Cost Efficiencies in the Management of Commodity Mutual Funds

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We examine determinants of cost efficiencies in the U.S. commodity mutual fund industry for the period 2001 to 2016. Empirical results show that cost increases in the U.S. commodity mutual fund industry have been less than proportional to increases in fund assets, pointing to economies of scale for the industry. Average cost elasticity varies by fund size, existence of 12b-1 fees, load versus no-load funds, and institutional versus retail funds. Funds without a 12b-1 plan show larger economies of scale than funds with a 12b-1 plan. Institutional funds show greater economies of scale than retail funds since 2010.

JEL Codes: G2, G11, G23

Keywords: commodity mutual funds, mutual fund expenses, economies of scale

INTRODUCTION

Open-end mutual funds are a dominant segment of the asset management industry, with $16.3 trillion in assets at the end of 2016. In 2001, mutual fund assets under management were $7 trillion. This dramatic growth over the last 15 years highlights the importance of open-end mutual funds as an investment vehicle. Within this vast and growing industry are commodity mutual funds. These funds invest in a broad variety of commodities from various categories such as energy (e.g., oil, natural gas, gasoline), agriculture (soybeans, corn, wheat), industrial (copper, aluminum), and precious metals (gold, silver). Rather than purchasing physical commodities, the funds gain exposure to commodities through derivative instruments such as futures, swaps, and options on the underlying physical commodities.

Commodity mutual funds are often added to portfolios as an inflation hedge and a means of providing diversification benefits for traditional equity and fixed income asset classes. Because commodity prices are closely linked to the overall price level, rising inflation produces higher returns for commodity investments. Since real returns for stocks and bonds tend to decline when inflation is rising, commodities help to offset the reduced real returns of traditional asset classes. Over the years, the overall size of the commodity mutual fund market has fluctuated. In 2012, total assets under management for these funds were approximately $129 billion. By 2016, commodity fund assets had declined to $24.8 billion—a sharp drop, but still a substantial part of the overall mutual fund space. Clearly, commodity fund flows have not kept pace with traditional asset classes; this, combined with their potential as a diversifying investment motivate our interest in studying the costs associated with managing them.

Despite the persistence of commodity mutual funds as a diversifying portfolio addition, relatively little is known about the cost of managing these specialty funds. The debate over the value of professional fund management for traditional asset classes is exemplified in Elton, et al. (1993). They work on the premise that fund management requires information that is costly to acquire, and they show that fund management fees for stock and bond funds are generally too high relative to the cost of acquiring this information. However, the relationship between commodity prices and assets in commodity mutual funds is mostly proportional, as the assets of a fund must rise when the prices of commodities rise even without any additional investment by mutual fund shareholders. As assets under management grow, one would then expect the production costs and fees of commodity mutual funds to decline, since the relationship between assets and commodity prices seems to be the primary determining factor in mutual fund performance.

In this paper, we investigate the relationship between commodity mutual fund expenses and fund size. In particular, we evaluate whether there are economies of scale in commodity fund management and whether those scale economies are passed along to fund shareholders in the form of reduced costs. We model fund expenses using a translog cost function and use the estimated cost function to compute cost elasticity of size. We find robust evidence of scale economies in U.S. commodity mutual funds. The cost elasticity of fund size for commodity mutual funds is less than one in every year of our sample except 2009 (in the aftermath of the financial crisis). Economies of scale persist across various sub-samples grouped by size, the existence of a 12b-1 fee plan, load versus no-load, and institutional versus retail funds. Scale economies are greatest among large funds with over $200 million in assets and funds with no 12b-1 plan.

This study is important for two reasons. First, previous studies on mutual funds argue that expenses have a direct impact on fund's return to investors. If economies of scale exist, then as fund size increases, fund expenses per dollar of assets invested will decline and returns to investors will increase. Recent studies show that individual investors are paying more attention to fund expenses and net fund flows are influenced by fund costs (e.g., Choi et al., 2010; Barber, Odean, and Zheng, 2005; Khorana and Servaes, 2004).

Second, with the rapid growth in the number of commodity funds in the market and decline in commodity prices worldwide, several commodity funds are being liquidated. If there are economies of scale in managing these funds, mergers among these funds can be a way to bring down the cost of managing these funds and improve the rate of return for fund investors. This study can help the fund industry as well as regulatory agencies such as the Securities and Exchange Commission (SEC) get a better understanding of the impact of fund mergers on fund's expenses and its benefits to fund shareholders in the form of higher returns and increased shareholder wealth.

