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Size and performance of Chinese mutual funds: The role of economy of scale and liquidity ☆

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ABSTRACT

Using a detailed stockholding for a comprehensive sample of Chinese open-end equity mutual funds from 2004 to the first half of 2010, we investigated the effect of economy of scale and liquidity on the relationship between fund size and performance. We find that an inverted U-shape relationship exists between fund size and performance as measured by various performance benchmarks. Both economy of scale and liquidity play important roles in Chinese mutual funds. Furthermore, their combined effect explains the inverted U-shape relationship of size and performance reasonably well.

1. Introduction

After 18 years of rapid development, China's capital market has risen to become the third largest in the world, giving it a very important role in the global economy. After China's first launch of a mutual fund, Hua An Chuang Xin, in September 2001, the mutual fund industry has become one of the fastest growing industries in China. A survey conducted by China Securities Journal at the end of 2007 showed that 83% out of 14,800 respondents would pick mutual funds as the first choice for their wealth management.[1] Yu and

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[1] Refer to the web page: http://www.industryweek.com/articles/china_mutual_fund_industry_nearly_quadruples_in_2007_15562.aspx.

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Du (2008) show that equities held by mutual funds accounted for approximately 28% of the total Chinese equity markets at the end of 2007. The number of Chinese fund management companies has grown to 62 with 576 funds under management. These include equity, currency, bond, and index funds with total net assets of approximately 2 trillion Yuan under management at the end of the first half of 2010. The mutual fund industry is expected to grow drastically as China opens its doors to international trading via the gate of Qualified Foreign International Investors (QFII). Fig. 1 shows the total net asset value that Chinese mutual funds have had from 2004 to the first half of 2010. This graph shows that the Chinese mutual fund industry experienced dramatic growth from 2004 to 2007 with a slight decrease during the credit crisis after 2007.

Fig. 2 plots the average performance measures (CAPM alpha, Fama–French alpha and style benchmark-adjusted return) across all equity funds in the mutual funds industry from 2004 to the first half of 2010. Surprisingly, it shows that the average alphas in CAPM and Fama–French and the style benchmark-adjusted return are nearly all positive, indicating that Chinese equity mutual funds are, on average, doing better than the market. Indeed, the exact reason for why Chinese mutual funds succeed in the market is worthy of further research. Here, we provide two reasons based on the current literature and our understanding. First, Li et al. (2001), Zhang and Li (2003) and Yu et al. (2009) show that the Chinese stock market is in a weak-form effective stage. Institutional investors (e.g., mutual funds) have information advantages and professional analysis abilities allowing them to make comprehensive, timely, and rational judgments about the stock market to ensure excess returns. Second, institutional investors only account for a relatively small portion of the Chinese stock market. In a market with a relatively large number of institutional investors, one mutual fund may find it hard to succeed because obtaining superior earnings means doing better than numerous competitors with professional investment skills. This is what happens in the American capital market, in which more than 60% of assets are held by numerous institutional investors; hence, mutual funds cannot outperform the market. On the contrary, institutional investors in China only account for a relatively small portion of the Chinese stock market. Even in the bull market of 2007, this ratio was no more than 30%. Hence, if one mutual fund wants to beat the market in China, it only needs to defeat a few rivals, which is a relatively easy task.

Fund performance is affected by many features of mutual funds; among them, the fund size is widely considered to be an important issue in the funds management industry. In this paper, we mainly investigate the following question: *What is the relationship between fund size and performance, and why is there such a relationship?* Although the effect of fund scale on performance is an important question, the academic literature has only recently begun to address the overall size–performance issue from both the theoretical perspective and the empirical perspective. In the meantime, there is no research on this issue with regard to Chinese mutual funds. With the growth of the Chinese mutual fund industry, the size of Chinese mutual funds is also increasing (refer to Fig. 3); hence, a thorough understanding of this question would naturally benefit market investors.

From an economy of scale point of view, fund expense is always an important factor driving fund performance (Carhart, 1992; Carhart, 1997; Wermers, 1997 and Shu et al., 2002). Researchers argue that large

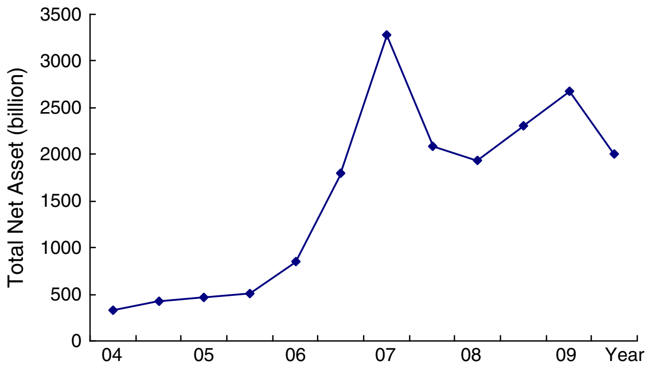

Fig. 1. Total amount of asset managed by the Chinese mutual fund industry. This figure plots the total amount of asset managed by the Chinese mutual fund industry each year. The sample period is from 2004 to the first half-year of 2010. The data are from Tianxiang Investment Analysis System database.

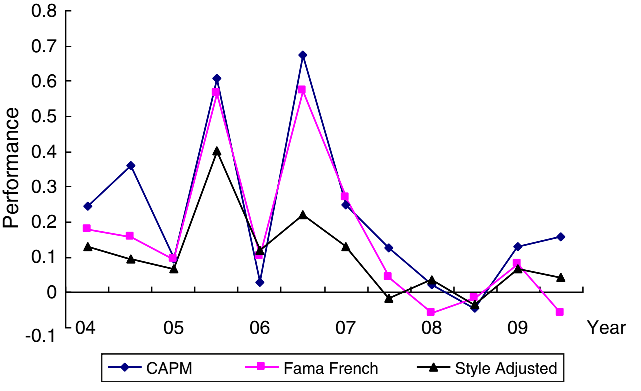

Fig. 2. The average performance of the Chinese mutual fund industry. This figure plots the averaged performance of Chinese open-end mutual funds, using three measures: CAPM alpha, Fama–French 3-Factor alpha and style benchmark adjusted returns. The sample period is from 2004 to the first half-year of 2010. The data is from Wind Financial and Tianxiang Investment Analysis System database. The sample includes all Chinese open-end mutual funds by excluding currency, bond, and index funds. Funds less than 6 months are excluded from our sample. CAPM alpha and Fama–French 3-factor alpha are in a unit of % per semi-annual. The style benchmark adjusted return measures the amount by which the fund exceeds its performance benchmark.

funds have less brokerage commissions and marketing and research costs than small funds and, therefore, should perform better. Grossman and Stiglitz (1980) and Engstrom (2003) stated that while informed investors are expected to earn greater gross and risk-adjusted returns, they also incur more expenses due to the costs of acquiring information. Dellva and Olson (1998) applied the Grossman and Stiglitz hypothesis to the mutual fund industry and discussed the motivation of mutual funds for economy of scale: mutual funds with more information can attract more money and can thus have a lower expense ratio while simultaneously providing higher risk-adjusted returns. Many researchers propose that the negative relationship between fund size and performance is due to reasons such as organizational diseconomy and liquidity. Williamson (1988) favors the organizational diseconomy of scale, arguing that bureaucracy and related coordination costs will erode fund performance. Nanda and Wang (2008) argue that some funds are too large relative to the investment opportunities and abilities of their managers. This agency costs argument can explain why larger funds have poorer performance. Stein (2002) argues that in the presence of hierarchy costs, small firms tend to outperform large firms in processing information; furthermore, agents tend to have a hard time convincing their colleagues to implement good strategies. Perold

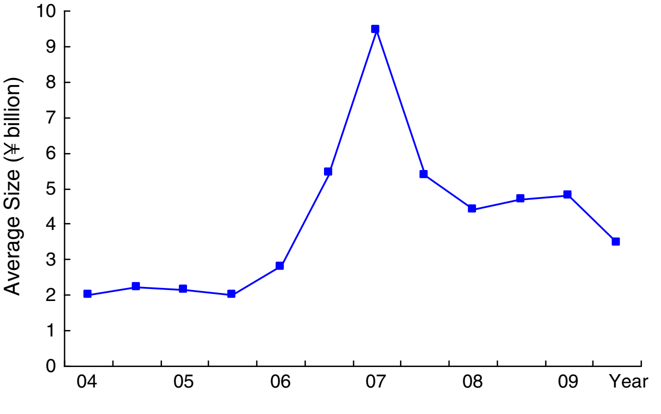

Fig. 3. The average fund size of the Chinese mutual funds. This figure plots the averaged fund size of the Chinese mutual funds. The sample period is from 2004 to the first half-year of 2010. The data is from Wind Financial and Tianxiang Investment Analysis System databases. The sample includes all Chinese mutual funds.

and Salomon (1991) argue that a large asset base might erode fund performance because of high transactional costs. Becker and Vaughan (2001) argue that the fund managers of large funds lose the flexibility of changing positions.

