	----	----	----	----	----
M&S	----	-0.70472*	----	----	----	----
Value	----	----	-1.17167*	----	----	----
General	----	----	----	-0.07549*	----	----
Special	----	----	----	----	-1.43665*	----
OTC	----	----	----	----	----	-0.02077*

Table 10.

Calculated cross-price elasticities

	Category Mutual Funds					
Cross-price Elasticities	Technology	M&S	Value	General	Special	OTC
Marshallian						
Uncompensated						
Technology	----	0.21676	-0.03517	-0.04950	-0.03857	0.01805
M&S	0.55994	----	0.12305	-2.02425	-0.12063	0.48525
Value	-0.35361	0.56044	----	0.45914	-0.12373	0.13028
General	-0.02874	-0.20498	0.00637	----	0.04877	-0.17913
Special	-1.15326	-1.03384	-0.30818	3.89276	----	-0.29870
OTC	0.23672	0.67806	0.04321	-1.26107	-0.03748	----
Hicksian						
Compensated						
Technology	----	0.28945	-0.01587	0.50416	-0.03090	0.07975
M&S	1.04898	----	0.15889	-0.99653	-0.10639	0.59977
Value	-0.21651	0.59827	----	0.74726	-0.11974	0.16239
General	0.23991	-0.13085	0.02606	----	0.05659	-0.11621
Special	-1.06157	-1.00854	-0.30146	4.08544	----	-0.27723
OTC	0.34056	0.70671	0.05082	-1.04286	-0.03446	----

Table 11.

Calculated incentives and changes of remuneration

	Category Mutual Funds					
Benchmarks (%)	Technology	M&S	Value	General	Special	OTC
Management fee	1.5	1.6	1.6	1.5	1.55	1.55
Incentives index	19.200	-4.152	0.273	-31.288	2.328	12.552
Price	-2.581	1.64	-0.3782	20.295	-0.348	5.777
Change of remuneration						
Incentives effect	28.8	-6.6432	0.4368	-46.932	3.6084	19.4556
Price effect	-3.8715	2.46	-0.605	30.4425	-0.5394	8.9544