We distinguish our study from previous studies in four ways. First, no study has looked at economies of scale for commodity mutual funds. Second, this study evaluates economies of scale in commodity mutual funds over a period of sixteen years from 2001 to 2016. This time period covers the period of commodity price boom, commodity market crash, and the post-economic crisis time period. Third, previous studies show that 12b-1 plan expenses are deadweight costs and have not resulted in reduced expenses to shareholders. We find further evidence to support this—funds without 12b-1 plans have greater economies of scale than funds with 12b-1 plans. Finally, Freeman and Brown (2001) report that institutional funds carry a lower expense ratio due to their better bargaining position that forces fees to decline as assets increase. We find mixed evidence here; retail funds exhibit greater economies of scale during 2001 to 2008, but institutional fund scale economies are greater from 2010 to 2016.

PREVIOUS STUDIES

Mutual funds have been the subject of considerable attention in financial literature. Early research by Treynor (1965), Sharpe (1966) and Jensen (1968) attempted to determine whether equity mutual funds were able to earn consistently positive risk-adjusted returns. Although these studies documented significant differences in risk-adjusted returns across funds, it was apparent that those differences were to a large extent attributable to differences in mutual fund fees.

Logically, mutual fund fees are justified if they offset other fund costs borne by investors. According to McDonald (1974) and Chevalier and Ellison (1999) mutual fund managers are justified in asking for management fees. In line with these findings, other research focuses on the utility of different types of mutual fund fees. Ferris and Chance (1987) contend that front-end loads, deferred sales charges, and redemption fees represent incentives to maintain investments in a mutual fund. These fees may be justified if they allow the fund to reduce its distribution costs and if they lower other costs that are passed on to investors. Other studies examine 12b-1 fees, which are sales and distribution expenses paid out of fund assets. Ferris and Chance (1987) and McLeod and Malhotra (1994) show that 12b-1 fees are largely a deadweight cost for investors. Due to economies of scale, larger funds have lower expense ratios (McLeod & Malhotra, 1994). The authors also find that 12b-1 fee mutual funds tend to have higher expense ratios than those without 12b-1 expenses. In their later study, Malhotra and McLeod (1997) re-examine the effect of 12b-1 fees and studied cross-sectional differences in expenses across the mutual fund industry. They find that turnover and 12b-1 fees are statistically significant and correlated with expense ratios, while fund size, age, and no-load status are associated with lower expense ratios. Dellva and Olson (1998) showed that 12b-1 fees, deferred sales charges, and redemption fees all increase expenses and that only a limited number of mutual funds with these fees can earn risk-adjusted returns that justify this assortment of fees. Dellva and Olsen advise investors not to select funds with front-end loads, 12b-1 fees, deferred sales charges and redemption fees but also caution that the avoidance of these fees will not necessarily result in superior risk-adjusted fund performance.

Economies of scale have been reported in many areas of the financial services sector. Amel et al. (2004) provide a thorough review of evidence in commercial and investment banking, insurance, and asset management. Within the mutual fund industry, economies of scale have been well-documented. Ferris and Chance (1987) find a negative relation between expense ratios and fund size. Malhotra, Martin, and Russel (2007), Baumol, Goldfeld, Gordon, and Koehn (1990), and Khorana, Servaes, and Tufano (2009) also document economies of scale for equity and bond funds. Banko, Beyer, and Dowen (2010) conduct their analysis at the fund management company level and find economies of scale and scope. The extant literature is not entirely in agreement. Indro et al. (1999) posit an optimal fund size where the expense ratio is minimized, and beyond that optimal size expenses increase as diseconomies of scale take over. In contrast, Latzko (1999) reports expense ratios continuously decline with fund size, although gains due to increased size are minimal once a fund reaches about $3.5 billion in assets. However, economies of scale specific to commodity mutual funds have not been studied in extant literature.

DATA

We obtain share class-level data from Morningstar Principia and CRSP. The data set covers funds categorized as commodity funds for the years 2001 through 2016. Our annual data for each fund includes fund age (in years), assets under management (dollars), front-end and deferred load (percent), total return over the preceding twelve months (percent), manager tenure (years), turnover ratio (percent), and 12b-1 plan fees (percent). The dollar cost of managing a fund is computed by multiplying the expense ratio by fund assets.

<Insert Exhibit 1 about here>

Exhibit 1 summarizes the data, and a few overall trends are evident. First, the number of funds grew leading up to the 2008 financial crisis, increasing from 64 in 2001 to 117 in 2007. In the aftermath of the crisis, the number of funds dropped sharply to 24 in 2009 before recovering. Fund age also declines around the time of the crisis before increasing, suggesting that older funds were closing as a result of the crisis. Average fund size varies substantially across the sample period, from a low of $88 million in 2002 to a high of over $2.4 billion in 2012. There is a clear pattern in sales loads. Average front-end loads decline from 1.8% in 2001 to 0.7% in 2010, subsequently increasing steadily to 1.2% in 2016. Deferred sales loads follow a similar pattern. In contrast, average 12b-1 fees show an overall declining trend throughout the sample. Average total dollar expenses increase from $1.1 million in 2001 to $10.7 million in 2010, falling dramatically after 2013.