Using samples of American equity mutual funds, Chen et al. (2004) find that fund returns, both before and after fees and expenses, decline with fund size. They explore the idea that scale erodes fund performance because of the interaction of liquidity and organizational diseconomies. Yan (2008) also finds a significant inverse relationship between fund size and fund performance for American equity mutual funds. This relationship is more pronounced among growth and high turnover funds because they tend to have high demands for immediacy. He mainly attributes this inverse relationship to the liquidity constraints of funds. Using Australian equity fund data, Chan et al. (2005) show that fund size detracts from performance because of market impact and transaction costs.

In this paper, we document an inverted U-shape relationship between fund size and performance for Chinese mutual funds. Furthermore, we show that the initial positive relationship between fund size and performance is likely caused by the economy of scale. In other words, growth in fund size provides cost advantages, namely, brokerage commissions, and research and marketing costs do not increase in direct proportion to fund size. However, as the fund grows, the negative relationship between fund size and performance contradicts the theory of economy of scale. Yet it remains consistent with the discoveries of Chen et al. (2004) and Yan (2008) in that it might be the liquidity constraints that are causing fund size to erode fund performance. More specifically, large funds tend to hold a large portion of portfolios that are not easily bought or sold at an ideal price; thus, large funds pay more in trading costs than do small funds. In the meantime, when facing a liquidity problem, large funds tend to liquefy their portfolio by, for example, adding some unfavorable but liquid stocks to the portfolio, thus eroding fund performance. We test the impact of economy of scale and liquidity on the relationship of fund size and performance in this paper. The results confirm that both economy of scale and liquidity constraints exist in the Chinese fund industry and that they simultaneously influence Chinese mutual fund performance. The combination of these two effects can explain the inverted U-shape between size and performance reasonably well.

The remainder of this paper is organized as follows: Section 2 shows the data used in this study; Section 3 documents the relationship between fund size and fund performance; Sections 4 and 5 study the effect of economy of scale and liquidity, respectively, in determining the relationship of fund size and fund performance; and Section 6 concludes the paper.

2. Data

Our study draws from two data sources. Wind Financial Terminal database provides the semi-annual stockholdings for all Chinese mutual funds. It also contains data describing fund characteristics including age, size, family size, expense ratio, and turnover rate. The second data source is the Tianxiang Investment Analysis System, which provides fund performance measures such as the CAPM alpha, the Fama–French three-factor alpha and the style benchmark-adjusted return, which measures the extent by which a fund exceeds its performance benchmark. The alphas are estimated on a rolling basis using *weekly* returns during the window of *6 months*.

We restrict our analysis to Chinese mutual funds from 2004 to the first half of 2010. There are two reasons for choosing data after 2004. First, many studies, such as Chen and Xiong (2001) and Jiang et al. (2008), show that before the non-tradable shares reform in 2004, only a small amount of stocks were tradable and thus were very illiquid; stock prices were far away from reflecting firms' fundamentals. Second, before 2004, there were only a small number of funds in the mutual funds industry; hence, focusing on this time period would not be suitable for testing the relationship between fund size and performance. Furthermore, like in many prior studies, we restrict our analysis to open-end funds and exclude bond, currency and index funds. Funds must also have had at least a six-month life to be included in our dataset.

Table 1 presents the descriptive statistics for fund characteristics. Panel A reports the statistics by grouping. In each semi-annual period, we divide all of the funds into five size quintiles based on the total net asset at the end of the *previous* semi-annual period with the smallest funds in quintile 1 and the largest ones in quintile 5. In addition to summary statistics for each separate quintile, we also report the summary statistics for all of the funds as a group. We first calculate the averages of each data item

Table 1
Descriptive statistics. This table presents the summary statistics for fund characteristics. The sample period is from 2004 to the first half-year of 2010. The data is from Wind Financial and Tianxiang Investment Analysis System databases. The sample includes all Chinese open-end mutual funds by excluding currency, bond, index funds. Funds less than 6 months are excluded from our sample. TNA is the fund's total net asset. FAM is the size of the family that the fund belongs to. AGE is the fund age. NUMBER is the number of stocks held by a certain fund. TURNOVER is the fund's stock turnover rate. EXP is the expense ratio. FLOW is the proportion of the new capital inflows. MI is the market impact, which is a proxy for liquidity. All the sample funds are divided into five size quintiles each semi-annual in Panel A, where the smallest funds are in quintile 1 and largest ones in quintile 5, time-series average of the cross sectional averages is reported in Panel A. Panel B reports the key statistics of all funds for each year.

Panel A

Data item	All funds	Fund size quintile				
		1(small)	2	3	4	5(large)
Number of funds	136	27	27	28	27	27
TNA (100 mil)	40.11	4.80	15.85	29.87	50.22	99.82
LOGTNA	1.27	0.51	1.07	1.35	1.58	1.85
FAM (100 mil)	382.40	169.49	296.12	361.17	479.82	605.37
AGE (months)	30.77	32.39	30.93	30.81	30.43	29.29
NUMBER	57.39	39.07	49.80	56.94	65.80	75.34
TURNOVER (%)	316.71%	523.49%	358.61%	281.24%	233.83%	186.35%
EXP (%)	2.44%	2.83%	2.47%	2.42%	2.28%	2.21%
FLOW (%)	24.86%	−24.32%	20.03%	10.40%	14.76%	103.45%
MI	8.36	6.61	7.95	8.53	9.10	9.60

Panel B

Data item	Year					
	2004	2005	2006	2007	2008	2009
Number of funds	36	70	89	141	199	241
TNA (100 mil)	13.97	17.42	15.47	79.38	56.31	58.15
LOGTNA	1.03	1.05	0.91	1.64	1.56	1.48
FAM (100 mil)	111.06	147.06	195.58	695.72	523.89	620.77
AGE (months)	18.68	23.50	30.80	32.42	36.51	42.71
NUMBER	49.60	48.62	40.60	66.30	69.04	70.17
TURNOVER (%)	234.40%	212.65%	334.84%	378.26%	237.71%	502.49%
EXP (%)	1.91%	1.72%	1.46%	3.98%	2.67%	2.91%
FLOW (%)	−99.20%	−9.11%	3.79%	255.28%	−10.64%	8.53%
MI	8.63	9.25	8.33	7.73	8.19	7.39

in each semi-annual period and then report the time-series averages. Panel B reports the statistics for every year.

As can be seen in Panel A of Table 1, in each semi-annual period, there are on average, 136 funds in our sample. They have on average, total net assets (TNA) of ¥4011 million. The average TNA in the smallest fund size quintile is ¥480 million, while the average TNA in the largest fund size quintile is more than ¥9 billion. For the usual reasons related to scaling, the proxy of fund size that we will use in our analysis is the denary logarithm of a fund's TNA (LOGTNA). The statistics for this variable are reported in the row below that of TNA. The size of the family to which the fund belongs is on average ¥38.24 billion.

The average fund age is 30.77 months, and the average age of the smallest fund quintile is 32.39 months, while the average age of the largest one is 29.29 months. The average number of stocks in the funds' portfolio is 57.39. The funds in the smallest quintile hold 39.07 stocks on average, and those in the largest quintile hold 75.34 stocks on average. The average fund turnover rate per year is 316.71%. Those in the smallest quintile have an average turnover of 523.49%, whereas the ones in the top quintile have an average turnover of 186.35%. The average expense ratio is 2.44% per year; the funds in the smallest quintile have an average expense ratio of 2.83%, and the largest ones have expense ratio of 2.21%. One can see that the fund turnover rate and expense ratio decrease with fund size.

