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Tracking Errors of Exchange Traded Funds and Index Funds

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Tracking Errors of Exchange Traded Funds and Index Funds

Exchange traded funds (ETF) are one of the recent financial innovations widely viewed as significantly better investments than mutual funds given their lower fee structure and tax efficiency. Individual investors are increasingly using ETFs tracking most popular stock indices to achieve their investment goals. In some cases, investors are using these ETFs to replace index mutual funds in their long-term portfolios. Thus, it is important to compare the performance of widely held ETFs and index funds in terms of their ability to consistently track the underlying index. Another interesting research question is whether tracking errors of these two investment vehicles exhibit significant differences in the periods associated with high degree of uncertainty and volatility. Recent extreme volatility in the financial market provides a perfect setting to empirically test tracking efficiency of index ETFs and corresponding index mutual funds. In this paper we compare ETFs and Index funds performance during the period 2007-2012. This period has seen a significant increase in the ETFs both in terms of total net assets and total number of ETFs. We document a significant improvement in tracking ability of all the ETFs during the six year period. Our results suggests that for index funds perform relatively better than the corresponding ETFs in tracking large-cap and broad-market indices. In contrast, ETFs exhibit lower tracking errors compared to corresponding index funds for mid-cap indices, small-cap indices and for narrower indices tracking a segment of large-cap markets. These results support empirical and theoretical predictions in Guedj and Huang (2008). They argue that ETFs are better suited for narrower and less liquid underlying indexes. This is due to the “in kind redemption” feature of ETFs, which help them avoid flow-induced trading costs. Our results also document significant increase in tracking errors for both ETFs and index funds when market volatility is high, however their relative performance do not change. The volatility of daily returns for ETFs is lower than the volatility of daily returns of their underlying index and that of corresponding index funds during the entire sample period.

JEL Classifications: G11, G23

Keywords: ETF, Index Fund, Indexing,

1. INTRODUCTION

Investors who choose indexed products over actively managed funds, can choose exchange traded funds or index funds. Indexed products are especially good in taxable accounts because their buy-and-hold style means they don't have to sell their holdings which have generated significant returns. This minimizes the annual capital gains distributions to investors and therefore reducing effective taxes. ETFs and index mutual funds are two popular indexed products which compete to attract institutional and individual investors. While mutual funds have a long history, exchange traded funds are recent financial innovation. However, exchange traded funds have become very popular in the short time and have witnessed tremendous growth in recent years. Popularity of ETFs amongst institutional and retail investors is evident from recent data which suggests ETFs now account for approximately one-third of the daily volume on the NYSE.

Agapova (2010) and Guedj and Huang (2008) show that fund flows in conventional index mutual funds are negatively affected by fund flows in ETFs. The Investment Company Institute in its July 2010 report states that while there was an overall outflow from domestic equity in first six months of 2010, outflows from domestic equity mutual funds were partly offset by net purchases of ETFs that invest in domestic equity. This suggests that ETFs are becoming suitable substitutes for index funds. Agapova (2010) documents this substitution effect. While comparing these two competing products, arguments have been made in context of the operational efficiency of mutual funds versus the tax efficiency of ETFs. Agapova (2010) suggests a *cliente effect*, ETFs are attractive for investors who are more sensitive to taxes and liquidity needs, while traditional index funds are more attractive to investors preferring low turnover and higher dollar value investments. This suggests a move towards market segmentation in the index investing market based on investor preferences. Recently there has been a push for making ETFs available as investment choice in tax-deferred accounts like 401(K) plans. Therefore we believe that it is important to compare long term performance of these competing and similar investment vehicles.

This paper examines and compares investment performance of two popular and similar investment vehicles; index mutual funds and exchange traded funds (ETFs) tracking the same underlying index. In this paper we compare pre-tax returns of these two products and measure their tracking errors relative to the underlying index. Tracking errors are defined as the difference between a fund's return and that of the index they are supposed to be tracking.

Rompotis (2008) has done a similar analysis and does not find any statistical significant differences between index funds and ETFs in terms of tracking errors. However, their analysis is based on two years data (2001-2002), whereas our data encompasses six year period from 2007 to 2012. We believe a longer time horizon will help us provide richer analysis and complement and extend their study. In addition, during our time

period (2007-2012), years 2008-2009 were characterized by high volatility in the financial markets. This provides us an opportunity to analyze how higher volatility impacts relative and absolute performance and tracking errors of ETFs and index funds. Recently, Guedj and Huang (2008) posit that if investors have more correlated liquidity needs, index mutual funds are expected to have large unbalanced demands from its investors. They suggest that this will result in a higher price impact on mutual funds due to trading in and out of mutual funds by active investors and therefore result in large tracking errors. Our data from the 2007-2012 period which was marked by a high degree of correlations among different markets and asset classes presents a perfect platform to test this theory.

We observe that ETFs have improved their performance in terms of tracking errors over the years. Tracking errors of all the ETFs in our sample have gradually and consistently decreased during 2007-2012. Our results suggests that for index funds perform relatively better than the corresponding ETFs in tracking large-cap and broad-market indices. In contrast, ETFs exhibit lower tracking errors compared to corresponding index funds for mid-cap indices, small-cap indices and for narrower indices tracking a segment of large-cap markets. These results support empirical and theoretical predictions in Guedj and Huang (2008). They argue that ETFs are better suited for narrower and less liquid underlying indexes (such as small cap). This is due to the “in kind redemption” feature of ETFs, which help them avoid flow-induced trading costs. ETFs are able to avoid trading related costs due to fund flows as they don’t need to purchase or liquidate the underlying assets. Our results also document significant increase in tracking errors for both ETFs and index funds when market volatility is high. However, the relative performance of the ETFs and index funds do not change during this period.

The remainder of paper includes a comparison of characteristics of ETFs and index funds and recent data on growth of these funds in section 2, sample description in section 3, section 4 presents average daily returns and volatility, section 5 presents estimation of tracking errors and section 6 concludes.

2. ETFs AND MUTUAL FUNDS

Recent emergence of ETFs has challenged the dominance of mutual funds in general and index funds in particular. Like mutual funds, ETFs pool investor assets and buy stocks or bonds according to a basic strategy spelled out when the ETF is created. Mutual funds have a long history and still represent a significant part of investments in the financial markets. Table 1 presents statistics on *total net assets* of equity funds and ETFs. By end of the year 2012, equity mutual funds in the US represent almost 6 trillion dollars in total net assets of which \$869 billion was invested in the domestic equity index funds. ETFs were introduced in 1993 in the US markets. The first ETF was the SPY (Standard & Poor's Depository Receipt) -- commonly known as Spyder -- which started trading on the American Stock Exchange in 1993. Since

1993 the total net assets of ETFs have grown from a measly \$0.46 billion dollars to \$1,207.09 billion dollars by the end of the year 2012.

