Why Do Mutual Funds Hold Lottery Stocks?

Internet Appendix

Section A.1 investigates the predictive power of funds' lottery holdings on future fund performance. We first perform a univariate portfolio-level analysis of lottery holdings and its relation with future fund performance. We then estimate multivariate cross-sectional regressions, and show that funds with more lottery holdings significantly underperform in the future and this result is robust after controlling for a large number of fund characteristics and other predictors of fund performance. Section A.2 conducts back-of-the-envelope calculation of the two offsetting effects of holding lottery stocks on fund flows.

A.1. Lottery Holdings and Future Fund Performance

A. Univariate sorts

Table A.2 presents the univariate portfolio results. At the beginning of each calendar quarter, we sort funds into deciles based on their lottery holdings (MAX^{Hold} or $\text{MAX5}^{\text{Hold}}$). Decile 1 contains funds with the lowest lottery holdings and decile 10 contains funds with the highest lottery holdings. We then examine the performance of funds in different deciles during the following quarter. Each portfolio is equally-weighted and has the same number of funds at the start of each quarter. A fund remains in the same portfolio for the next three months.

[Table A.2 about here]

Table A.2 shows the monthly 4-factor FFC alpha (using both net-of-expense and gross returns) of mutual funds sorted on the two measures of lottery holdings. In the second column of Table A.2 where we proxy the lottery holdings with MAX^{Hold}, the average alpha decreases almost monotonically from 0.08% to −0.31% per month from decile 1 to decile 10. This indicates a monthly average return difference of −0.39% between the high- and low-MAX^{Hold} deciles with a Newey-West t-statistic of -3.75, showing that this negative return spread is both economically and statistically significant. This result also indicates that funds in the lowest MAX decile generate 4.68% higher risk-adjusted returns per annum than funds in the highest MAX decile. In the fifth column of Table A.2, where we proxy lottery holdings by MAX5$^{\text{Hold}}$, the monthly average alpha spread between the high- and low-MAX$^{\text{Hold}}$ deciles is even larger, -0.51% per month (t-stat. = -3.93). The results remain similar for the 4-factor alpha computed from gross returns instead of net-of-expense returns, suggesting that differences in expenses do not drive the return spread.

Next, we investigate the source of the risk-adjusted return difference between the high- and low-MAX$^{\text{Hold}}$ portfolios of funds: is it due to outperformance of low-MAX$^{\text{Hold}}$ funds, underperformance of high-MAX$^{\text{Hold}}$ funds, or both? For this purpose, we focus on the economic and statistical significance of the risk-adjusted returns of decile 1 versus decile 10. As reported in Table A.2, for all lottery holding measures and net-of-expense returns, 4-factor alphas of funds in decile 10 (high-MAX$^{\text{Hold}}$ funds) are significantly negative, whereas 4-factor alphas of funds in decile 1 (low-MAX$^{\text{Hold}}$ funds) are positive but insignificant. Therefore, we conclude that the significantly negative alpha spread between high- and low-MAX$^{\text{Hold}}$ funds is largely due to the underperformance of high-MAX$^{\text{Hold}}$ funds.

B. Fama-MacBeth cross-sectional regressions

To the extent that lottery holdings are correlated with a large number of fund characteristics shown in Tables 1 and 2, multivariate cross-sectional regressions allow for fund-specific controls. Therefore, we estimate the following Fama-MacBeth regression:

$$\begin{aligned} ALPHA_{i,t+1} &= \lambda_{0,t} + \lambda_{1,t} \cdot ALPHA_{i,t} + \lambda_{2,t} \cdot MAX_{i,t}^{Hold} + \lambda_{3,t} \cdot MAX_{i,t}^{Fund} \\ &\quad + \textstyle\sum_{k=1}^{K} \lambda_{k,t} \cdot FUND\_CONTROLS_{k,t} + \varepsilon_{i,t+1}. \end{aligned} \tag{A.1}$$

where ALPHA$_{i,t+1}$ is the quarterly percentage alpha for fund i in calendar quarter $t+1$ estimated from the FFC four-factor model using the daily returns of fund i. ALPHA$_{i,t}$ is the alpha in quarter t. MAX$_{i,t}^{\text{Hold}}$ is the lottery holdings of fund i in quarter t. Following Goldie, Henry, and Kassa

(2019), we define $\text{MAX}_{i,t}^{\text{Fund}}$ as the maximum daily returns of fund i in the last month of quarter t. $\text{FUND\_CONTROLS}_{i,t}$ include the natural log of total net assets (TNA), natural log of fund age, expense ratio, turnover ratio, fund flows, and fund family size, all measured as of the end of quarter t. We also include the fund's exposure to SMB, HML, and UMD measured using daily returns during quarter t. All of the independent variables are standardized to a mean of zero with a standard deviation of one. This allows us to interpret the coefficients as the change in next quarter's fund alpha for a one standard deviation change in the independent variable.