As can be seen in Panel B of Table 1, the number of open-end equity mutual funds and the average net assets managed by funds and fund families all increase exponentially from 2004 to 2009, when ignoring

Table 2
Correlations among fund characteristics. This table presents the correlation among fund characteristics. The sample period is from 2004 to the first half-year of 2010. The data is from Wind Financial and Tianxiang Investment Analysis System databases. The sample includes all Chinese open-end mutual funds by excluding currency, bond, and index funds. Funds less than 6 months are excluded from our sample. LOGTNA is the denary logarithm of fund total net asset, LOGFAM is the denary logarithm of fund family size. LOGAGE is the denary logarithm of fund age. TURNOVER is the averaged stock turnover rate of the fund. EXP is the fund expense ratio. FLOW is the proportion of new capital inflow. MI is the market impact, which is a proxy for liquidity.

	LOGTNA	LOGFAM	LOGAGE	TURNOVER	EXP	FLOW	MI
LOGTNA	1.00						
LOGFAM	0.48	1.00					
LOGAGE	−0.02	0.16	1.00				
TURNOVER	−0.36	−0.24	0.03	1.00			
EXP	−0.13	−0.06	0.12	0.47	1.00		
FLOW	0.18	0.09	−0.01	−0.05	0.03	1.00	
MI	0.70	0.41	0.00	−0.43	−0.03	0.18	1.00

the slight decrease in 2008 due to the financial crisis, giving us a brief impression of the significant growth that occurred in the Chinese mutual fund industry.

Table 2 presents the correlations among various fund characteristics. We calculate the cross-sectional correlations at each semi-annual period and then report their time-series averages. Several correlations are noteworthy. First, larger funds and funds in larger fund families have lower expense ratios. Second, the expense ratio is positively correlated with fund turnover rate, indicating that higher trading activity will incur more costs.

3. Size and performance

In this section, we study the relationship between fund size and performance through the portfolio approach and regressions.

We first estimate the approximate relationship between fund size and performance using a portfolio approach. Table 3 shows the alphas and style benchmark-adjusted returns for portfolios of different fund sizes. Regardless of which performance measure used, funds in quintile 4 perform the best. Specifically, the magnitudes of the return difference across the portfolios are small. For example, the semi-annual CAPM alpha for portfolio 1 (smallest size) is 0.198%, and it is 0.261% for portfolio 4 (the second largest in size), indicating that the return difference is 0.063% per semi-annual period, which seems to have a weak economic significance. One possible explanation for this is that China's mutual fund industry is still in its

Table 3
Portfolio approach on the fund size and performance. This table presents the summary statistics for fund characteristics. The sample period is from 2004 to the first half-year of 2010. The data is from Wind Financial and Tianxiang Investment Analysis System databases. The sample includes all Chinese open-end mutual funds by excluding currency, bond, and index funds. Funds less than 6 months are excluded from our sample. CAPM alpha, Fama–French 3-factor alpha and style benchmark adjusted return are the three measures of fund performance. CAPM alpha and Fama–French 3-factor alpha are in a unit of % per semi-annual. All funds are divided into five size quintiles each semi-annual, where the smallest funds are in quintile 1 and largest ones in quintile 5, and we report the time-series averages in this table. Numbers in parentheses are t-statistics. We use the matched-pair *t*-test to calculate the t-stats for the performance difference between portfolios. One, two and three asterisks denote significance at the 10%, 5% and 1% level, respectively.

Performance measure	Fund size quintile					Difference 4–1	Difference 4–5
	1(small)	2	3	4	5(large)		
CAPM alpha	0.198	0.204	0.240	0.261	0.202	0.062**	0.058**
	(0.97)	(1.14)	(0.96)	(0.93)	(0.85)	(2.13)	(2.19)
Fama–French 3-factor alpha	0.132	0.146	0.180	0.204	0.144	0.073**	0.061**
	(0.68)	(0.87)	(0.75)	(0.77)	(0.64)	(2.71)	(2.28)
Style benchmark adjusted return	0.104	0.093	0.114	0.126	0.088	0.023*	0.038**
	(0.76)	(0.91)	(0.82)	(0.95)	(0.90)	(1.59)	(2.54)

infant stage with little discrepancy among the fund managers' stock-picking skills; thus, potential rewards for superior stock-picking skills do not vary largely across different mutual funds. Hence, return differences across portfolios are small.

However, from the t-stats of the performance spreads between portfolios 4 and 1 and between portfolios 4 and 5, we can see that the performance of quintile 4 is significantly better than quintile 1 and quintile 5 for all three performance measures. This indicates that size plays a significant role in affecting fund performance, which is consistent with the inverted U-shape between the fund size and performances (plotted in Fig. 4). Here, we use a matched-pair *t*-test to calculate the t-stats for the performance spreads.[2] This type of *t*-test method is based on the fact that the performances of different portfolios are connected with each other at each semi-annual period because they are affected by the same macro-economic factors. It is also reasonable to assume that the performance spreads at different semi-annual periods are mutually independent.

Next, we study the relationship between fund size and performance using the Fama and MacBeth (1973) regression[3]; specifically, we first estimate the regression of each cross-section and then report the time-series average coefficients. We use the CAPM alpha, the alpha in the Fama–French three-factor model and the style benchmark-adjusted return to measure the fund performance. Note that all of these performance measures have been provided by the data vendor. Specifically, the vendor calculates the Fama–French 3-Factor Alpha as follows:

$$R_{i,t}-R_{f,t}=\alpha_i+\beta_i\left(R_{M,t}-R_{f,t}\right)+\gamma_i R_{SMB,t}+\theta_i R_{HML,t}+e_{it},$$

where $R_{i,t}$ is the return on fund i in period t, $R_{f,t}$ is the risk free rate (the one-year deposit rate), $R_{M,t}$ is the Chinese market return (the return of the Shanghai Composite Index), and $R_{SMB,t}$ and $R_{HML,t}$ are returns for the Chinese size and book-to-market factors, respectively. All of the alphas are estimated on a rolling basis by using weekly returns within the window of 6 months. The style benchmark-adjusted return is calculated as the fund's net growth rate[4] minus its performance benchmark. Mutual funds of different investment styles (e.g., aggressive growth and balanced growth) have their own performance benchmarks. For example, suppose fund A's performance benchmark is calculated as Shanghai Composite Index × 80% + CITIC Bond Index × 20%. If fund A achieves 20% net growth at a certain semi-annual period while its performance benchmark increases by 8% during the same period, then the style benchmark-adjusted return for fund A is 12%. Note that the vendor reports the fund's style benchmark-adjusted returns at each semi-annual period. Moreover, we also introduce several simplified control variables in our regression, including fund family size, fund age, turnover rate, expense ratio and cash flow.

As mentioned in the Introduction section, the economy of scale and liquidity constraints might exist simultaneously. Therefore, for small funds, liquidity might not be an important issue due to their lack of large stock positions. However, the economy of scale would play an important role in this stage because, as their size grows, funds can save their broker fees, marketing fees, and so on. In contrast, as funds become very large, the economy of scale effect might not improve, and the liquidity issue might be more important instead. Thus, there can be an inverted U-shape relationship between fund size and performance. Hence, we hypothesize the following:

H1. Fund size and performance exhibit an inverted U-shape relationship.

To test this hypothesis, we examine a quadratic relationship between fund size and performance. The specification of the cross-sectional regression is as follows:

$$\begin{aligned}\alpha_{i,t}=a_{0,t}&+a_{1,t}\mathrm{LOGTNA}_{i,t-1}+a_{2,t}\left(\mathrm{LOGTNA}_{i,t-1}\right)^2+a_{3,t}\mathrm{LOGFAM}_{i,t-1}+a_{4,t}\mathrm{LOGAGE}_{i,t-1}\\&+a_{5,t}\mathrm{TURNOVER}_{i,t-1}+a_{6,t}\mathrm{EXP}_{i,t-1}+a_{7,t}\mathrm{FLOW}_{i,t-1}+\varepsilon_{i,t}\end{aligned}\tag{1}$$

2 Specifically, at each semi-annual, we first calculate the average return for each portfolio, and obtain the performance spreads between different portfolios. Then, we calculate the t-stats for performance spreads.