Table 1: Total Net Assets (billions of dollars)

Year	Equity Mutual Funds	Domestic Equity Index Funds	Exchange Traded Funds
1993	\$740.67	\$22.78	\$0.46
1994	852.76	26.12	0.42
1995	1,249.08	47.38	1.05
1996	1,726.01	83.99	2.41
1997	2,368.02	149.53	6.71
1998	2,977.94	235.16	15.57
1999	4,041.89	346.24	33.87
2000	3,961.92	343.01	65.59
2001	3,418.16	321.66	82.99
2002	2,662.46	269.21	102.14
2003	3,684.16	384.52	150.98
2004	4,383.98	465.65	227.54
2005	4,939.70	505.39	300.82
2006	5,910.50	598.07	422.55
2007	6,515.87	652.53	608.42
2008	3,704.27	431.00	531.29
2009	4,957.58	585.53	777.13
2010	5,596.17	701.35	991.99
2011	5,215.26	734.32	1048.13
2012	5,934.30	869.42	1337.11

Source: Investment Company Institute

ETFs are organized as unit trusts that hold a specified pool of assets. ETF shares are created when an authorized financial institution deposits a portfolio of securities with the trustee and receive ETF shares in exchange. The key characteristics of ETFs is that they are traded on an exchange. Therefore investors can buy and sell ETF shares at any point during the day through their brokers. Exchange trading for investors entails costs in the form of commissions and liquidity costs as measured by bid-ask spreads. Exchange trading also means, ETF shares can be purchased on margin and sold short. In addition, many ETFs have related options contracts. On the other hand, mutual funds can be bought and sold only at their end of the day NAV directly from the fund administrator. Thereby mutual funds cannot be sold short or bought at margin and investors don't incur commissions or spread costs when buying or selling.

Since short selling and options contracts are not available for mutual funds, it makes ETFs better for day-traders betting on short-term price changes of entire market sectors. For long-term investors, these features don't matter. Most ETFs are index-style investments, similar to index mutual funds. That means the ETF simply buys and holds the stocks or bonds in a market gauge like the Standard & Poor's 500 stock index or Russell 2000 index. Investors therefore know what securities their fund holds, enjoy returns closely matching those of the underlying index.

ETF shares are created or redeemed using the underlying index assets “in-kind redemption” thus ensuring ETF share prices do not diverge significantly from the underlying net asset value. Further, by avoiding the need for purchase or sales of the underlying assets, ETFs do not incur trade related cost upon creation and redemption of shares hence ETFs are expected to be more efficient. While small investors can redeem their shares by selling them on an exchange; large shareholders are redeemed “in kind” which avoids realization of capital gains at the fund level.

In contrast, mutual fund investors buy and sell through a fund's parent company, such as Vanguard or Fidelity. Orders that are placed during the day are filled after the stock market closes at 4 p.m., and investors purchase the shares at the net asset value. As investors' money flows in, the fund company uses it to buy more shares of the stocks in the fund. When investors withdraw money, the fund sells holdings to free up cash for redemptions, which are paid at the end-of-day price. Mutual funds make annual payments to shareholders representing the net profits realized on stocks or other assets sold by the fund during the year, and these distributions are taxed in the year they are received. Many managed funds pay big distributions on realized profits as they constantly buy and sell in pursuit of hot investments, thus triggering big annual tax bills. This can be a major drain on performance of mutual funds, however for index funds the portfolio turnover and therefore such tax is low.

Due to these characteristics which underline key differences between ETFs and mutual funds, different kind of investors find them attractive. ETFs are more attractive to investors looking for low operating costs, higher liquidity demand and greater transparency of portfolio composition. Mutual funds are more attractive to investors who want to avoid trading spread and commission charge and have less demand for immediate liquidity. However, ETFs and mutual funds both have operating expenses and they track a specific market index. ETFs and index mutual funds ensure investors to closely match pre-tax returns on the index tracked. The difference between the performance of a fund and the performance of the index tracked is termed as “tracking error”. This tracking error is a cost especially for long term investors as any error is likely to get compounded overtime.

Our analysis is focused on ETFs and mutual funds which track broad based indices. Table 2 presents data on number of Index Funds in the United States. Data indicates that growth in Index funds has stabilized in last five years. On the other hand, as we report later in Table 4 ETFs have seen significant growth and most of the ETF growth has been in broad-based index tracking ETFs. While the vast majority of ETFs are index investments, mutual funds come in both flavors, indexed and actively managed, which employ analysts and managers to hunt for stocks or bonds that will generate alpha—return in excess of a standard performance benchmark. Recently actively managed ETFs have been launched and in addition ETFs have also moved into some very narrowly defined markets focused on very small stocks, foreign stocks and foreign bonds. Table 2 data also show that a large number of index funds track the S&P 500. However most of the recent growth in the number of index funds has come from growing interests in funds focused on fixed income and international markets.

Table 2 Number of Index Funds in US

Year	Total	Equity			Hybrid and Bond
		S&P 500	Other domestic	Global/ International	
1993	69	38	15	6	10
1994	81	42	17	7	15
1995	90	47	18	8	17
1996	108	59	22	8	19
1997	135	71	27	13	24
1998	158	85	36	16	21
1999	199	96	58	21	24
2000	276	119	99	26	32
2001	288	125	109	26	28
2002	314	131	123	29	31
2003	326	127	133	31	35
2004	335	127	146	29	33
2005	329	119	147	30	33
2006	348	125	158	33	32
2007	357	125	161	36	35
2008	361	122	164	41	34
2009	359	113	154	48	44
2010	365	111	162	50	42
2011	383	111	170	57	45
2012	373	103	167	57	46

Source: Investment Company Institute

ETFs have become popular not only amongst institutional investors but also among individual investors. While active traders have used ETFs for day trading, data indicates that many investors are using ETFs in

their long-term portfolios and retirement accounts. It is interesting to note the profile of investors who own ETFs. Recent data from the Investment Company Institute, as reported in Table 3 below, indicates that investors, who own ETFs have higher household income, higher financial assets, are highly educated and own IRA accounts. This data suggests that ETF investors are relatively sophisticated and informed investors. As more investors start investing in ETFs, it is important to look at the relative performance of ETFs and index funds.