METHODOLOGY

Our methodology involves estimation of the coefficients of a translog cost function to determine which factors contribute to economies of scale and their degree of contribution. We then estimate cost elasticity with respect to fund assets using the first derivative of the translog cost function. Cost elasticity is estimated for the full sample, for each year, and for subsets of the annual samples. In the full sample, a panel data approach allows for pooling of observations on a cross-section of funds over sixteen years. When observations possess the double dimension (cross-sectional and time series), the crucial aspect of the problem is to have a clear understanding of how differences in behavior across individuals and/or through time could and should be modeled. A panel data set offers several econometric benefits over traditional pure cross-sectional or time series data sets. The most obvious advantage is that the number of observations is typically much larger in panel data, which will produce more reliable parameter estimates and thus enable us to test the robustness of our linear regression results. Panel data also alleviates the problem of multicollinearity; when the explanatory variables vary in two dimensions (cross-sectional and time series), they are less likely to be highly correlated. With panel data, individuals, firms, states or countries may be heterogeneous across time (Balestra, 1995). Time series and cross-sectional studies not controlling for this heterogeneity run the risk of obtaining biased results (Baltagi, 2000). Panel data controls for individual heterogeneity. The most intuitive way to account for individual and/or time differences in the context of panel data regression is to use the fixed effects model. We employ the least squares dummy variable fixed effects model to estimate cost efficiencies in the mutual fund industry.

Translog Cost Function[1]

In financial economics, the translog model is the most pervasive approach for investigating economies of scale.[2] The translog cost model implicitly assumes a U-shaped average total cost function. We use this model because it allows economies of scale to vary with level of fund assets. The estimation of scale economies with a translog cost function requires cost and output measures. For commodity mutual funds, the output is total assets under management. The total cost of each fund is defined as the total expenses of operating its funds, including its management fee. A fund's total operating expense is modeled as a function of total assets and control variables that affect level of expenses.

Equation 1 is the translog cost function, which we estimate via OLS regression.

$$\ln COST_i = \beta_0 + \beta_1 \ln ASSETS_i + 0.5\beta_2 (\ln ASSETS_i)^2 + \Sigma_i \beta_i X_i + e_i \qquad (1)$$

[1]A translog cost function is a Taylor series expansion for estimating the Cobb-Douglas production function. In the area of models of producer behavior, Arrow, Chenery, Minhas, and Solow (1961) call into question the inherent restriction of the Cobb-Douglas model that all elasticities of factor substitution are equal to one. Researchers have since developed numerous flexible functions that allow substitution to be unrestricted. The transcendental logarithmic, or translog, function is the most frequently used flexible function in empirical work. The function was developed by Kmenta (1967) as a means of approximating the production function. According to Guilkey, Lovell, and Sickles (1983), a translog function is the most reliable of the several available alternatives. Typically, the translog cost function includes input prices. For the mutual fund industry, we do not have access to input prices.

[2] Many studies have used translog cost functions to study economies of scale in the financial services industry. These include studies by Bers, Springer, and Thomas (1990) (real estate investment trusts), Goldberg, Hanweck, Keenan, and Young (1991) (securities industry), Drake (1992) (U.K. Building societies), Noulas, Miller, and Ray (1993) (large sized U.S. banks), Zumpano and Elder (1994) (real estate brokerage services), Clark and Speaker (1994) (banking industry), McNulty, Verbrugge, and Blackwell (1995) (thrifts), Altunbas and Molyneuz (1996)(French, German, Italian, and Spanish banking markets), and Lang and Welzel (1996) (German cooperative banks).

In the translog function, COST is the dollar amount of a fund's total operating expenses, ASSETS is total fund assets, and X_j includes control factors that affect the costs of management and administration of a fund based on previous studies. Our control variables and reasons for selecting them are as follows.

Age: Chance and Ferris (1987), Ferris and Chance (1990), McLeod and Malhotra (1994), and Malhotra and McLeod (1997) observe that an older fund is expected to have lower costs, because as funds get older they learn from past mistakes and become more efficient in managing costs. Thus, we expect a negative coefficient for fund age.

Loads: Front-end load and deferred load are included as control variables, because studies by McLeod and Malhotra (1994) and Malhotra and McLeod (1997) show that the size of the load is positively related to expense ratio and cost of managing a fund. We expect a positive regression coefficient for both of these variables.