3 Note that we use the Fama–MacBeth method in all of our studies in this paper.

4 Note that the net growth rate takes the dividends and splits into consideration.

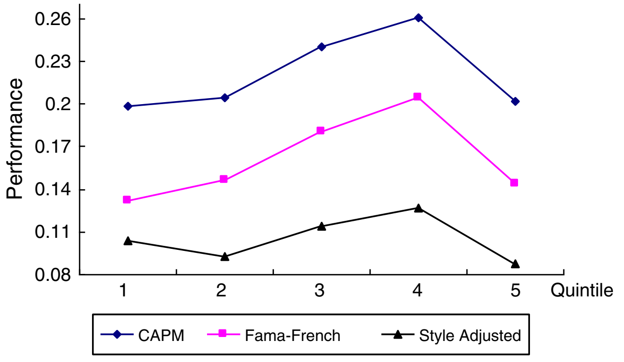

Fig. 4. Relationship between size quintile and performance. This figure plots the relationship between size quintile and performance. The sample period is from 2004 to the first half-year of 2010. The data is from Wind Financial and Tianxiang Investment Analysis System databases. The sample includes all Chinese open-end mutual funds by excluding currency, bond, and index funds. Funds less than 6 months are excluded from our sample. All the sample funds are divided into five size quintiles each semi-annual, where the smallest funds are in quintile 1 and largest ones in quintile 5, then we report the time-series average of their performance. CAPM alpha and Fama–French 3-factor alpha are in a unit of % per semi-annual. The style benchmark adjusted return measures the extent by which the fund exceeds its performance benchmark.

where α_{it} is the measure of fund performance, LOGTNA is the denary logarithm of the fund's total net assets, and LOGFAM is the denary logarithm of the fund-family size. LOGAGE is the denary logarithm of the fund age. TURNOVER is the averaged stock turnover rate of the fund. EXP is the expenditure ratio. FLOW is the proportion of new capital inflow. ε_{it} is a random error term.

Table 4 reports the regression results. For all of the performance measures used, fund performance is significantly positively related to the size of the *fund family*. We will analyze this phenomenon in a later section. More importantly, the coefficient of LOGTNA is significantly positive, and the coefficient of $(\text{LOGTNA})^2$ is significantly negative.[5] Of note, the dramatic increase in the average fund size in 2007, which is most likely caused by unusual inflows due to the Chinese stock market's bubble, could have distorted the relationship between fund size and performance; therefore, we examine the basic results by excluding the year of 2007. The results are shown in Table 5. The coefficient of LOGTNA is still significantly positive with the coefficient of $(\text{LOGTNA})^2$ being significantly negative, regardless of the performance measure used. This is consistent with our main result, which shows that an inverted U-shape relationship exists between fund size and performance. Note that, using an American dataset, Indro et al. (1999) also document an inverted U-shape relationship between fund size and performance, which is consistent with our discovery.

The economic significance of the estimated coefficients on fund size and size-squared in this main regression indicates that there is an optimal size for Chinese mutual funds. For mutual funds with sizes below (above) the optimal, their performance increases (decreases) with size. From Table 4, taking the CAPM alpha as a proxy for the fund performance (the second column), we see that the maximum point of the inverted U-shaped curve occurs when LOGTNA equals 1.32, which is very close to the average LOGTNA (1.58) of quintile 4. Furthermore, if we divide the funds into deciles instead of quintiles, we find that the decile of funds with the best performance has an average LOGTNA of 1.41, which is much closer to 1.32. Considering that different estimation methods can lead to different results, we report an interval for the optimal fund size, namely RMB 2–3 billion (i.e., $10^{1.32}$–$10^{(1.58+1.41)/2}$ hundred million).

If fund managers expect a negative relationship between fund size and fund performance when a fund size is over an optimal value, then fund managers often start a new fund when new money comes in. This should be the case especially when the Chinese mutual funds industry experiences rapid growth, which causes fund sizes to become larger and larger (refer to Fig. 3). Therefore, we expect that the average fund numbers per fund family will increase with time. Fig. 5 shows the average number per fund family from 2004 to the first half of 2010, confirming our notion mentioned above.

[5] When using style benchmark adjusted returns as the performance measure, although the coefficients of LOGTNA and LOGTNA square are not significant, they are very close to the 10% significant level.

Table 4
Regression results on the size–performance relationship. This table examines the relationship between fund size and performance. The sample period is from 2004 to the first half-year of 2010. The data is from Wind Financial and Tianxiang Investment Analysis System databases. The sample includes all Chinese open-end mutual funds by excluding currency, bond, and index funds. Funds less than 6 months are excluded from our sample. CAPM alpha, Fama–French 3-factor alpha and style benchmark adjusted return are the three measures of fund performance. We use Fama and MacBeth (1973) method to run the regression. Numbers in parentheses are t-statistics. One, two and three asterisks denote significance at the 10%, 5% and 1% level, respectively.

Independent variable	Dependent variable					
	CAPM alpha		Fama–French 3-factor alpha		Style benchmark adjusted return	
INTERCEPT	0.136	0.133**	0.074	0.063	0.088	0.057
	(1.36)	(2.69)	(0.75)	(1.28)	(0.65)	(1.37)
LOGTNA	0.132***	0.167**	0.155***	0.183**	0.095	0.099
	(3.14)	(2.87)	(3.22)	(2.89)	(1.72)	(1.63)
$(LOGTNA)^2$	−0.068**	−0.063*	−0.080***	−0.071*	−0.056	−0.044
	(−2.72)	(−1.94)	(−3.24)	(−2.13)	(−1.69)	(−1.40)
LOGFAM	0.047*		0.061**		0.044*	
	(1.95)		(2.55)		(1.97)	
LOGAGE	−0.062		−0.060		−0.126	
	(−0.92)		(−1.02)		(−1.28)	
TURNOVER	0.005		0.005		0.008	
	(1.25)		(1.66)		(1.42)	
EXP	2.060		−0.269		3.403	
	(0.55)		(−0.07)		(1.18)	
FLOW	0.073*		0.075*		−0.007	
	(1.86)		(1.80)		(−0.16)	

4. The economy of scale

To explain the inverted U-shape between fund size and fund performance, we must first check whether the economy of scale exists in mutual funds.

Table 5
The relationship between fund size and performance when excluding the data of year 2007. This table examines the relationship between fund size and performance when excluding the data of year 2007. The sample period is from 2004 to the first half-year of 2010. The data is from Wind Financial and Tianxiang Investment Analysis System databases. The sample includes all Chinese open-end mutual funds by excluding currency, bond, and index funds. Funds less than 6 months are excluded from our sample. CAPM alpha, Fama–French 3-factor alpha and style benchmark adjusted return are the three measures of fund performance. We use Fama and MacBeth (1973) method to run the regression. Numbers in parentheses are *t*-statistics. One, two and three asterisks denote significance at the 10%, 5% and 1% level, respectively.

Independent variable	Dependent variable		
	CAPM alpha	Fama–French 3-factor alpha	Style benchmark adjusted return
INTERCEPT	0.117	0.068	0.009
	(0.98)	(0.57)	(0.06)
LOGTNA	0.133**	0.162**	0.129*
	(2.67)	(2.83)	(2.13)
$(LOGTNA)^2$	−0.077**	−0.092***	−0.073*
	(−2.62)	(−3.27)	(−1.97)
LOGFAM	0.040	0.053*	0.041
	(1.40)	(1.90)	(1.51)
LOGAGE	−0.069	−0.075	−0.099
	(−0.84)	(−1.07)	(−0.85)
TURNOVER	0.003	0.003	0.006
	(0.60)	(0.87)	(0.84)
EXP	2.567**	0.085	4.415
	(0.57)	(0.02)	(1.30)
FLOW	0.088*	0.091*	−0.008
	(1.92)	(1.86)	(−0.15)

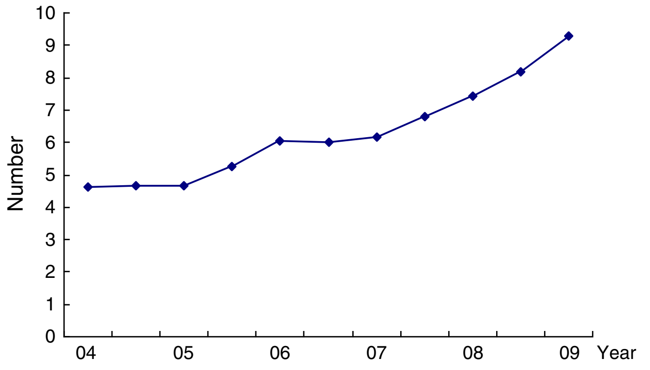

Fig. 5. Averaged fund number per family. This figure plots the averaged fund number per family in Chinese mutual fund industry. The sample period is from 2004 to the first half-year of 2010. The data is from Wind Financial and Tianxiang Investment Analysis System databases.