Table 3: Characteristics of ETF-Owning Households (May 2012)

	All U.S. households	Households owning ETFs	Households owning individual stocks
Median			
Age of head of household	50	49	53
Household income	\$50,000	\$125,000	\$87,500
Household financial assets	\$62,500	\$500,000	\$250,000
Percentage of households			
Household primary or co-decision maker for saving and investing:			
Married or living with a partner	61	75	73
Widowed	10	2	7
Four-year college degree or more	31	66	52
Employed (full- or part-time)	58	72	66
Retired from lifetime occupation	30	25	30
Household owns:			
IRA(s)	40	90	69
DC retirement plan account(s)	51	69	74

Source: Investment Company Institute

Table 4 reports the total net assets (TNA) and the total number (in parenthesis) of ETFs in the US by the type of ETF. Both of these data sets show explosive growth in ETFs. The TNA for ETFs has grown from \$0.46 billion in 1993 to 102 billion in 2002, a ten year period. Since 2002, total net assets under ETFs have grown significantly almost at the rate \$100 billion every year except for year 2008 during the financial crisis. In the year 2011, TNA for ETF surpassed *one trillion dollars* for the first time. By the year 2002 there were 80 ETFs and the growth in the number of ETFs remain modest until the year 2003-04, the

number of ETFs doubled between 2006 and 2009. Between 2006 and 2007 the number of ETFs went from 359 to 629 and by the end of the year 2012 the number of ETFs reached a total of 1194. Most of the recent growth in the number of ETFs has come from growing interests in ETFs tracking fixed income, commodities and international markets. In comparison, as is evident from the Table 2 growth in the total number of conventional index funds was nominal during 2006-2012. In addition recent reports suggest that some closed-end funds have started reorganizing as ETFs.

Table 4: Exchange-Traded Funds: Total Net Assets (in billions of dollars) and number of ETFs in US (in parenthesis) by Type of Fund

Investment Objective		Equity			Commodities	Bond
		Domestic equity		Global/ International		
Year	Total	Broad-based	Sector			
1993	\$0.464(1)	\$0.464(1)	-	-	-	-
1994	\$0.424(1)	\$0.424(1)	-	-	-	-
1995	\$1.052(2)	\$1.052(2)	-	-	-	-
1996	\$2411(19)	\$2.159(2)	-	\$0.252(17)	-	-
1997	\$6.707(19)	\$6.2(2)	-	\$0.506(17)	-	-
1998	\$15.568(29)	\$14.058(3)	\$0.484(9)	\$1.026(17)	-	-
1999	\$33.873(30)	\$29.374(4)	42.507(9)	\$1.992(17)	-	-
2000	\$65.585(80)	\$60.529(29)	\$3.015(26)	\$2.041(25)	-	-
2001	\$82.993(102)	\$74.752(34)	\$5.224(34)	\$3.016(34)	-	-
2002	\$102.143(113)	\$86.985(34)	\$5.919(32)	\$5.324(39)	-	\$3.915(8)
2003	\$150.983(119)	\$120.43(39)	\$11.901(33)	\$13.984(41)	-	\$4.667(6)
2004	\$227.540(152)	\$163.73(60)	\$20.315(42)	\$33.644(43)	\$1.335(1)	\$8.516(6)
2005	\$300.820(204)	\$186.832(81)	\$28.975(65)	\$65.21(49)	\$4.798(3)	\$15.004(6)
2006	\$422.550(359)	\$232.487(133)	443.655(119)	\$111.194(85)	\$14.699(16)	\$20.514(6)
2007	\$608.422(629)	\$300.93(197)	\$64.117(191)	\$179.702(159)	\$28.906(28)	\$34.648(49)
2008	\$531.288(728)	\$266.161(204)	\$58.374(186)	\$113.684(225)	\$35.728(45)	\$57.209(62)
2009	\$777.128(797)	\$304.044(222)	\$82.073(179)	\$209.315(244)	\$74.528(49)	107.018(98)
2010	\$991.989(923)	\$372.377(243)	\$103.807(193)	\$276.622(298)	\$101.081(55)	\$137.781(128)
2011	\$1048.134(1134)	\$400.696(287)	\$108.548(229)	\$245.114(368)	\$109.176(75)	\$184.222(168)
2012	\$1337.112(1194)	\$509.338(274)	\$135.378(222)	\$328.521(404)	\$120.016(79)	\$243.203(202)

Source: Investment Company Institute (Hybrid Funds not reported here)

3. DATA

In our analysis we use daily data for 12 matched ETFs and Index funds which track the same underlying indices. We have selected funds which are not actively managed and track broad based equity indices. ETFs and index funds in our sample track major equity indices in the US covering large-cap, mid-cap and small-cap companies. The choice of indices also depended on the availability of data for ETFs and index funds tracking these indices. The twelve indices we selected are the S&P 500, NASDAQ 100, Russell 1000 Value,

Russell 1000 Growth, Russell 2000, Russell 2000 Growth, Russell 3000 Value, Russell 3000 Growth, S&P 400 midcap, Wilshire 5000, Russell Midcap Value and Russell Midcap Growth index. Corresponding index funds and ETFs were chosen based on their popularity among investors. Most of ETFs we selected are from iShares and therefore we report results for IVV (from iShares) an ETF tracking S&P 500 rather than the more popular SPY. However in unreported results we find that the performance of SPY and IVV is almost identical in our sample period.

The time period for our analysis is years 2007-2012, we have 250 daily observations in 2007, 253 in 2008 and 252 in 2009, 252 in 2010, 252 in 2011, 250 in 2012, giving us a total of 1509 daily observations. We collected data on end-of-day value of the indices from Russell Investments and Standards and Poor's website. The data on ETF closing prices is from iShares and Bloomberg while end of the day NAV for the Index funds is from Bloomberg.

4. AVERAGE DAILY RETURNS AND VOLATILITY

In this section, we compute and compare average daily returns of ETFs, index funds and corresponding underlying indices. We also calculate the volatility of daily returns for these funds and indices. Daily returns are the percentage change in the end of day closing price for the ETF (NAV for index funds) on any given day compared to that on the previous day. For calculating ETF and Index fund return we assume that all dividend and capital gains distributions are reinvested on ex-dividend date at ex-dividend price and net asset value respectively. Volatility is measured as standard deviation of these daily returns for a given period. As mentioned earlier the time period of 2007-2012 is of particular interest as it includes periods with high volatility, for this reason we report results for each year in addition to result for the entire six-year period.

In Table 5, we report average daily returns for each year from 2007 to 2012 and six year averages for the period of 2007-2012. It has been noted in the financial press and previous academic literature that index funds and ETFs that track large-cap indexes or broader market exhibit very low tracking errors. Our results in Table 5 confirm this. Average daily returns for ETFs and index funds in our sample tracking the large cap indices (S&P 500, NASDAQ 100) and the broad-market (Wilshire 5000) indices track very closely the actual returns on the underlying index. For example, the average daily return during the six year period 2007-2012, on the S&P 500 is 2.1 basis points and it is 1.8 basis points for both the iShares ETF (IVV) and corresponding Vanguard index fund (VFINX). Similarly, for the NASDAQ 100 where the average daily return during the six year period is 4.08 basis points both the ETF (QQQQ) and index fund (RYOCX) tracking this index have an average daily return of about 3.96 basis points. This tracking efficiency of ETFs and index funds for large-cap indices and broad-market is true even during volatile periods of 2008.