Table A.3 presents the average intercept and slope coefficients from the Fama-MacBeth cross-sectional regressions. We report the Newey-West adjusted t-statistics in parentheses. Consistent with our earlier findings from the univariate analysis, model (1) provides evidence of a negative and highly significant relation between MAX^{Hold} and future fund alphas. The average slope coefficient on MAX^{Hold} alone is -0.38 with a t-statistic of -3.22, implying that a one standard deviation increase in MAX^{Hold} is associated with a 0.38% decrease in the next quarter's alpha.

[Table A.3 about here]

The signs of slope coefficients on the control variables are consistent with earlier studies. Smaller fund size, lower turnover, and lower expense ratio each have a positive effect on future alpha. Compared with the effect of lottery holdings, the economic significance of a one standard deviation change in any of the fund characteristics is relatively small (0.01% to 0.10% per quarter). As shown in model (4), MAX^{Hold} has an impact on future fund performance even after controlling for past alpha, factor exposures, and a large set of fund characteristics.

Finally, models (5) through (10) control for empirical proxies for the unobservable skill of fund managers, whenever available, and fund characteristics simultaneously, including the return gap measure of Kacperczyk, Sialm, and Zheng (2008), the active share measure of Cremers and Petajisto (2009), the R^2 measure of Amihud and Goyenko (2013), and fund volatility (Jordan and Riley, 2005), all of which have been shown to predict fund performance. In all these specifications, MAX^{Hold} remains a strong predictor of fund performance. Overall, Table A.3 shows that funds with more lottery holdings significantly underperform in the future and this result is robust after controlling for a large number of fund characteristics and other predictors of fund performance.

A.2. Cost-benefit analysis of holding lottery stocks

We conduct back-of-the-envelope calculation of the two offsetting effects of holding lottery stocks on fund flows separately for the Low performance (LOW), Middle performance (MID), and High performance (HIGH) funds defined in Table 3 to account for the nonlinear relation between flows and a fund's past performance. First, we examine LOW funds defined as the bottom 20% of funds based on rankings of quarterly alpha. The benefits of holding lottery stocks to attract more flows is 0.531% $\times$ MAX^{OPT}, where 0.531 is the coefficient on MAX^{Hold} associated with one-standard-deviation increase in MAX^{Hold}, as shown in Panel A of Table 3 (see Model 4). The costs of holding lottery stocks are associated with two channels. First of all, a one-standard-deviation increase in MAX^{Hold} is associated with a decrease of -0.40% of quarterly alpha (see Model 10) in Table A.3 of the Internet Appendix, which translates to a -0.2 decrease in LOW in terms of fractional performance ranking in Table 3. As a result, outflows due to the negative performance of funds holding lottery stocks is -0.02146.[19] In addition, LOW funds will lose additional flows because of the interaction term: LOW $\times$ MAX^{Hold}, as shown in Model 5 of Table 3, and the magnitude is: -2.432% $\times$ MAX^{OPT}. Setting the benefits and costs of holding lottery stocks equal, we solve for MAX^{OPT}, and find it to be equal to 0.72, indicating that LOW funds need to increase their lottery holdings by at least 0.72 standard deviation above the average, in order to have net inflows from holding lottery stocks. Based on summary statistics in Table 1, the average MAX^{Hold} in our sample is 4.30 with a standard deviation of 2.27. That is, worst performing funds need to have a MAX^{Hold} of 5.93 ($= 4.30 + 0.72 \times 2.27$) for benefits of holding lottery stocks to outweigh costs.