Several researchers have empirically found that there are scale economies in the administration of open-end mutual funds (Ferris and Chance, 1987; Malhotra and McLeod, 1997; Latzko, 1999; Rea et al., 1999; Ruckman, 2003). These researchers argue that, because one of the significant expenses of operating a mutual fund comes from fixed costs, larger funds can improve their performance by reducing their average fixed cost. Hence, there is a potentially significant economy of scale effect in the mutual fund industry.

Grossman and Stiglitz (1980) provide a theoretical model demonstrating the relationship between expense ratio and return in the securities market. They discuss the informed and uninformed investors' roles in determining a well-informed efficient market. While they are expected to earn greater gross and risk-adjusted returns, informed investors also incur more expenses due to the costs of acquiring information. Dellva and Olson (1998) apply the Grossman and Stiglitz hypothesis to the mutual fund industry and suggest an interesting explanation regarding the effect of economy of scale on fund performance. Their argument begins with the premise that mutual funds charge fees for acquiring and applying information about companies. The superior mutual funds with higher returns may be more informed or more competent in processing information than their counterparts. If the superior mutual funds are more informed, one would expect that they would have higher expenses than less informed mutual funds because information gathering is a costly endeavor. However, if more well-informed funds receive more investor attention and attract more money, the infusion of additional money can then be used to cover fixed costs, thereby allowing these funds to have lower expense ratios and achieve the economy of scale. Thus, the more informed and competent fund can be more efficient in its operations.

If economy of scale applies to the mutual funds, one would expect that the fund expense ratio would decrease with increasing fund size because many costs associated with funds are not directly proportional to fund size. We hypothesize the following:

H2. Fund size is negatively correlated with expense ratio.

To test this hypothesis, we run the following regression

$$\begin{aligned}\mathrm{EXP}_{i,t} &= b_{0,t} + b_{1,t}\mathrm{LOGTNA}_{i,t} + b_{2,t}(\mathrm{LOGTNA}_{i,t})^2 + b_{3,t}\mathrm{LOGFAM}_{i,t} + b_{4,t}\mathrm{LOGAGE}_{i,t} \\ &\quad + b_{5,t}\mathrm{FLOW}_{i,t} + \varepsilon_{i,t}.\end{aligned} \tag{2}$$

To eliminate the endogeneity between EXP (the fund expense ratio) and dependent variables, we take one period's lagged variables as independent variables and rerun the above regression. We also regress the fund's expense ratio only on the fund size and its square. Table 6 shows the results. From Panel A and Panel B in Table 6, one can see that the coefficient of LOGTNA is significantly negative. This is consistent with our hypothesis. Also, using U.S. mutual fund data, Tufano and Sevick (1997) show a negative linear relationship between fund size and fund expense ratio. Additionally, the coefficient of $(\mathrm{LOGTNA})^2$ in Panel B is significantly positive, which indicates that the marginal effect of fund size on expense rate decreases with

Table 6
The relationship between expense ratio and fund size. This table examines the relationship between fund size and expense ratio. The sample period is from 2004 to the first half-year of 2010. The data is from Wind Financial and Tianxiang Investment Analysis System databases. The sample includes all Chinese open-end mutual funds by excluding currency, bond, and index funds. Funds less than 6 months are excluded from our sample. CAPM alpha, Fama–French 3-factor alpha and style benchmark adjusted return are the three measures of fund performance. We use Fama and MacBeth (1973) method to run the regression. Numbers in parentheses are t-statistics. One, two and three asterisks denote significance at the 10%, 5% and 1% level, respectively.

Panel A: contemporaneous regression				
Independent variable	Dependent variable: EXP			
	Model (1)		Model (2)	
INTERCEPT	0.034***	(4.92)	0.033***	(5.74)
LOGTNA	−0.005*	(−2.12)	−0.007*	(−2.16)
$(\text{LOGTNA})^2$	0.001	(1.48)	0.001	(1.01)
LOGFAM	−0.003**	(−2.47)		
LOGAGE	0.003*	(2.10)		
FLOW	0.002	(0.91)		
Panel B: regression adjusted for endogeneity				
Independent variable (with lagged one period)	Dependent variable: EXP			
	Model (1)		Model (2)	
INTERCEPT	0.037***	(5.10)	0.035***	(5.88)
LOGTNA	−0.008**	(−2.46)	−0.010**	(−2.45)
$(\text{LOGTNA})^2$	0.002**	(2.40)	0.002*	(2.03)
LOGFAM	−0.003**	(−3.01)		
LOGAGE	0.002*	(1.80)		
FLOW	0.003	(1.79)		

fund size. Hence, as funds grow, the scale of economy becomes less important. We do not see other variables, such as family size or fund flow, influencing the expense rate significantly.

To check the robustness of our identification of the expense ratio as the reason for the positive relationship between fund size and performance, we investigate whether the impact of fund size on performance diminishes when eliminating the influence of the expense ratio. We adopt two approaches to test this. First, we divide the funds into ten subsamples, each containing funds with similar expense ratios and then rerun regressions separately for each subsample. We thus get ten coefficients; then, obtain the average coefficient and its t-statistic (the same as that in the Fama–Macbeth method), which are reported in Table 7. The coefficient of TNA is not significant; therefore, the positive effect of size on performance is much weaker than before. Additionally, the coefficient of $(\text{LOGTNA})^2$ is significantly negative. This implies that when the effect of economy of scale is excluded, the fund size is negatively correlated with fund performance, most likely due to the liquidity constraints as mentioned in the Introduction section. The second approach requires running a regression of fund size on the expense ratio and using the residual (denoted by RESID) as the proxy for fund size, thus removing the impact of economy of scale. We rerun the regression of Eq. (1), using RESID to replace LOGTNA. As we see in the results shown in Table 8, both the coefficient of RESID and that of $(\text{RESID})^2$ are negative. This indicates that when the effect of scale economy is excluded, the fund size is negatively correlated with fund performance, which is likely to be caused by the liquidity constraints. Those two approaches support the notion that the expense ratio is the reason for the positive relationship between fund size and performance.[6]

Also, in considering economy of scale, funds with a large family should have a scale effect of lowering the average fixed costs. Hence, we hypothesize the following:

H3. Fund performance is positively correlated with fund family size.

[6] In Table 4, when the regression model includes both fund size and the expense ratio, the coefficient on the expense ratio is positive (but insignificant), which is inconsistent with the hypothesis H2. The inconsistency is likely to be caused by the multicollinearity between fund size and the expense ratio, or the influence of the nonlinear term of fund size. We thank the referee for pointing this out.

Table 7
The relationship between fund size and performance conditional on the expense ratio. This table examines the relationship between fund size and performance conditional on the fund expense ratio. The sample period is from 2004 to the first half-year of 2010. The data is from Wind Financial and Tianxiang Investment Analysis System databases. The sample includes all Chinese open-end mutual funds by excluding currency, bond, and index funds. Funds less than 6 months are excluded from our sample. CAPM alpha, Fama–French 3-factor alpha and style benchmark adjusted return are the three measures of fund performance. We divide the funds into ten subsamples, where each subsample contains funds with similar levels of expense ratio, and rerun the regression of Eq. (1) separately for each subsample. We thus get ten coefficients; then we obtain the average coefficient and its t-statistics (the same as that in Fama–Macbeth method). Numbers in parentheses are t-statistics. One, two and three asterisks denote significance at the 10%, 5% and 1% level, respectively.