For example, in 2008 average daily return on the S&P 500 is negative 14.9 basis points, for the index fund (VFINX) it is negative 14.6 basis points and for ETF (IVV) it is negative 14.8 basis points. Similarly, for the NASDAQ 100 average daily return for the index and the index fund (RYOCX) both is negative 17.9 basis points and for the ETF (QQQQ) it is negative 18.33 basis points. For the broad-market represented by Wilshire 5000 index, average daily returns for both the ETF and index funds also track closely the returns on the underlying index. For example, the average daily return during the six year period 2007-2012, for Wilshire 5000 is 2.4 basis points while it is 1.9 basis points and 2.1 basis points respectively for the ETF (VTI) and corresponding index fund (VTSMX).

However, ETFs fair better than the corresponding index funds in tracking the underlying indices for the indices which target a subset of these large-cap and broad-market indices. For example, in the year 2008 average daily return for the Russell 1000 Value index was negative 14.3 basis points, a negative 13.9 basis points for the ETF (IWD), however it was statistically different at negative 11.3 basis points for the index fund (VEIPX). In 2009, average daily returns for Russell 1000 Value index was positive 9.1 basis points, a positive 7.9 basis points for the ETF (IWD) but statistically different at positive 6.3 basis points for the index fund (VEIPX). For the ETF (IWD) the year 2011 is an aberration and it's performance lags the underlying index significantly. Similarly if we look at the Russell 1000 Growth index, in 2008 average daily returns was negative 16.2 basis points, a negative 16.1 basis points for the ETF (IWF), however it was statistically different at negative 22.5 basis points for the index fund (VGEQX). In 2009, average daily returns for the Russell 1000 Growth index was positive 13.04 basis points, a positive 12.91 basis points for the ETF (IWF) and positive 12.3 basis points for the index fund (VGEQX).

Next we look at mid-cap indices, our results suggest that ETFs are better at tracking returns of underlying indices; more so during periods with high volatility in the financial markets. During 2007-2012 six year period, the S&P Midcap 400 index had an average daily return of 3.7 basis points, the ETF (IJH) closely tracks it at 3.4 basis points, while return for the index fund (VIMSX) was statistically different at 2.7 basis points. This tracking efficiency of ETFs for mid-caps is further evident in 2008, the S&P Midcap 400 index had an average daily return of negative 14.1 basis points, the corresponding ETF (IJH) returned a negative 13.9 basis points, however the return for the index fund (VIMSX) was statistically different at negative 17.3 basis points. Our results as reported in Table 5 suggest similar pattern of overall better tracking (especially during period of high volatility) by ETFs compared to index funds for the Russell Midcap Value and Russell Midcap Growth index. The average daily returns during the six year period for the Russell Midcap Value index was 2.7 basis points, a 2.5 basis points for the ETF (IWS), however it was at 1.8 basis points for the index fund (VASVX).

Table 5: Average daily return for index, ETF and index funds

Average Daily Returns							
	Underlying Index	ETF	Index Fund		Underlying Index	ETF	Index Fund
	S&P 500	IVV	VFINX		Wilshire 5000	VTI	VTSMX
2007	0.027%	0.027%	0.027%		0.028%	0.027%	0.027%
2008	-0.149%	-0.148%	-0.146%		-0.152%	-0.149%	-0.147%
2009	0.108%	0.099%	0.100%		0.118%	0.106%	0.108%
2010	0.062%	0.057%	0.057%		0.072%	0.066%	0.064%
2011	0.019%	0.016%	0.017%		0.014%	0.013%	0.014%
2012	0.063%	0.057%	0.056%		0.063%	0.058%	0.058%
2007-2012	0.021%	0.018%	0.018%		0.024%	0.019%	0.021%
	NASDAQ 100	QQQQ	RYOCX		Russell 3000 Value Index	IWW	VUVLX
2007	0.075%	0.074%	0.073%		0.003%	0.001%	0.001%
2008	-0.179%	-0.183%	-0.179%		-0.139%	-0.136%	-0.118%
2009	0.184%	0.184%	0.181%		0.092%	0.081%	0.056%
2010	0.077%	0.077%	0.075%		0.068%	0.059%	0.046%
2011	0.022%	0.021%	0.021%		0.012%	0.008%	0.017%
2012	0.067%	0.066%	0.068%		0.068%	0.058%	0.059%
2007-2012	0.041%	0.040%	0.040%		0.017%	0.012%	0.010%
	Russell 1000 Value Index	IWD	VEIPX		Russell 3000 Growth Index	IWZ	VMRGX
2007	0.006%	0.005%	0.024%		0.048%	0.047%	0.048%
2008	-0.143%	-0.139%	-0.113%		-0.162%	-0.165%	-0.167%
2009	0.091%	0.079%	0.063%		0.138%	0.131%	0.118%
2010	0.065%	0.058%	0.050%		0.071%	0.067%	0.068%
2011	0.014%	0.009%	0.039%		0.020%	0.017%	0.002%
2012	0.068%	0.061%	0.044%		0.060%	0.055%	0.054%
2007-2012	0.017%	0.012%	0.018%		0.029%	0.025%	0.021%
	Russell 1000 Growth Index	IWF	VGEQX		SP 400 Midcap	IJH	VIMSX
2007	0.049%	0.047%	0.086%		0.035%	0.034%	0.029%
2008	-0.162%	-0.161%	-0.225%		-0.141%	-0.139%	-0.173%
2009	0.138%	0.131%	0.122%		0.147%	0.139%	0.149%
2010	0.067%	0.063%	0.067%		0.102%	0.097%	0.096%
2011	0.021%	0.018%	0.012%		0.009%	0.007%	0.005%
2012	0.060%	0.057%	0.056%		0.070%	0.066%	0.059%
2007-2012	0.029%	0.026%	0.019%		0.037%	0.034%	0.027%

Table 5 Contd. : Average daily return for index, ETF and index funds

Average Daily Returns							
	Underlying Index	ETF	Index Fund		Underlying Index	ETF	Index Fund
	Russell Midcap Value Index	IWS	VASVX		Russell 2000	IWM	NAESX
2007	-0.001%	0.005%	0.001%		0.002%	0.001%	0.011%
2008	-0.153%	-0.142%	-0.133%		-0.120%	-0.123%	-0.137%
2009	0.140%	0.134%	0.110%		0.121%	0.118%	0.145%
2010	0.097%	0.096%	0.068%		0.107%	0.102%	0.104%
2011	0.008%	0.013%	0.012%		0.005%	0.001%	0.007%
2012	0.072%	0.07%	0.052%		0.066%	0.062%	0.068%
2007-2012	0.027%	0.025%	0.018%		0.030%	0.027%	0.032%
	Russell Midcap Growth Index	IWP	VMGRX		Russell 2000 Growth Index	IWO	VEXPX
2007	0.049%	0.051%	0.059%		0.036%	0.035%	0.025%
2008	-0.193%	-0.193%	-0.159%		-0.152%	-0.153%	-0.157%
2009	0.169%	0.168%	0.131%		0.139%	0.135%	0.119%
2010	0.101%	0.100%	0.087%		0.113%	0.111%	0.094%
2011	0.008%	0.010%	0.018%		0.011%	0.009%	0.018%
2012	0.063%	0.064%	0.055%		0.061%	0.059%	0.055%
2007-2012	0.033%	0.033%	0.032%		0.034%	0.032%	0.024%