Next, we focus on HIGH funds defined as the top 20% of funds based on rankings of quarterly alpha. The benefits of holding lottery stocks to attract more flows is 0.531% $\times$ MAX^{OPT}, from Panel A of Table 3. At the same time, HIGH funds will attract additional flows because of the interaction term: HIGH $\times$ MAX^{Hold} as shown in Model 5 of Table 3: 2.906% $\times$ MAX^{OPT}. Note that due to greater sensitivity of flows to fund performance when best performing funds hold lottery stocks, benefits are higher than those for the worst performers. The estimated costs of holding lottery stocks are outflows from the best performing funds due to performance drag on

[19] This is calculated by using 10.73% (coeff. on LOW in Model 4 of Table 3) multiplied by -0.2.

account of lottery holdings, computed as $12.773\% \times -0.8$, where -0.8 is the decrease in HIGH in terms of fractional performance ranking in Table 3. Setting benefits and costs of holding lottery stocks equal, we again solve for MAX^{OPT}, which in this case turns out to be 2.97, indicating that HIGH funds need to increase lottery holdings by about three standard deviations above the average, in order to have net inflows from holding lottery stocks. That is, best performing funds need to have a MAX^{Hold} of 11.04 ($= 4.30 + 2.97 \times 2.27$) for benefits of holding lottery stocks to outweigh the costs. It is interesting to note that even though both costs and benefits of holding lottery stocks are higher for best performing funds, costs are much higher than the benefits. Therefore, these funds need to hold more lottery stocks than worst performers for benefits to outweigh costs.

Finally, we investigate MID funds defined as the middle 60% of funds based on rankings of quarterly alpha. The benefits of holding lottery stocks to attract more flows is still $0.531\% \times \text{MAX}^{\text{OPT}}$. For MID funds, there are two channels through which the costs are incurred of holding lottery stocks. First, there are outflows due to the performance decline associated with holding lottery stocks, $1.014\% \times -0.6 = -0.00608$, where -0.6 is the decrease in MID in terms of fractional performance ranking in Table 3. In addition, MID funds will not lose any additional flows due to incremental sensitivity of flows to these funds' performance conditional on them holding lottery stocks. As shown in MID, the coefficient on $\text{MID} \times \text{MAX}^{\text{Hold}}$ is statistically insignificant. Again, setting the benefits and costs of holding lottery stocks equal, we solve for MAX^{OPT} and find it to be 1.14, indicating that for the MID funds, they need to increase lottery holdings by at least 1.14 standard deviation above the average, in order to have net inflows from holding lottery stocks. That is, middle-of-the-road performers need to have a MAX^{Hold} of 6.89 ($= 4.30 + 1.14 \times 2.27$) for benefits of holding lottery stocks to outweigh the costs. Not surprisingly, these funds need to hold more lottery stocks than the worst performers but less than the best performers to make it worthwhile.

Table A.1: Descriptive summary statistics for alternative lottery holding measures

This table reports summary statistics for three alternative lottery holding measures. MAX_PROP is average monthly proportion of fund's stock holdings that is invested in lottery stocks (i.e., stocks whose MAX is in the top quintile among all stocks) during a quarter. $\text{TOP10\_MAX}^{\text{Hold}}$ is the average monthly holding-weighted lottery measure (i.e., MAX of the stocks) for the top 10 stocks held by the funds based on their investments during a quarter. LTRY is the composite lottery index. Panel B shows the average characteristics of portfolios of mutual funds in the portfolio formation quarter by each of the three lottery holding measures. At the beginning of each calendar quarter, decile portfolios of mutual funds are formed based on their lottery holdings. Decile 1 contains funds with the lowest lottery holdings and decile 10 contains funds with the highest lottery holdings. Results are also presented for the fifth decile of lottery holdings. The last row reports the *t*-statistic of the difference-in-means test for each lottery holding measure.

Panel A: Quarterly lottery holding measures

Variable	N	Mean	Median	Q1	Q3
MAX_PROP	161,466	0.05	0.03	0.01	0.06
$\text{TOP10\_MAX}^{\text{Hold}}$	161,466	4.11	3.39	2.59	4.79
LTRY	161,210	53.38	50.68	44.42	60.98

Panel B: Fund characteristics

Low MAX_PROP	0.01	Low $\text{TOP10\_MAX}^{\text{Hold}}$	2.55	Low LTRY	38.02
5	0.02	5	3.60	5	48.52
High MAX_PROP	0.16	High $\text{TOP10\_MAX}^{\text{Hold}}$	7.61	High LTRY	77.20
Difference	0.15	Difference	5.06	Difference	39.18
t-stat	26.81	*t*-stat	11.83	*t*-stat	33.73