Turnover ratio: Turnover measures a fund's trading activity, calculated as the ratio of fund purchases or sales (whichever is smaller, and excluding short-term assets) in a fund's portfolio by average net assets. Connelly (1997) and Fortin and Michelson (1998) show that transactions costs make up a significant percent of fund expense ratios. A fund's transactions costs should be higher if turnover in the portfolio is higher. Thus, the regression coefficient should be positive for turnover ratio.

12b-1 Plan: In 1980, the SEC approved Rule 12b-1, which allows payment of distribution fees to selling agents out of the net assets of a mutual fund. Proponents of 12b-1 plans argue that increasing the sales incentive for brokers will lead to increased inflow of investment funds, which will in turn lead to economies of scale in fund management. Opponents of 12b-1 plans argue that these plans are nothing more than an attempt to conceal additional sales charges. Previous studies show that funds with 12b-1 plans have higher expenses. Thus, we expect a positive regression coefficient for this variable.

12-month total return: Some in the mutual fund industry argue that you get what you pay for. Therefore, we use 12-month total return as a control variable.

Share Class: We also distinguish between institutional share classes from retail funds by using a dummy variable that is assigned a value of 1 if the fund belongs to an institutional share class and 0 otherwise.

Cost Elasticity

The most common measure of operating efficiency in economies of scale studies is the elasticity of cost with respect to output. When the rate of increase in output exceeds the rate of increase in cost in an industry, economies of scale characterize that industry. For the mutual fund industry, cost elasticity with respect to assets can be used to evaluate the existence and extent of economies of scale. It is measured as the percentage change in cost associated with a percentage change in fund assets. We calculate this cost elasticity by taking the first derivative of the translog cost function (Equation 1) with respect to assets. The result is Equation 2.

$$\frac{\partial(\ln \text{COST})}{\partial(\ln \text{ASSETS})} = \beta_1 + \beta_2(\ln \text{ASSETS}) \qquad (2)$$

If cost elasticity is less than one, mutual fund expenses increase less than proportionately with changes in fund assets. This implies that economies of scale exist. If the elasticity is greater than one, we can infer that there are diseconomies of scale. To investigate the existence of economies of scale, we estimate the scale economy measure for each fund and then average across funds to derive various group scale economy measures.

EMPIRICAL RESULTS

Exhibit 2 summarizes regression results for the translog cost function as specified in equation 1 above.

<Insert Exhibit 2 about here>

Adjusted R-squared ranges between 0.53 in 2005 and 0.995 in 2009. The panel data model shows that our model explains 85.5 percent of the total variation in dollar expenses of commodity mutual funds. In the whole sample, the coefficients on fund size are positive and significant, in line with expectations. This implies positive cost elasticity in that the level of assets directly affects fund costs. Coefficients for the 12b-1 plan variable are all positive and highly statistically significant, as expected. Thus, funds with 12b-1 plans have significantly higher fund management costs. The panel data shows that manager tenure is negatively related to dollar cost of managing commodity funds, and the coefficient is statistically significant. Managers learn to manage commodity funds in a more cost-effective manner and, therefore, bring more returns to shareholders. Panel data results also show a positive and significant relation between a fund’s turnover ratio and dollar cost of managing a commodity fund. Consistent with previous studies, we find that higher turnover is associated with higher dollar cost of fund management. Furthermore, twelve-month total return is positively related to dollar cost of fund management and is statistically significant. The coefficient on front-end load is positive and significant in the full sample.

Economies Scale by Year

After modeling the dollar cost of fund management, we obtain cost elasticities for each fund year in our sample. Figure 1 shows average cost elasticities by year. With the exception of 2009, average cost elasticities range between 0.89 and 0.93 each year, indicating the presence of economies of scale in commodity fund management. A two-tailed t-test shows that the differences are significantly different from one for each year. In contrast, the average cost elasticity in 2009 is 1.08, suggesting diseconomies of scale in that year. The 2008 financial crisis and 2009 post-crisis recovery are likely driving the difference between 2009 and the rest of the sample. Average fund turnover in 2009 (393%) was substantially higher than any other year in the sample. Transaction costs associated with this turnover would increase fund expenses. Consolidation and liquidation of funds during the year probably led to higher expenses as well; the number of funds in the sample declined by 56% between 2008 and 2009, from 55 to 24.

For the full panel of data, the cost elasticity is significantly less than one, further evidence that commodity mutual funds exhibit economies of scale. Overall, fund expenses increase less than proportionately with fund assets.