Finally, we look at the small-cap indices. For Russell 2000 index both the ETF (IWM) and the index fund (NAESX) do a good job of tracking the underlying index with slightly better performance by the index fund. The average daily returns during the six year period for the Russell 2000 index was 3 basis points, a 2.7 basis points for the ETF (IWS) and slightly better at 3.2 basis points for the index fund (NAESX). However, ETFs fair better than the corresponding index funds for the indices which target a subset of small-cap index. For example, in the year 2008 average daily return for the Russell 2000 Growth index was negative 15.2 basis points, a negative 15.3 basis points for the ETF (IWO), however it was at negative 15.7 basis points for the index fund (VEXPX). In 2009, average daily returns for Russell 2000 Growth index was positive 13.9 basis points, a positive 13.5 basis points for the ETF (IWO) but positive 11.9 basis points for the index fund (VEXPX). Overall, the average daily returns during the six year period for the Russell 2000 Growth index was 3.4 basis points, a 3.2 basis points for the ETF (IWO), however it was at 2.4 basis points for the index fund (VEXPX).

Table 6: Average daily return volatility for the underlying index, ETF and index funds

Daily Return Volatility			
	Underlying Index	ETF	Index Fund
	S&P 500	IVV	VFINX
2007	1.009%	0.995%	1.001%
2008	2.581%	2.363%	2.469%
2009	1.719%	1.575%	1.606%
2010	1.137%	1.049%	1.058%
2011	1.467%	1.341%	1.344%
2012	0.804%	0.731%	0.732%
2007-2012	1.568%	1.445%	1.482%
	NASDAQ 100	QQQQ	RYOCX
2007	1.179%	1.144%	1.179%
2008	2.665%	2.515%	2.666%
2009	1.671%	1.608%	1.672%
2010	1.227%	1.216%	1.231%
2011	1.499%	1.493%	1.500%
2012	0.975%	0.968%	0.970%
2007-2012	1.635%	1.577%	1.636%
	Russell 1000 Value Index	IWD	VEIPX
2007	1.055%	1.055%	0.970%
2008	2.783%	2.522%	2.176%
2009	1.989%	1.979%	1.740%
2010	1.228%	1.108%	0.861%
2011	1.549%	1.370%	1.044%
2012	0.821%	0.735%	0.591%
2007-2012	1.704%	1.546%	1.288%
	Russell 1000 Growth Index	IWF	VGEQX
2007	0.971%	0.658%	1.146%
2008	2.435%	2.295%	2.530%
2009	1.551%	1.459%	1.465%
2010	1.093%	1.046%	1.118%
2011	1.465%	1.382%	1.519%
2012	0.832%	0.787%	0.907%
2007-2012	1.492%	1.413%	1.543%
	Underlying Index	ETF	Index Fund
	Wilshire 5000	VTI	VTSMX
	0.999%	0.988%	1.001%
	2.551%	2.436%	2.477%
	1.756%	1.612%	1.666%
	1.174%	1.096%	1.104%
	1.528%	1.400%	1.418%
	0.820%	0.769%	0.760%
	1.582%	1.488%	1.514%
	Russell 3000 Value Index	IWW	VUVLX
	1.071%	1.044%	1.051%
	2.787%	2.537%	2.260%
	2.021%	1.815%	1.418%
	1.254%	1.141%	0.988%
	1.582%	1.404%	1.248%
	0.834%	0.725%	0.677%
	1.721%	1.562%	1.367%
	Russell 3000 Growth Index	IWZ	VMRGX
	0.988%	1.004%	1.124%
	2.452%	2.237%	2.308%
	1.583%	1.485%	1.365%
	1.122%	1.068%	1.104%
	1.513%	1.424%	1.478%
	0.847%	0.791%	0.816%
	1.517%	1.417%	1.406%
	SP 400 Midcap	IJH	VIMSX
	1.022%	1.014%	1.048%
	2.710%	2.636%	2.744%
	2.041%	1.950%	1.969%
	1.323%	1.266%	1.311%
	1.801%	1.709%	1.632%
	0.959%	0.903%	0.889%
	1.757%	1.688%	1.709%

Table 6 Contd. : Average daily return volatility for the underlying index, ETF and index funds

Daily Return Volatility							
	Underlying Index	ETF	Index Fund		Underlying Index	ETF	Index Fund
	Russell Midcap Value Index	IWS	VASVX		Russell 2000	IWM	NAESX
2007	1.039%	1.030%	0.910%		1.278%	1.326%	1.159%
2008	2.780%	2.521%	2.055%		2.921%	2.797%	2.739%
2009	2.176%	1.959%	1.426%		2.286%	2.106%	2.163%
2010	1.363%	1.263%	1.194%		1.581%	1.492%	1.447%
2011	1.657%	1.499%	1.378%		2.082%	1.923%	1.896%
2012	0.870%	0.789%	0.729%		1.076%	0.981%	0.973%
2007-2012	1.777%	1.619%	1.329%		1.976%	1.868%	1.835%
	Russell Midcap Growth Index	IWP	VMGRX		Russell 2000 Growth Index	IWO	VEXPX
2007	1.048%	1.038%	1.058%		1.260%	1.324%	1.093%
2008	2.763%	2.609%	2.299%		2.820%	2.725%	2.186%
2009	1.885%	1.803%	1.570%		2.099%	1.967%	1.563%
2010	1.290%	1.248%	1.212%		1.539%	1.471%	1.248%
2011	1.726%	1.662%	1.649%		2.127%	2.047%	1.739%
2012	0.946%	0.907%	0.909%		1.113%	1.055%	0.964%
2007-2012	1.727%	1.650%	1.521%		1.918%	1.846%	1.525%

Now, we turn our attention to the volatility of daily returns. Volatility is measured as standard deviation of these daily returns for a given period. Results are reported in Table 6. In our sample period (2007-2012), large-cap Russell 1000 Growth index (S&P 500 is close second) exhibits lowest volatility in daily returns while small-cap Russell 2000 index exhibits highest volatility. As expected, in the years 2008 and 2009 all the indices, ETFs and index funds exhibit significant increase in daily return volatility. For example, volatility of the daily returns for S&P 500, corresponding ETF and index fund was about 1% in the year 2007 and it jumps to about 2.5% in the year 2008 and remains elevated during the year 2009 before subsiding during the period 2010-2012. In addition, our results suggest that irrespective of the time period and capitalization, the volatility of daily returns for ETFs is in general lower than the volatility of daily returns of their underlying index. On the other hand, Index funds either closely track or exhibit slightly lower volatility of daily returns compared to that of the underlying index.