Independent variable	Dependent variable		
	CAPM alpha	Fama–French 3-factor alpha	Style benchmark adjusted return
INTERCEPT	0.021	0.003	0.144
	(0.20)	(0.03)	(1.75)
LOGTNA	0.038	0.051	−0.025
	(0.69)	(0.90)	(−0.60)
$(LOGTNA)^2$	−0.050**	−0.063**	−0.014
	(−2.33)	(−3.08)	(−0.97)
LOGFAM	0.081*	0.083***	0.034*
	(2.81)	(3.62)	(2.15)
LOGAGE	−0.008	−0.004	−0.066***
	(−0.19)	(−0.10)	(−4.01)
TURNOVER	0.007	−0.007	0.002
	(1.12)	(−1.00)	(0.28)
FLOW	0.014*	0.016**	0.000
	(2.07)	(2.23)	(−0.11)

This hypothesis has already been tested in Eq. (1), with the results shown in Table 4. No matter which fund performance measure is used, we always find that fund performance has a significantly positive relationship with fund family size.

Table 8
The relationship between fund performance and size after removing the effect of economy of scale. This table examines the relationship between fund performance and size after removing the effect of economy of scale. The sample period is from 2004 to the first half-year of 2010. The data is from Wind Financial and Tianxiang Investment Analysis System databases. The sample includes all Chinese open-end mutual funds by excluding currency, bond, and index funds. Funds less than 6 months are excluded from our sample. CAPM alpha, Fama–French 3-factor alpha and style benchmark adjusted return are the three measures of fund performance. We first run a regression of fund size on expense ratio, and use the residual (denoted by RESID), as the size variable, then rerun the regression of Eq. (1). We use Fama and MacBeth (1973) method in the regression. Numbers in parentheses are t-statistics. One, two and three asterisks denote significance at the 10%, 5% and 1% level, respectively.

Independent variable	Dependent variable		
	CAPM alpha	Fama–French 3-factor alpha	Style benchmark adjusted return
INTERCEPT	0.213	0.119	0.153
	(1.62)	(0.96)	(1.11)
RESID	−0.052	−0.055*	−0.043
	(−1.73)	(−1.93)	(−1.74)
$(RESID)^2$	−0.048	−0.065*	−0.062
	(−1.29)	(−2.17)	(−1.70)
LOGFAM	0.048*	0.062**	0.046*
	(2.04)	(2.70)	(2.06)
LOGAGE	−0.059	−0.056	−0.113
	(−0.92)	(−1.04)	(−1.17)
TURNOVER	0.001	−0.001	0.007
	(0.22)	(−0.30)	(1.46)
FLOW	0.073**	0.072**	−0.011
	(2.30)	(2.25)	(−0.28)

5. The role of liquidity

As mentioned above, fund performance is eroded by fund size because of liquidity constraints. We divide the impact of liquidity into two aspects: 1) the market impact (or transaction) cost incurred from holding a large position of stocks, and 2) the distortion of the fund portfolio caused by liquidity constraints.

5.1. Market impact cost

We first begin our investigation by checking the relationship between the aggregate market impact cost incurred by each fund and its relationship with fund size. Clearly, for small funds, the market impact cost should be minimal or even insignificant; however, as funds grow larger, the market impact cost should dramatically increase. We thus hypothesize the following:

H4. Fund size is positively correlated with the market impact cost.

To test this hypothesis, we have to first calculate the market impact for each fund. When selecting market impact measures, we follow a method similar to Yan (2008) and use the average market impact (MI) across all stocks held by a certain fund. Intuitively, the market impact of a large trade for a mutual fund should relate positively to the position of a certain stock within the fund and negatively to the trading volume of this stock. Mathematically, MI is defined as

$$\mathtt{MI} = \frac{1}{\sum_{i=1}^{N} w_i} \sum_{i=1}^{N} \left[w_i \times F\left(\frac{w_i}{DVOL_i}\right)\right] \tag{3}$$

$$F\left(\frac{w_i}{DVOL_i}\right) = \begin{cases} 1 \quad \text{if } 0 < \frac{w_i}{DVOL_i} \le 0.001 \\ 2 \ \text{ if } 0.001 < \frac{w_i}{DVOL_i} \le 0.002 \\ 3 \ \text{ if } 0.002 < \frac{w_i}{DVOL_i} \le 0.005 \\ 4 \ \text{ if } 0.005 < \frac{w_i}{DVOL_i} \le 0.01 \\ 5 \ \text{ if } 0.01 < \frac{w_i}{DVOL_i} \le 0.02 \\ 6 \ \text{ if } 0.02 < \frac{w_i}{DVOL_i} \le 0.05 \\ 7 \ \text{ if } 0.05 < \frac{w_i}{DVOL_i} \le 0.25 \end{cases} \quad \begin{cases} 8 \ \text{ if } 0.25 < \frac{w_i}{DVOL_i} \le 0.5 \\ 9 \ \text{ if } 0.5 < \frac{w_i}{DVOL_i} \le 1 \\ 10 \ \text{ if } 1 < \frac{w_i}{DVOL_i} \le 2 \\ 11 \ \text{ if } 2 < \frac{w_i}{DVOL_i} \le 5 \\ 12 \ \text{ if } 5 < \frac{w_i}{DVOL_i} \le 10 \\ 13 \ \text{ if } \frac{w_i}{DVOL_i} > 10 \end{cases} \tag{4}$$

where w_i is the holding of a stock i, and $DVOL_i$ is the average daily trading volume of stock i over the past semi-annual period.

The key feature of MI is the ability to measure the trading difficulty for an institution. The larger the *relative* order size (the ratio between the holding size and the average daily trading volume), the more market impact the trade will bring. Yan (2008) also takes MI as one measure of liquidity along with the bid-ask spread; the larger the MI, the lower the fund liquidity. Table 1 shows the average MI for different fund sizes and in different years.

To investigate how liquidity varies along with time, we plot the averaged market impact of Chinese open-end equity mutual funds in Fig. 6. The liquidity of Chinese mutual funds has improved since 2004 and especially since 2007. The average MI decreased from 9.25 in 2005 to 7.73 in 2007. We can explain this phenomenon with two reasons. First, the Chinese stock market has grown rapidly since the insurance funds and annuity funds were permitted to enter the stock market in 2004, thus enlarging the size and increasing the investment products of the capital market and, as a result, improving the liquidity of the market. Second, the Chinese stock market performed exceptionally strong in 2007, which greatly improved the funds' liquidity. However, the liquidity of the mutual funds industry deteriorated shortly after the end of 2007, correlating with the burst of the Chinese capital market bubble.

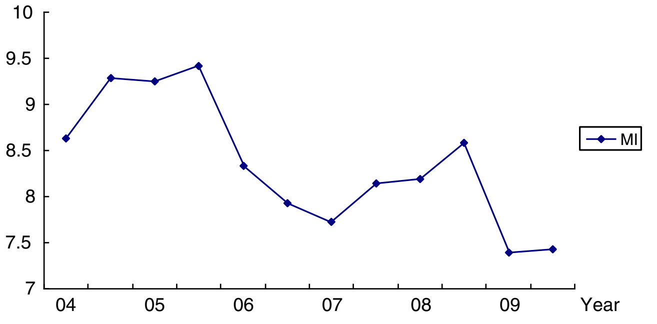

Fig. 6. Average market impact (MI) of Chinese mutual funds. This figure plots the averaged market impact (MI) of Chinese mutual funds. The sample period is from 2004 to the first half-year of 2010. The data is from Wind Financial and Tianxiang Investment Analysis System databases. The sample includes all Chinese open-end mutual funds by excluding currency, bond, and index funds and funds less than 6 months.

To test hypothesis H4, we run the following regression:

$$\begin{aligned} \mathrm{MI}_{i,t} &= c_{0,t} + c_{1,t}\mathrm{LOGTNA}_{i,t} + c_{2,t}(\mathrm{LOGTNA}_{i,t})^2 + c_{3,t}\mathrm{LOGFAM}_{i,t} + c_{4,t}\mathrm{LOGAGE}_{i,t} \\ &+ c_{5,t}\mathrm{TURNOVER}_{i,t} + c_{6,t}\mathrm{EXP}_{i,t} + c_{7,t}\mathrm{FLOW}_{i,t} + \varepsilon_{i,t}. \end{aligned} \tag{5}$$

Similar to before, to avoid endogeneity between MI and independent variables, we also regressed MI on the one-period-lagged independent variables in the above regression, and Table 9 shows the results. From the table, one can see that the market impact of a certain fund is in a significant relationship with its size. Although

Table 9

Market impact (MI) and fund size. This table examines the relationship between fund MI and various fund characteristics. The sample period is from 2004 to the first half-year of 2010. The data is from Wind Financial and Tianxiang Investment Analysis System databases. The sample includes all Chinese open-end mutual funds by excluding currency, bond, and index funds. Funds less than 6 months are excluded from our sample. We use Fama and MacBeth (1973) method to run the regression. Numbers in parentheses are t-statistics. One, two and three asterisks denote significance at the 10%, 5% and 1% level, respectively.