<Insert Figure 1 about here>

Economies Scale by Fund Size

To estimate economies of scale for commodity funds by asset size, we divide the sample into four size categories: (1) very small funds with $10 million in assets or less, (2) small funds with assets between $10 million and $50 million, (3) medium-sized funds with assets from $50 million to $200 million, and (4) large funds with over $200 million in assets. Exhibit 3 presents average cost elasticities for funds groups divided into the four asset size categories.

<Insert Exhibit 3 about here>

In all the cases except for the year 2009, statistically significant economies of scale exist for the fund subsets according to size. In 2009, average cost elasticity is above one, but in all other years it ranges between 0.86 and 0.96. For the years 2001 to 2016 and in the whole sample, largest economies of scale are for large funds over $200 million in assets, with a cost elasticity of 0.87. This figure implies that a one percent increase in assets under management for a large commodity fund is associated with a 0.87 percent increase in the cost of managing that fund, holding other factors constant.

Economies of Scale by No 12b-1 Plan and 12b-1 Plan

Next, we divide the sample into funds with and without 12b-1 fees. Exhibit 4 shows average cost elasticities for these groups.

<Insert Exhibit 4 about here>

Both 12b-1 and non-12b-1 plan funds show statistically significant economies of scale for each year except 2009 as well as for the full sample. The panel data model shows that non-12b-1 plan funds enjoy larger economies of scale in comparison to commodity funds with 12b-1 plans. Therefore, the contention that 12b-1 plans will bring in increased returns through economies of scale is not supported by our results.

Economies of Scale by Institutional and Retail Funds

Exhibit 4 also shows retail funds tend to have a lower cost elasticity relative to institutional funds from 2001 to 2007 (just before the economic crisis started), which translates into greater cost efficiency for retail commodity funds relative to institutional funds. From 2008 to 2016, institutional funds show a lower cost elasticity and thus greater scale economies relative to retail commodity funds. Panel data analysis shows that on average institutional funds have the same economies of scale as retail funds.

Economies of Scale by Load

Front-end load funds, deferred-load funds, and no-load funds all exhibit economies of scale, with cost elasticities less than one for every year from 2001 to 2016 except for 2009. The full panel also shows cost elasticity less than one for front-end, deferred, and no-load funds, and it also shows that no-load funds have slightly greater cost efficiencies relative to load funds (front-end and deferred load combined) and the difference in cost efficiencies is statistically significant.

SUMMARY AND CONCLUSIONS

We examine economies of scale in commodity mutual funds and the factors that impact fund management costs in the commodity mutual fund industry. We study economies of scale over a period of sixteen years from 2001 to 2016—no study has looked at economies of scale in the mutual fund industry over such a long period of time. We estimate a translog cost function and compute average cost elasticities for funds grouped according to size, the existence of 12b-1 plans, load versus no-load funds, and institutional versus retail funds. Cost elasticities are less than one for all of these subsets and for the full sample, providing robust evidence of economies of scale in the commodity fund industry. Funds without a 12b-1 plan enjoy larger economies of scale in contrast to funds with a 12b-1 plan. Therefore, funds with 12-1 plans have failed to achieve the intended objective of economies of scale from increased sales incentives. Shareholders of these funds are not benefiting through better returns as a result of these fee plans.

Our results clearly show that the size of the economies of scale is not constant on a year to year basis. In fact, we find that the size of economies of scale varies over time.

Therefore, policy decisions on fund mergers that are purported to achieve economies of scale should not be based on a single year of data. Although beyond the scope of this study, future research could shed light on what drives this time variation in cost elasticity, particularly for the post-crisis year 2009 where the industry exhibits diseconomies of scale.

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Exhibit 1: Summary statistics

Exhibit 1 presents means and standard deviations for the main variables in our analysis.