In this section we compared average daily returns and volatility of those returns for the index funds, ETFs and the underlying index. Our results suggest that in general ETFs and index funds track large-cap indices very effectively. However for the mid-cap indices and for subset of the large-cap and small-cap indices

ETFs appear have lower tracking errors than the corresponding index funds. Our analysis so far is based on before tax returns and before taking in to account individual tax situation and other costs such as expense ratios and liquidity costs. Before deciding between ETFs or index funds for investment, individual and institutional investors need to take in to account these costs as applicable to specific situation (for example whether investments is for taxable or tax deferred accounts). In addition, we observe that the volatility of daily returns for ETFs is lower than the volatility of daily returns of their underlying index and corresponding index funds. This is important for investors who use return per unit of risk metric for their investment decision.

In the next section, we look at some specific measures of the tracking errors for the ETFs and the index funds to confirm our initial observations from this section.

5. TRACKING ERROR ESTIMATION

In this section we calculate tracking errors using three methods similar to Rompotis (2008) and Frino and Gallagher (2001). The first method estimates tracking errors as an average absolute daily return difference between fund and underlying index. The second method estimates tracking error as a standard deviation of the daily return difference between funds and underlying indexes. We run t-tests to test difference in the means to test significance of difference in tracking errors of ETFs and that of corresponding index funds. Finally, the third method reports tracking errors as the standard error of regression residual from the following regression:

$$R_{ft} = \alpha_t + \beta_t R_{it} + \varepsilon_t \dots \dots (1)$$

where, R_{ft} is the daily return on the index fund or ETF and R_{it} is daily return on the underlying index. We run the regressions for each index fund and each ETF using daily return data for each year and for the entire period from 2007-2012 (giving us 1509 observations). We report standard errors and R-square from the regression in the last two columns of Table 7. Our results suggest that tracking errors in general are lower than 100 basis points and tracking errors for both ETFs and index funds increase significantly during the year 2008 at the height of financial crisis.

Our results as reported in the Table 7 indicate that during the 2007-2012 period all the ETFs in our sample exhibit a gradual decrease in the tracking errors. However, tracking errors for the index funds have remained relatively stable during this period. The index funds tracking the large cap indices (S&P 500, NASDAQ 100) and the broad market (Wilshire 5000) indices exhibit very low tracking error. For example, the tracking error as measured by mean absolute return difference for VFINX relative to return on S&P 500 is only 5 basis points. For the same time period ETF (IVV) exhibits on average a tracking error of 13 basis

points. We apply t-tests to check whether these differences in tracking errors of index funds and ETFs are statistically significant. Results show significance at 1% level. A similar pattern is observed when we use the second method for estimating tracking error using standard deviation of daily return difference between funds and underlying indexes. While index fund VFINX on average have a tracking error of 9 basis points, the tracking error for the corresponding ETF (IVV) is about 19 basis points. Finally, we report tracking errors using the third method by looking at standard errors of residuals from regression 1 above, index funds have a tracking error of 3 basis points and that for the corresponding ETF is 15 basis points. These differences are statistically significant. Regressions with index fund returns as dependent variable also have higher R-square compared to R-squares for regressions with ETF returns as dependent variable. This again indicates index fund is better in tracking the S&P 500 index as compared to the ETF.

We look at another large cap widely followed index by analyzing ETFs and index funds tracking the NASDAQ 100 index. Similar to our results for S&P 500 we observe that index fund (RYOCX) have lower tracking error of 4 basis points as measured by method one and 6 basis points per both methods two and three. In comparison, tracking error for ETF (QQQQ) tracking the NASDAQ 100 exhibit higher tracking error of 9 basis points as measured by method one, 19 basis points per method two and 18 basis point as measured by method three. The differences between tracking errors of index funds and ETFs are statistically significant at the 1% level based on the t-tests. This relatively better performance of index funds is observed in each and every year during the six year period.

However, our results indicate that ETFs are more efficient in tracking indices which represent subset of the large-cap and broad-market indices. For example, for the six year period ETF (IWD) tracking the Russell 1000 Value index (a subset of large-cap Russell 1000) exhibits average tracking error of 15 basis points as measured by method one, 27 basis points as measured by method two and 20 basis points as measured by method three. In comparison, corresponding index fund (VEIPX) has a higher average tracking error of 32 basis points as measured by method one, 47 basis points per method two and 19 basis point as measured by method three. Similarly, for the six year period ETF (IWF) tracking the Russell 1000 Growth index exhibit lower average tracking error of 14 basis points as measured by method one and 22 basis points as measured by method two and 20 basis points as measured by method three. In comparison, corresponding index fund (VGEQX) has a higher tracking error of 19 basis points as measured by method one, 26 basis points per methods two and three.

We also observe relatively better performance by ETF for subset of the broad-market index Russell 3000. The ETF (IWW) tracking the Russell 3000 Value index exhibit average tracking error of 15 basis points as measured by method one and 29 basis points per method two and 17 basis points per method three during the six year period. In comparison, for same time period corresponding index fund (VUVLX) has a higher

tracking error of 26 basis points as measured by method one, 40 basis points per method two and 18 basis point as measured by method three. The differences between tracking errors of index funds and ETFs are statistically significant at 1% level based on the t-tests.

For the Russell 3000 Growth index overall results for the six year period are mixed, the ETF (IWZ) and the index fund (VMRGX) appears to have similar performance. However, if we look at the results carefully, we observe that during the most recent period (2010-2012) the ETF have outperformed the corresponding index fund.

Next we look at the results for the mid-cap indices. Our results suggest that ETFs are relatively better than the corresponding index funds in tracking mid-cap indices. For the six year period, ETF (IJH) tracking the S&P Midcap 400 index exhibits lower average tracking error of 5 basis points as measured by method one, 7 basis points per method two and 2 basis point as measured by method three; in comparison for same period, corresponding index fund (VIMSX) have higher tracking error of 17 basis points as measured by method one, 23 basis points per method two and 22 basis points as measured by method three. This superior performance of ETF as compared to index funds is observed in each individual year as reported in Table 7.