Panel A: contemporaneous regression				
Independent variable	Dependent variable: MI			
	Model (1)		Model (2)	
INTERCEPT	4.737***	(15.24)	5.175***	(17.85)
LOGTNA	2.807***	(9.29)	3.017***	(10.14)
$(\mathrm{LOGTNA})^2$	−0.251*	(−1.86)	−0.365**	(−2.87)
LOGFAM	−0.163*	(−1.86)		
LOGAGE	0.047	(0.83)		
TURNOVER	−0.071***	(−4.21)		
EXP	48.332***	(4.76)		
FLOW	0.109	(0.89)		
Panel B: regression adjusted for endogeneity				
Independent variable (with one lagged period)	Dependent variable: MI			
	Model (1)		Model (2)	
INTERCEPT	5.206***	(11.87)	5.245***	(28.44)
LOGTNA	2.938***	(8.79)	3.117***	(8.63)
$(\mathrm{LOGTNA})^2$	−0.386**	(−2.63)	−0.470**	(−3.09)
LOGFAM	−0.168	(−1.46)		
LOGAGE	−0.074	(−0.75)		
TURNOVER	−0.040*	(−2.10)		
EXP	37.148	(1.75)		
FLOW	0.319*	(2.19)		

Table 10
The effect of market impact on the relationship between fund size and performance. This table examines the effect of market impact on the relationship between fund size and performance by adding the cross terms LOGTNA × MI. The sample period is from 2004 to the first half-year of 2010. The data is from Wind Financial and Tianxiang Investment Analysis System databases. The sample includes all Chinese open-end mutual funds by excluding currency, bond, and index funds. Funds less than 6 months are excluded from our sample. Fama–French 3-factor alpha is the measure of fund performance. We use Fama and MacBeth (1973) method to run the regression. Numbers in parentheses are t-statistics. One, two and three asterisks denote significance at the 10%, 5% and 1% level, respectively.

Independent variable	Fama–French 3-factor alpha	
INTERCEPT	−0.042	(−0.46)
LOGTNA	0.117	(1.59)
LOGTNA × MI	−0.020**	(−2.42)
MI	0.032	(1.42)
LOGFAM	0.062**	(2.80)
LOGAGE	−0.057	(−1.00)
EXP	−0.332	(−0.10)
FLOW	0.070*	(1.90)

the coefficient for $(\text{LOGTNA})^2$ is significantly negative, the turning point of the parabola is far beyond the largest fund size; thus, overall, there is a positive relationship between fund size and market impact.

Next, we test whether it is through the role of fund size that MI affects fund performance. Following Yan (2008), we introduce the interaction term between fund size and market impact, i.e., LOGTNA × MI, into our regression. As shown in Table 10, the coefficient of LOGTNA × MI is significantly negative at the 5% level. This means that the inverse relationship between fund sizes and performance is more negative for less liquid funds, which is consistent with our story that fund performance is eroded by fund size because of liquidity constraints.

More importantly, if large funds have poorer returns because of an increased market impact of their trading, the impact of fund size on performance would be much weaker for funds with similar market impacts. We thus divide the funds into ten subsamples based on their levels of MI and then rerun the regression separately for each subsample. The result is shown in Table 11.[7] The coefficients of LOGTNA and $(\text{LOGTNA})^2$ are both negative but not significant in general. These results indicate that the liquidity impact of fund size diminishes conditional on market impact. It is worth noting that, here, the coefficient of the expense ratio is significantly negative, which implies that the economy of scale is the driving force behind fund performance.

5.2. Trading activity and portfolio construction

If large fund managers face higher than expected market liquidity in comparison to small fund managers, their portfolio construction and trading activity should reflect these liquidity constraints. For instance, private information should be more valuable to a small fund than to a large fund because a small fund is able to make faster transactions without incurring higher market transaction costs. Therefore, we should detect a difference in the way that large and small fund managers construct their trade portfolios.

Facing a large market impact, large fund managers should be hesitant to trade because of the resulting large market impact costs. Hence, the fund stock turnover rate should be smaller for large funds than for small funds. We hypothesize the following:

H5. A fund's turnover rate is negatively correlated with fund size.

To test H5, we run the following regressions,

$$\begin{aligned}\text{TURNOVER}_{i,t} = d_{0,t} + d_{1,t}\text{LOGTNA}_{i,t} + d_{2,t}(\text{LOGTNA}_{i,t})^2 + d_{3,t}\text{LOGFAM}_{i,t} + d_{4,t}\text{LOGAGE}_{i,t} \\ + d_{5,t}\text{EXP}_{i,t} + d_{6,t}\text{FLOW}_{i,t} + \varepsilon_{i,t}.\end{aligned} \tag{6}$$

[7] Similar to Section 4, we first get ten coefficients from regressions; then obtain the average coefficient and its t-statistic accordingly. When looking at the coefficients for LOGTNA and $(\text{LOGTNA})^2$ for each subsample, we have not found a visible pattern across the 10 subsamples. For briefness of the paper, we here do not provide these coefficients; it is available based on request.

Table 11
The relationship between fund size and performance conditional on the market impact. This table examines the impact of fund size on fund performance conditional on the market impact. The sample period is from 2004 to the first half-year of 2010. The data is from Wind Financial and Tianxiang Investment Analysis System databases. The sample includes all Chinese open-end mutual funds by excluding currency, bond, and index funds. Funds less than 6 months are excluded from our sample. CAPM alpha, Fama–French 3-factor alpha and style benchmark adjusted return are the three measures of fund performance. We divide the funds into ten subsamples, where each subsample contains funds with similar levels of market impact, and rerun regressions separately for each subsample of funds. We thus get ten coefficients; then we obtain their average coefficient, standard deviation and t-statistics (the same as that in Fama–Macbeth method). Numbers in parentheses are t-statistics. One, two and three asterisks denote significance at the 10%, 5% and 1% level, respectively.

Independent variable	Dependent variable		
	CAPM alpha	Fama–French 3-factor alpha	Style benchmark adjusted return
INTERCEPT	0.403**	0.416***	0.325***
	(2.93)	(4.61)	(4.63)
LOGTNA	−0.137	−0.221	−0.078
	(−0.85)	(−1.05)	(−0.95)
$(\mathrm{LOGTNA})^2$	−0.026	−0.002	−0.007
	(−0.47)	(−0.04)	(−0.21)
LOGFAM	0.078***	0.077***	0.020
	(5.24)	(5.45)	(1.01)
LOGAGE	−0.049**	−0.049**	−0.083***
	(−2.22)	(−2.22)	(−3.33)
TURNOVER	0.022***	0.003	0.020*
	(3.72)	(0.70)	(2.32)
EXP	−6.037***	−3.906*	−3.801***
	(−4.33)	(−2.60)	(−3.69)
FLOW	0.013***	0.016***	0.003
	(4.95)	(5.82)	(1.21)

Table 12
Fund size and turnover rate. This table examines the relationship between turnover rate and fund size. The sample period is from 2004 to the first half-year of 2010. The data is from Wind Financial and Tianxiang Investment Analysis System databases. The sample includes all Chinese open-end mutual funds by excluding currency, bond, and index funds. Funds less than 6 months are excluded from our sample. We use Fama and MacBeth (1973) method to run the regression. Numbers in parentheses are t-statistics. One, two and three asterisks denote significance at the 10%, 5% and 1% level, respectively.