		2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	Full Sample
Number of Funds		64	82	98	95	87	97	115	55	24	73	49	53	45	45	72	63	1117
Age	Mean	10.4	9.7	9.6	10.4	11.6	11.9	10.8	10.4	6.3	3.8	4.6	4.9	4.6	5.7	5.2	6.9	8.6
	SD	(7.9)	(8.0)	(8.0)	(8.3)	(8.6)	(8.9)	(9.2)	(8.5)	(3.1)	(3.2)	(4.1)	(4.2)	(3.2)	(3.1)	(3.1)	(3.0)	(7.5)
Deferred Load	Mean	1.0%	1.1%	0.9%	0.8%	0.9%	0.9%	0.6%	1.0%	0.8%	0.4%	0.4%	0.3%	1.0%	0.7%	0.5%	0.6%	0.8%
	SD	(1.8%)	(1.8%)	(1.7%)	(1.6%)	(1.7%)	(1.7%)	(1.4%)	(1.7%)	(1.6%)	(1.1%)	(1.0%)	(1.0%)	(1.0%)	(0.9%)	(0.8%)	(0.8%)	(1.5%)
Turnover Ratio	Mean	62%	86%	261%	203%	78%	72%	94%	129%	393%	102%	133%	189%	238%	199%	131%	189%	145%
	SD	(53%)	(66%)	(519%)	(396%)	(119%)	(69%)	(105%)	(220%)	(398%)	(139%)	(148%)	(293%)	(562%)	(256%)	(181%)	(296%)	(281%)
Front-End Load	Mean	1.8%	1.6%	1.2%	1.2%	1.2%	1.4%	1.2%	1.1%	1.0%	0.7%	1.0%	1.2%	1.0%	1.1%	1.1%	1.1%	1.2%
	SD	(2.4%)	(2.4%)	(2.2%)	(2.2%)	(2.3%)	(2.3%)	(2.2%)	(2.2%)	(2.1%)	(1.8%)	(2.1%)	(2.2%)	(2.1%)	(2.2%)	(2.2%)	(2.2%)	(2.2%)
Manager Tenure	Mean	4	4	4.1	4.6	5.2	5.4	4.6	4.6	4.5	3.7	3.5	3.3	3.7	4.6	4.4	5.8	4.4
	SD	(3.0)	(3.4)	(3.2)	(3.7)	(3.7)	(3.9)	(3.8)	(4.9)	(2.7)	(3.1)	(3.1)	(1.9)	(2.6)	(2.6)	(2.7)	(2.8)	(3.4)
Net Assets	Mean	100	88	134	226	425	434	394	456	851	1,800	728	2,414	657	535	150	287	533
	SD	(215)	(194)	(252)	(548)	(841)	(935)	(839)	(911)	(2,221)	(7,136)	(2,270)	(10,118)	(1,687)	(1,427)	(485)	(872)	(3,041)
Dollar Expenses	Mean	1.1	1.1	1.6	2.4	2.1	4.0	4.3	3.5	7.8	10.7	6.5	11.9	5.5	4.3	1.2	2.3	3.9
	SD	(1.5)	(1.4)	(1.9)	(3.2)	(4.1)	(5.5)	(7.2)	(5.3)	(16.6)	(31.4)	(17.1)	(41.8)	(12.7)	(10.7)	(3.7)	(6.5)	(14.1)
12-month Return	Mean	20%	24%	42%	16%	37%	20%	31%	-38%	24%	20%	-6%	0%	-7%	-22%	-25%	13%	13%
	SD	(30%)	(33%)	(19%)	(20%)	(12%)	(12%)	(14%)	(15%)	(13%)	(26%)	(6%)	(3%)	(6%)	(6%)	(4%)	(3%)	(28%)
12b-1 Fees	Mean	0.42%	0.48%	0.43%	0.41%	0.42%	0.42%	0.43%	0.43%	0.44%	0.23%	0.34%	0.31%	0.30%	0.30%	0.30%	0.29%	0.38%
	SD	(0.4%)	(0.4%)	(0.4%)	(0.4%)	(0.4%)	(0.4%)	(0.4%)	(0.4%)	(0.4%)	(0.4%)	(0.4%)	(0.4%)	(0.4%)	(0.4%)	(0.4%)	(0.4%)	(0.4%)

Exhibit 2: Translog cost function results

Exhibit 2 presents estimates of the translog cost function for commodity mutual funds. The dependent variable is the natural log of a fund’s total dollar expenses. Regressions include year fixed effects. ***, ** and * indicate statistical significance at the 0.01, 0.05 and 0.10 levels, respectively.