Similarly, we observe lower tracking errors for the ETFs compared to the corresponding index funds for Russell Midcap Value index and Russell Midcap Growth index. For example, during the six year period (2007-2012) the ETF (IWS) tracking the Russell Midcap Value index exhibits lower average tracking error of 16 basis points as measured by method one, 26 basis points per method two and 20 basis point as measured by method three; in comparison, corresponding index fund (VASVX) have higher tracking error of 35 basis points as measured by method one, 54 basis points per method two and 26 basis points as measured by method three. Similarly, the ETF (IWP), tracking the Russell Midcap Growth index exhibits lower average tracking error of 12 basis points as measured by method one, 27 basis points per method two and 25 basis point as measured by method three; in comparison, corresponding index fund (VMGRX) have higher tracking error of 21 basis points as measured by method one, 33 basis points per method two and 25 basis points as measured by method three. This superior performance of ETFs (IWS and IWP) as compared to index funds (VASVX and VMGRX) is observed in each individual year in the sample period.

Finally, we look at small-cap indices, during the six year period (2007-2012) index funds (NAESX) tracking the small-cap Russell 2000 index have lower tracking error as compared to corresponding ETF (IWM). However, in the recent years (2010-2012) IWM have improved its performance and now have comparable or better performance than the corresponding index fund in terms of tracking errors. However for the Russell 2000 growth index which is a subset of the Russell 2000 index, the ETF (IWO) consistently perform better than the corresponding index fund (VEXPX).

Table 7: Tracking Errors of ETFs and Index Funds

	Underlying Index	Mean Absolute Return Difference		Standard deviation of Return Difference		Standard Errors and R-squared from regression	
		ETF	Index Fund	ETF	Index Fund	ETF	Index Fund
	S&P 500	IVV	VFINX	IVV	VFINX	IVV	VFINX
2007		0.15%	0.01%*	0.20%	0.01%*	0.19%/0.96	0.01%/0.99
2008		0.19%	0.07%*	0.33%	0.11%*	0.24%/0.99	0.03%/0.99
2009		0.15%	0.08%*	0.19%	0.11%*	0.12%/0.99	0.01%/0.99
2010		0.09%	0.06%*	0.12%	0.08%*	0.07%/0.99	0.01%/0.99
2011		0.10%	0.08%*	0.15%	0.12%*	0.07%/0.99	0.01%/0.99
2012		0.08%	0.05%*	0.11%	0.07%*	0.08%/0.98	0.01%/0.99
2007-2012		0.13%	0.05%*	0.19%	0.09%*	0.15%/0.99	0.03%/0.99
	NASDAQ 100	QQQQ	RYOCX	QQQQ	RYOCX	QQQQ	RYOCX
2007		0.10%	0.05%*	0.15%	0.06%*	0.14%/0.98	0.06%/0.99
2008		0.20%	0.05%*	0.39%	0.06%*	0.35%/0.98	0.06%/0.99
2009		0.11%	0.04%*	0.15%	0.05%*	0.13%/0.99	0.05%/0.99
2010		0.06%	0.03%*	0.09%	0.06%*	0.09%/0.99	0.06%/0.99
2011		0.04%	0.03%*	0.06%	0.06%	0.06%/0.99	0.06%/0.99
2012		0.05%	0.03%*	0.07%	0.06%	0.07%/0.99	0.06%/0.99
2007-2012		0.09%	0.04%*	0.19%	0.06%*	0.18%/0.99	0.06%/0.99
	Russell 1000 Value Index	IWD	VEIPX	IWD	VEIPX	IWD	VEIPX
2007		0.12%	0.12%	0.17%	0.16%	0.17%/0.97	0.13%/0.98
2008		0.28%	0.44%*	0.56%	0.65%*	0.41%/0.97	0.21%/0.99
2009		0.20%	0.42%*	0.27%	0.57%*	0.17%/0.99	0.16%/0.98
2010		0.11%	0.31%*	0.14%	0.41%*	0.14%/0.97	0.08%/0.99
2011		0.13%	0.38%*	0.19%	0.55%*	0.06%/0.99	0.17%/0.97
2012		0.08%	0.22%*	0.11%	0.28%*	0.06%/0.99	0.13%/0.95
2007-2012		0.15%	0.32%*	0.27%	0.47%*	0.20%/0.98	0.19%/0.98
	Russell 1000 Growth Index	IWF	VGEQX	IWF	VGEQX	IWF	VGEQX
2007		0.18%	0.22%*	0.26%	0.3%*	0.25%/0.93	0.26%/0.95
2008		0.25%	0.32%*	0.38%	0.40%	0.35%/0.98	0.40%/0.97
2009		0.17%	0.18%	0.24%	0.23%	0.21%/0.98	0.21%/0.98
2010		0.07%	0.13%*	0.09%	0.17%*	0.08%/0.99	0.17%/0.98
2011		0.07%	0.14%*	0.10%	0.18%	0.06%/0.99	0.18%/0.98
2012		0.06%	0.15%*	0.09%	0.20%*	0.06%/0.99	0.19%/0.96
2007-2012		0.14%	0.19%*	0.22%	0.26%*	0.20%/0.98	0.26%/0.97

Table 7 Contd. : Tracking Errors of ETFs and Index Funds

		Mean Absolute Return Difference		Standard deviation of Return Difference		Standard Errors and R-squared from regression	
		VTI	VTSMX	VTI	VTSMX	VTI	VTSMX
	Wilshire 5000						
2007		0.11%	0.02%*	0.15%	0.03%*	0.15%/0.97	0.03%/0.99
2008		0.24%	0.06%*	0.38%	0.09%*	0.35%/0.98	0.06%/0.99
2009		0.14%	0.07%*	0.19%	0.09%*	0.12%/0.99	0.04%/0.99
2010		0.08%	0.05%*	0.09%	0.07%*	0.07%/0.99	0.02%/0.99
2011		0.10%	0.08%*	0.15%	0.11%*	0.07%/0.99	0.03%/0.99
2012		0.06%	0.05%*	0.08%	0.06%*	0.06%/0.99	0.02%/0.99
2007-2012		0.12%	0.05%*	0.20%	0.08%*	0.17%/0.98	0.05%/0.99
	Russell 3000 Value Index	IWW	VUVLX	IWW	VUVLX	IWW	VUVLX
2007		0.09%	0.11%	0.15%	0.14%	0.14%/0.98	0.14%/0.98
2008		0.23%	0.43%	0.41%	0.59%*	0.31%/0.98	0.24%/0.99
2009		0.18%	0.44%*	0.26%	0.63%*	0.16%/0.99	0.15%/0.99
2010		0.09%	0.20%	0.13%	0.27%*	0.07%/0.99	0.07%/0.99
2011		0.15%	0.24%	0.22%	0.35%*	0.12%/0.99	0.09%/0.99
2012		0.12%	0.14%	0.16%	0.18%	0.11%/0.98	0.08%/0.96
2007-2012		0.15%	0.26%*	0.24%	0.40%*	0.17%/0.99	0.18%/0.98
	Russell 3000 Growth Index	IWZ	VMRGX	IWZ	VMRGX	IWZ	VMRGX
2007		0.15%	0.11%	0.29%	0.16%*	0.29%/0.92	0.16%/0.98
2008		0.21%	0.24%*	0.37%	0.32%*	0.30%/0.98	0.20%/0.99
2009		0.11%	0.20%*	0.15%	0.29%*	0.10%/0.99	0.17%/0.98
2010		0.10%	0.11%*	0.14%	0.14%*	0.12%/0.99	0.14%/0.98
2011		0.09%	0.12%*	0.13%	0.15%*	0.09%/0.99	0.14%/0.99
2012		0.07%	0.09%*	0.10%	0.11%*	0.08%/0.99	0.11%/0.98
2007-2012		0.12%	0.14%*	0.22%	0.21%	0.19%/0.98	0.17%/0.98
	SP 400 Midcap	IJH	VIMSX	IJH	VIMSX	IJH	VIMSX
2007		0.01%	0.13%*	0.02%	0.16%*	0.01%/0.99	0.16%/0.97
2008		0.05%	0.25%*	0.08%	0.33%*	0.02%/0.99	0.34%/0.98
2009		0.06%	0.18%*	0.09%	0.24%*	0.01%/0.99	0.22%/0.98
2010		0.04%	0.12%*	0.10%	0.18%*	0.01%/0.99	0.16%/0.98
2011		0.07%	0.19%*	0.09%	0.25%*	0.01%/0.99	0.18%/0.98
2012		0.04%	0.14%*	0.05%	0.18%*	0.01%/0.99	0.16%/0.97
2007-2012		0.05%	0.17%*	0.07%	0.23%*	0.02%/0.99	0.22%/0.98