Table A.2: Univariate portfolio of mutual funds sorted on lottery holdings

This table reports the monthly Fama-French-Carhart (FFC) four-factor alpha from both gross returns and net-of-expense returns on portfolios of mutual funds sorted on the two measures of lottery holdings. At the beginning of each calendar quarter from January 2000 to February 2018, decile portfolios of mutual funds are formed based on the two measures of lottery holdings, MAX^{Hold} or $MAX5^{Hold}$. Decile 1 contains funds with the lowest lottery holdings and decile 10 contains funds with the highest lottery holdings. Each portfolio is equal-weighted and has the same number of funds at the start of each quarter. A fund remains in the same portfolio for the next three months and then portfolio is rebalanced. The alphas are monthly and reported in percentage. Newey-West adjusted t-statistics are given in parentheses. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

		FFC 4-factor alphas from			FFC 4-factor alphas from	
Deciles	MAX^{Hold}	Net-of-expense returns	Gross-of-expense returns	$MAX5^{Hold}$	Net-of-expense returns	Gross-of-expense returns
Low	2.95	0.08	0.19***	1.88	0.12**	0.22***
		(1.39)	(3.12)		(2.06)	(3.82)
2	3.35	0.02	0.12**	2.09	0.04	0.14**
		(0.28)	(2.18)		(0.69)	(2.50)
3	3.53	0.00	0.10**	2.19	-0.02	0.09**
		(0.03)	(2.61)		(-0.45)	(2.36)
4	3.71	-0.04	0.06	2.28	-0.02	0.07
		(-1.10)	(1.48)		(-0.57)	(1.74)
5	3.91	-0.02	0.08	2.40	-0.03	0.07
		(-0.45)	(1.53)		(-0.65)	(1.41)
6	4.18	-0.02	0.09	2.54	-0.02	0.08
		(-0.33)	(1.49)		(-0.37)	(1.40)
7	4.51	-0.02	0.09	2.73	0.01	0.12*
		(-0.34)	(1.51)		(0.21)	(1.94)
8	4.95	-0.06	0.05	2.96	-0.04	0.07
		(-0.94)	(0.86)		(-0.69)	(1.15)
9	5.54	-0.18***	-0.06	3.28	-0.17**	-0.05
		(-2.90)	(-1.06)		(-2.38)	(-0.71)
High	7.06	-0.31***	-0.20**	3.93	-0.38	-0.27**
		(-3.34)	(-2.16)		(-3.67)	(-2.62)
High − Low	4.11***	-0.39***	-0.38***	2.07***	-0.51***	-0.50***
	(10.78)	(-3.75)	(-3.68)	(8.98)	(-3.93)	(-3.85)

Table A.3: Does fund lottery holdings predict future fund performance?

This table reports average slope coefficients from the following Fama and MacBeth (1973) cross-sectional regressions:

$$ALPHA_{i,t+1} = \lambda_{0,t}+\lambda_{1,t}\cdot ALPHA_{i,t}+\lambda_{2,t}\cdot MAX_{i,t}^{Hold}+\lambda_{3,t}\cdot MAX_{i,t}^{Fund}+\sum_{k=1}^{K}\lambda_{k,t}\cdot FUND\_CONTROLS_{k,t}+\varepsilon_{i,t+1}.$$

The dependent variable is the quarterly percentage alpha for fund i in calendar quarter $t+1$ calculated from the FFC four-factor model using daily returns within a quarter. $\text{ALPHA}_{i,t}$ is alpha in the prior quarter. Fund lottery holdings in this table is measured by MAX^{Hold}, the holding-weighted lottery characteristics using stocks' maximum daily returns within the current month. $\text{MAX}_{i,t}^{\text{Fund}}$ is the maximum daily returns of fund i in the last month of quarter t. Fund controls include the natural log of assets, natural log of age, expense ratio, turnover ratio, fund flows, and fund family size, all measured as of the end of quarter t. Controls for FFC SMB (size), HML (value), and UMD (momentum) exposures calculated from daily returns during prior quarter, are included. Other control variables include return gap, active share, fund R^2, and fund volatility (VOL^{Fund}), all measured as of the end of quarter t. All right-hand variables are z-scored (demeaned and divided by their standard deviation) within each quarter. Newey-West adjusted t-statistics are given in parentheses. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