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	Full Sample
Number of Funds	64	82	98	95	87	97	115	55	24	73	49	53	45	45	72	63	1,117
Adjusted R^2	0.977	0.969	0.974	0.976	0.530	0.972	0.982	0.985	0.995	0.985	0.987	0.993	0.991	0.990	0.993	0.991	0.855
Ln of Assets	2.439	0.836	2.303	1.735	5.173	1.264	0.909	1.627	1.000	1.189	1.217	1.123	1.176	1.149	1.116	1.134	1.11
t-statistic	7.4***	2.97***	7.89***	8.72***	2.55**	5.94***	5.14***	7.34***	17.73***	8.58***	6.03***	8.8***	7.34***	7.02***	9.14***	8.8***	16.30***
½ Ln (Assets)^2	-0.090	0.003	-0.079	-0.046	-0.217	-0.019	0.002	-0.039	-0.025	-0.014	-0.016	-0.008	-0.012	-0.010	-0.009	-0.009	-.009
t-statistic	-4.7***	0.2	-4.64***	-4.01***	-1.96*	-1.56	0.2	-3.14***	-1.94*	-1.86*	-1.41	-1.1	-1.26	-1	-1.23	-1.19	-2.35**
12b-1 Plan	32.37	48.56	55.02	49.76	126.41	75.44	63.89	0.90	0.48	31.56	51.63	62.94	58.27	61.35	60.23	67.78	55.64
t-statistic	2.87***	3.93***	5.8***	4.87***	1.48	5.58***	7.45***	6.24***	4***	2.26**	2.98***	4.18***	3.11***	3.38***	5.11***	5.17***	8.95***
Manager Tenure	0.001	0.006	-0.004	-0.008	-0.226	0.002	-0.001	-0.008	-0.034	-0.067	-0.027	-0.038	-0.040	-0.031	-0.037	-0.031	-0.02
t-statistic	0.1	0.63	-0.41	-1.08	-3.53***	0.19	-0.19	-0.91	-0.87	-0.84	-1.03	-1.49	-0.96	-0.85	-1.78*	-1.44	-3.46***
Turnover Ratio	0.081	0.164	0.011	0.006	0.026	0.125	0.087	0.001	0.000	0.032	0.007	-0.008	-0.010	0.030	0.007	0.015	0.037
t-statistic	1.38	3.13***	1.95*	0.71	1.74*	2.5**	3.12***	2.58**	0.01	1.22	0.26	-0.67	-1.19	1.71*	0.35	1.19	4.27***
12-month Total Return	-0.001	0.004	0.004	-0.001	0.087	0.002	0.000	0.003	0.002	-0.001	-0.008	-0.011	-0.002	0.001	0.012	-0.016	0.004
t-statistic	-1.3	4.49***	2.98***	-0.92	4.54***	0.63	-0.2	0.92	0.54	-0.55	-1.21	-1.09	-0.2	0.15	1.59	-1.4	2.91**
Front-end Load	-2.094	0.550	0.245	0.087	5.814	2.924	1.248	0.030	0.020	0.087	0.520	-1.791	-0.765	-0.524	-1.106	0.015	1.08
t-statistic	-1.48	0.33	0.19	0.06	0.54	1.81*	1	1.6	1.14	0.04	0.23	-0.95	-0.29	-0.21	-0.68	0.01	.99
Deferred Load	0.462	0.110	-3.919	-1.535	-0.920	-0.845	0.355	-0.026	-0.019	3.797	-3.020	-5.024	-2.143	0.606	0.116	-0.472	.02
t-statistic	0.2	0.04	-1.68*	-0.65	-0.05	-0.29	0.15	-0.83	-0.64	1	-0.62	-1.17	-0.35	0.1	0.02	-0.09	.79
Fund Age	0.010	0.002	0.006	0.001	-0.004	0.007	0.005	0.012	0.036	0.077	0.026	0.021	0.033	0.018	0.037	0.013	0.004
t-statistic	2.03**	0.4	1.37	0.32	-0.14	1.57	1.18	1.96*	1.7	1.03	1.16	1.72*	0.82	0.55	1.87*	0.6	1.29
Institutional	-0.529	-0.325	-0.186	-0.313	1.459	-0.111	-0.170	-0.031	-0.026	-0.389	-0.193	-0.283	-0.243	-0.278	-0.188	-0.137	-0.14
t-statistic	-4.25***	-2.46**	-1.67*	-3.09***	1.78*	-0.88	-1.7*	-0.23	-0.27	-3.9***	-1.62	-2.84***	-1.7*	-1.98*	-2.15**	-1.4	-2.16**

Exhibit 3: Cost elasticity by fund size

Exhibit 3 presents mean cost elasticities for commodity mutual funds according to fund size. T-statistics for the null hypothesis that the mean cost elasticity equals one (i.e., constant returns to scale) are also presented. ***, ** and * indicate statistical significance at the 0.01, 0.05 and 0.10 levels, respectively.