Panel A: contemporaneous regression				
Independent variable	Dependent variable: TURNOVER			
	Model (1)		Model (2)	
INTERCEPT	1.703*	(1.80)	6.870***	(6.80)
LOGTNA	−2.015***	(−3.31)	−3.279***	(−4.09)
$(\mathrm{LOGTNA})^2$	0.182	(0.77)	0.387	(1.48)
LOGFAM	0.003	(0.03)		
LOGAGE	−0.009	(−0.06)		
EXP	131.451***	(3.51)		
FLOW	−0.020	(−0.11)		
Panel B: regression adjusted for endogeneity				
Independent variable (with lagged one period)	Dependent variable: TURNOVER			
	Model (1)		Model (2)	
INTERCEPT	4.331***	(3.17)	7.188***	(7.91)
LOGTNA	−3.102***	(−4.40)	−4.004***	(−5.12)
$(\mathrm{LOGTNA})^2$	0.574**	(2.21)	0.700**	(2.68)
LOGFAM	−0.367**	(−2.72)		
LOGAGE	0.386	(1.18)		
EXP	74.969*	(1.90)		
FLOW	−0.091	(−0.69)		

As above, we also regress TURNOVER on the one-period-lagged variables to avoid endogeneity, and Table 12 lists the results. We see a significant negative coefficient for LOGTNA but an insignificant (significant) positive coefficient for $(\mathrm{LOGTNA})^2$ for the contemporaneous (lagged) regression. Because the minimal (turning) point of the parabola in the lagged regression is far beyond the largest fund size, overall there is a negative relationship between fund size and turnover rate. Thus, larger funds tend to have a smaller turnover rate. This is consistent with the notion that managers in large funds tend to think twice about strategies involving heavy trading. We also see a positive correlation between fund expense ratio and turnover rate because, when funds trade stocks more frequently, they tend to pay more money to brokers.

Similar to Section 5.1, to test the effect of turnover rate on the relationship between fund size and fund performance, we divide the funds into ten subsamples, each containing funds with similar turnover rate. We rerun the regressions for the subsamples separately. As shown in Table 13, the coefficients of both LOGTNA and $(\mathrm{LOGTNA})^2$ are not significant in general, indicating that the impact of fund size on performance diminishes after controlling for liquidity. Moreover, the coefficient of expense ratio is significantly negative, which again shows that the economy of scale becomes the main force on fund performance conditional on the fund's turnover rate. This is consistent with our findings in Section 5.1.

Given the trading volume constraint, large fund managers tend to consider the liquidity issue more than small fund managers when constructing their portfolio and, hence, choose to hold more stocks when the fund size increases. Thus, we hypothesize the following:

H6. The number of securities in the portfolio is positively correlated with fund size.

To test this hypothesis, we then run the following regression.

$$\begin{aligned}\mathrm{NUMBER}_{i,t} &= e_{0,t} + e_{1,t}\mathrm{TNA}_{i,t} + e_{2,t}(\mathrm{TNA}_{i,t})^2 + e_{3,t}\mathrm{LOGFAM}_{i,t} + e_{4,t}\mathrm{LOGAGE}_{i,t} \\ &\quad + e_{5,t}\mathrm{TURNOVER}_{i,t} + e_{6,t}\mathrm{EXP}_{i,t} + e_{7,t}\mathrm{FLOW}_{i,t} + \varepsilon_{i,t},\end{aligned} \tag{7}$$

where NUMBER is the number of stocks that a fund holds, TNA is the fund's total net assets. From the results reported in Table 14, we can see that the coefficient of fund size is significantly positive, while the

Table 13

The relationship between fund size and performance conditional on turnover rates. This table examines the relationship between fund size and performance conditional on turnover rates. The sample period is from 2004 to the first half-year of 2010. The data is from Wind Financial and Tianxiang Investment Analysis System databases. The sample includes all Chinese open-end mutual funds by excluding currency, bond, and index funds. Funds less than 6 months are excluded from our sample. CAPM alpha, Fama–French 3-factor alpha and style benchmark adjusted return are the three measures of fund performance. We divide the funds into ten subsamples, where each subsample contains funds with similar levels of turnover rate, and rerun regressions separately for each subsample. We thus get ten coefficients; then obtain its average coefficient and its t-statistics (the same as that in Fama–Macbeth method). Numbers in parentheses are t-statistics. One, two and three asterisks denote significance at the 10%, 5% and 1% level, respectively.

Independent variable	Dependent variable		
	CAPM alpha	Fama–French 3-factor alpha	Style benchmark adjusted return
INTERCEPT	0.432***	0.386***	0.391***
	(8.23)	(6.89)	(7.24)
LOGTNA	0.020	0.028	−0.022
	(0.31)	(0.36)	(−0.28)
$(\mathrm{LOGTNA})^2$	−0.037	−0.050	−0.004
	(−1.76)	(−1.93)	(−0.14)
LOGFAM	0.047	0.040	0.003
	(1.26)	(1.21)	(0.14)
LOGAGE	−0.078	−0.083*	−0.102***
	(−2.25)	(−2.71)	(−5.70)
EXP	−7.944***	−7.347**	−4.933*
	(−3.26)	(−2.92)	(−2.13)
FLOW	0.016**	0.021**	0.007
	(2.66)	(2.99)	(1.46)

Table 14
Fund size and the number of stock holding. This table examines the relationship between fund size and the number of stock holding. The sample period is from 2004 to the first half-year of 2010. The data is from Wind Financial and Tianxiang Investment Analysis System databases. The sample includes all Chinese open-end mutual funds by excluding currency, bond, and index funds. Funds less than 6 months are excluded from our sample. We use Fama and MacBeth (1973) method to run the regression. Numbers in parentheses are t-statistics. One, two and three asterisks denote significance at the 10%, 5% and 1% level, respectively.

Independent variable	Dependent variable: NUMBER			
	Model (1)		Model (2)	
Panel A: contemporaneous regression				
INTERCEPT	47.754***	(7.90)	39.087***	(15.32)
TNA	0.735***	(3.76)	0.848***	(5.88)
$(TNA)^2$	−0.010*	(−1.94)	−0.009*	(−2.14)
LOGFAM	5.274***	(4.08)		
LOGAGE	−17.098***	(−5.75)		
TURNOVER	−1.757	(−1.71)		
EXP	519.884***	(3.16)		
FLOW	−2.735	(−1.33)		
Panel B: regression adjusted for endogeneity				
INTERCEPT	45.342***	(7.17)	37.594***	(16.29)
TNA	0.785***	(3.78)	0.905***	(6.00)
$(TNA)^2$	−0.011*	(−2.00)	−0.010**	(−2.21)
LOGFAM	5.661***	(3.88)		
LOGAGE	−17.078***	(−5.44)		
TURNOVER	−1.734	(−1.58)		
EXP	483.115**	(2.60)		
FLOW	−3.814*	(−1.87)		

coefficient of fund size squared is significantly negative. This is to say, a fund indeed diversifies as its size increases, but the marginal impact of fund size on its number of securities decreases as the fund grows larger. Though funds can diversify their securities to alleviate the liquidity restraint as they become bigger, they tend to choose to add only a certain number of securities instead of a large quantity. In addition, we also see from Table 9 that the market impact (MI) increases with the fund size. This supports our finding in that funds would not diversify their securities as much as possible when they become larger; otherwise, sufficient diversification would have pulled down the MI as well. As we know, constructing portfolios by including unfavorable stocks will incur an opportunity cost because favorable securities cannot be found at all times. This is consistent with Pollet and Wilson (2008) in that funds overwhelmingly respond to asset growth by increasing their ownership shares rather than increasing the number of investments in their portfolio because of the managers' inability to generate additional investment ideas after the existing opportunities have been fully exploited. Therefore, fund managers should balance the liquidity cost against the opportunity cost, as shown by Chan et al. (2005). Large funds cannot avoid these two costs simultaneously.

6. Conclusion

This paper aims to examine the relationship between fund size and performance in the Chinese mutual fund industry. Using stock transaction data along with detailed stockholdings of Chinese equity mutual funds from 2004 to the first half of 2010, we document that the size–performance relationship follows an inverted U-shape.

In explaining the relationship between fund size and performance, we focus on the factors of economy of scale and liquidity. We first document that economy of scale and liquidity constraints indeed exist simultaneously in mutual funds. Specifically, the impact of the economy of scale (liquidity) on fund performance decreases (increases) with increasing fund size. Hence, for small funds, the scale of economy plays a more important role than does liquidity; however, for large funds, the role of liquidity is substantial. Therefore, the combination of economy of scale and liquidity explains the inverted U-shape in the relationship between fund size and performance reasonably well.

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