	1	2	3	4	5	6	7	8	9	10
MAX^{Hold}	-0.38***		-0.35***	-0.35***	-0.27**	-0.31***	-0.30***	-0.28***	-0.25**	-0.40***
	(-3.22)		(-3.70)	(-4.70)	(-2.39)	(-3.29)	(-3.70)	(-2.97)	(-2.51)	(-3.09)
MAX^{Fund}		-0.22***	-0.12	-0.18	-0.11	-0.12	-0.10	-0.12	-0.05	-0.18
		(-2.81)	(-1.48)	(-1.52)	(-1.38)	(-1.30)	(-1.21)	(-1.55)	(-0.94)	(-1.25)
ALPHA				0.27***	0.23***	0.25***	0.24***	0.25***	0.23***	0.23***
				(3.77)	(2.76)	(3.35)	(3.59)	(3.74)	(2.94)	(2.92)
LN_TNA				-0.04***						-0.03
				(-2.68)						(-0.93)
LN_AGE				0.02						-0.01
				(1.34)						(-0.68)
EXPENSE				-0.10***						-0.09**
				(-3.58)						(-2.31)
TURNOVER				-0.07**						-0.09**
				(-2.24)						(-2.21)
FLOW				-0.01						-0.01
				(-0.57)						(-0.23)
FAMILY_TNA				0.02						0.02
				(1.17)						(0.67)
β^{SMB}				0.17**						0.24**
				(2.48)						(2.41)
β^{HML}				0.17						0.35**
				(1.43)						(2.26)
β^{UMD}				-0.16*						-0.27**
				(-1.74)						(-2.12)
RETURN_GAP					0.09**				0.10**	0.07**
					(2.09)				(2.24)	(2.10)
ACTIVE_SHARE						0.05			0.14**	0.10*
						(0.93)			(2.31)	(1.73)
R^2							0.09		0.12	0.01
							(1.38)		(1.22)	(0.16)
VOL^{Fund}								-0.04	-0.07	-0.19*
								(-0.46)	(-0.84)	(-1.82)
Fund-quarter obs	163,338	163,338	163,338	163,338	140,949	141,801	161,199	163,338	140,949	140,949
Average R-squared	0.05	0.05	0.08	0.21	0.12	0.13	0.14	0.14	0.18	0.27

Table A.4: Bivariate portfolios of fund lottery holdings (MAX^{Hold}) and fund maximum daily returns (MAX^{Fund})

This table reports the FFC four-factor alphas for bivariate portfolios of mutual funds sorted on fund lottery holdings (MAX^{Hold}) and fund maximum daily returns (MAX^{Fund}). In Panel A, for each quarter funds are first sorted into quintiles based on MAX^{Fund}, and then within each quintile, funds are sorted into decile portfolios based on fund lottery holdings (MAX^{Hold}) over the previous quarter so that decile 1 (10) contains funds with the lowest (highest) lottery holdings. In Panel B, reverse sequential sort is conducted by first sorting funds into quintiles based on MAX^{Hold}, and then within each quintile, funds are sorted into decile portfolios based on fund maximum daily returns (MAX^{Fund}). The alphas are monthly and reported in percentage. Newey-West adjusted t-statistics are given in parentheses. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

Panel A: First sort on MAX^{Fund} then MAX^{Hold}

Low MAX^{Hold}	2	3	4	5	6	7	8	9	High MAX^{Hold}	High − Low
0.09	0.04	-0.01	-0.03	-0.04	-0.04	-0.04	-0.04	-0.09	-0.18*	-0.27***
(1.55)	(0.80)	(-0.24)	(-0.67)	(-0.82)	(-0.77)	(-0.80)	(-0.63)	(-1.43)	(-1.91)	(-3.13)

Panel B: First sort on MAX^{Hold} then MAX^{Fund}

Low MAX^{Fund}	2	3	4	5	6	7	8	9	High MAX^{Fund}	High − Low
0.01	-0.01	-0.00	-0.02	-0.06	-0.07	-0.08	-0.09	-0.09	-0.10	-0.11
(0.47)	(-0.21)	(-0.07)	(-0.44)	(-1.23)	(-1.57)	(-1.56)	(-1.54)	(-1.56)	(-1.53)	(-1.20)