Fund Assets ($)	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	Full Sample
<$10	0.94	0.94	0.94	0.94	0.93	0.94	0.94	0.94	1.13	0.94	0.95	0.96	0.96	0.95	0.96	0.95	0.95
million	-26.6***	-19.9***	-27.5***	-15.7***	-19.5***	-11.2***	-19.7***	-9.4***	15.8***	-8.4***	-7.2***	-5.2***	-6.6***	-9.1***	-12.9***	-11.4***	-27.1***
$10 – $50	0.91	0.91	0.91	0.91	0.91	0.91	0.92	0.91	1.10	0.91	0.91	0.92	0.92	0.91	0.91	0.91	0.92
million	-80.8***	-87.7***	-81.8***	-71.6***	-50.9***	-54.9***	-72.3***	-41.6***	58.1***	-46.9***	-57.8***	-50.3***	-43.4***	-29.0***	-36.7***	-44.0***	-51.4***
$50 - $200	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	1.09	0.89	0.89	0.90	0.89	0.89	0.89	0.89	0.90
million	-68.6***	-93.8***	-103.1***	-123.1***	-127.2***	-126.5***	-116.9***	-70.3***	42.8***	-71.4***	-48.0***	-65.5***	-45.4***	-35.9***	-75.4***	-85.8***	-62.9***
> $200	0.87	0.87	0.87	0.87	0.86	0.87	0.86	0.86	1.05	0.86	0.86	0.86	0.86	0.86	0.87	0.87	0.87
million	-38.4***	-38.3***	-63.0***	-65.2***	-61.9***	-65.8***	-75.6***	-48.2***	12.1***	-45.6***	-38.5***	-35.2***	-40.7***	-34.7***	-38.0***	-31.9***	-66.5***

Exhibit 4: Cost elasticity by 12b-1 plan, load, and institutional vs. retail

Exhibit 4 presents mean cost elasticities for commodity mutual funds according to whether the fund has a 12b-1 fee plan, load types, and institutional versus retail funds. T-statistics for the null hypothesis that the mean cost elasticity equals one (i.e., constant returns to scale) are also presented. ***, ** and * indicate statistical significance at the 0.01, 0.05 and 0.10 levels, respectively.

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	Full Sample
Number of Funds	64	82	98	95	87	97	115	55	24	73	49	53	45	45	72	63	
Funds with 12b-1 Plan	0.91	0.91	0.90	0.90	0.89	0.89	0.90	0.90	1.08	0.89	0.90	0.89	0.91	0.91	0.93	0.92	0.91
	-31.2***	-29.2***	-36.5***	-32.3***	-35.6***	-36.4***	-31.2***	-20.7***	12.9***	-15.6***	-16.8***	-19.5***	-11.0***	-11.4***	-12.0***	-12.3***	-56.9***
Funds with no 12b-1 Plan	0.90	0.91	0.90	0.89	0.88	0.89	0.89	0.89	1.07	0.88	0.88	0.91	0.89	0.89	0.91	0.90	0.89
	-18.7***	-16.0***	-22.1***	-26.3***	-25.7***	-17.6***	-22.9***	-13.7***	4.5***	-25.5***	-19.5***	-9.8***	-10.0***	-11.3***	-11.5***	-14.4***	-51.1***
Funds with front-end Load	0.90	0.90	0.90	0.89	0.89	0.89	0.89	0.89	1.08	0.89	0.89	0.88	0.91	0.92	0.93	0.92	0.90
	-25.5***	-28.6***	-29.7***	-25.2***	-25.4***	-22.8***	-21.0***	-18.7***	6.0***	-15.4***	-12.3***	-14.6***	-5.5***	-6.4***	-8.4***	-8.6***	-44.1***
Funds with deferred load	0.92	0.92	0.91	0.91	0.90	0.90	0.90	0.91	1.10	0.91	0.91	0.88	0.91	0.90	0.93	0.92	0.91
	-21.4***	-22.9***	-30.6***	-30.9***	-29.3***	-31.2***	-26.0***	-16.4***	14.5***	-17.7***	-13.6***	-7.6***	-10.4***	-11.7***	-10.5***	-12.0***	-40.2***
No Load Funds	0.91	0.91	0.90	0.89	0.88	0.89	0.90	0.89	1.07	0.88	0.89	0.90	0.90	0.91	0.93	0.92	0.90
	-16.3***	-14.2***	-25.0***	-23.4***	-26.2***	-19.5***	-22.9***	-14.0***	6.1***	-21.6***	-15.7***	-13.9***	-9.2***	-9.3***	-10.3***	-10.8***	-50.0***
Institutional Funds	0.93	0.94	0.93	0.92	0.91	0.92	0.92	0.91	1.06	0.88	0.89	0.90	0.89	0.89	0.91	0.90	0.91
	-11.2***	-9.3***	-10.1***	-10.3***	-15.7***	-9.3***	-10.4***	-9.2***	5.0***	-20.0***	-13.9***	-11.0***	-9.9***	-11.1***	-11.6***	-14.1***	-33.5***
Non-institutional Funds	0.91	0.91	0.90	0.89	0.89	0.89	0.89	0.89	1.09	0.90	0.90	0.88	0.92	0.92	0.94	0.93	0.91
	-33.4***	-33.1***	-43.5***	-43.1***	-41.2***	-40.2***	-37.8***	-23.0***	12.6***	-21.4***	-17.9***	-17.3***	-10.7***	-11.1***	-11.4***	-12.1***	-67.5***