Table 7 Contd. : Tracking Errors of ETFs and Index Funds

		Mean Absolute Return Difference		Standard deviation of Return Difference		Standard Errors and R-squared from regression	
		IWS	VASVX	IWS	VASVX	IWS	VASVX
	Russell Midcap Value Index						
2007		0.14%	0.19%*	0.21%	0.24%*	0.21%/0.96	0.19%/0.96
2008		0.24%	0.57%*	0.44%	0.85%*	0.34%/0.98	0.37%/0.96
2009		0.22%	0.60%*	0.33%	0.83%*	0.24%/0.98	0.28%/0.96
2010		0.11%	0.28%*	0.16%	0.38%*	0.19%/0.99	0.17%/0.98
2011		0.13%	0.25%*	0.18%	0.33%*	0.12%/0.99	0.17%/0.97
2012		0.09%	0.17%*	0.12%	0.22%*	0.09%/0.99	0.15%/0.95
2007-2012		0.16%	0.35%*	0.26%	0.54%*	0.20%/0.98	0.26%/0.96
	Russell Midcap Growth Index						
2007		IWP	VMGRX	IWP	VMGRX	IWP	VMGRX
2007		0.15%	0.17%	0.22%	0.24%*	0.21%/0.96	0.24%/0.95
2008		0.25%	0.39%*	0.55%	0.57%*	0.52%/0.96	0.30%/0.98
2009		0.15%	0.29%*	0.21%	0.42%*	0.19%/0.99	0.26%/0.97
2010		0.07%	0.15%*	0.09%	0.19%*	0.08%/0.99	0.16%/0.98
2011		0.07%	0.16%*	0.09%	0.21%*	0.05%/0.99	0.19%/0.98
2012		0.05%	0.13%*	0.08%	0.17%*	0.05%/0.99	0.17%/0.96
2007-2012		0.12%	0.21%*	0.27%	0.33%*	0.25%/0.98	0.25%/0.98
	Russell 2000						
2007		IWM	NAESX	IWM	NAESX	IWM	NAESX
2007		0.24%	0.14%*	0.32%	0.20%*	0.32%/0.94	0.14%/0.98
2008		0.29%	0.21%*	0.42%	0.31%*	0.39%/0.98	0.24%/0.99
2009		0.23%	0.18%*	0.31%	0.24%*	0.24%/0.98	0.20%/0.99
2010		0.11%	0.14%*	0.14%	0.18%*	0.14%/0.99	0.11%/0.99
2011		0.14%	0.17%*	0.19%	0.23%*	0.12%/0.99	0.13%/0.99
2012		0.11%	0.12%	0.14%	0.15%*	0.09%/0.99	0.10%/0.99
2007-2012		0.18%	0.16%*	0.27%	0.22%*	0.24%/0.98	0.16%/0.99
	Russell 2000 Growth Index						
2007		IWO	VEXPX	IWO	VEXPX	IWO	VEXPX
2007		0.21%	0.20%	0.29%	0.29%*	0.29%/0.95	0.22%/0.96
2008		0.29%	0.52%*	0.48%	0.73%*	0.46%/0.97	0.32%/0.98
2009		0.23%	0.44%*	0.32%	0.59%*	0.28%/0.98	0.22%/0.98
2010		0.11%	0.27%*	0.12%	0.36%*	0.11%/0.97	0.19%/0.98
2011		0.11%	0.33%*	0.15%	0.45%*	0.11%/0.99	0.20%/0.98
2012		0.09%	0.20%*	0.11%	0.25%*	0.09%/0.99	0.19%/0.96
2007-2012		0.17%	0.33%*	0.28%	0.48%*	0.26%/0.97	0.23%/0.97

* indicates difference between tracking errors of ETFs and tracking errors of index funds is significant at 1% level.

In our analysis we have looked at tracking errors of ETFs and index funds to compare their relative performance, there are other costs investors need to take into account based on individual situation. First, relative tax advantages of ETF over index fund will depend on whether investment under consideration is for a taxable account or a tax-deferred account. Second, the broker's commission you pay with every purchase and sale will vary for ETF and traditional mutual fund. While not an issue for most index funds, many actively managed mutual funds carry "loads," which are upfront sales commissions, often 3 percent to 5 percent of the investment. The fund would then need a significant gain before the investor could break even. Most of the index funds do not carry any significant upfront sales commissions. Third, buying and selling ETFs will entail broker's commission which can be significant when used with certain investing strategies. For example with a dollar-cost averaging strategy, where to mitigate the risk of investing during a big swing in the market investors invest a small amount every month. With this strategy, broking commissions would add up, even if they are only \$8 or \$10 like for an online brokerage. Investor will also pay commissions when making withdrawals in retirement, which can be minimized by taking out more money on fewer occasions. So, for investing a large sum in one block, an ETF may be the cheaper choice. For piecemeal investing every month, the index mutual fund could be the better option. Fourth, trading (ETF) on the exchange investors will incur liquidity cost as measured by bid-ask spread. Finally, both ETFs and index funds charge management fee which varies from fund to fund and by fund family.

In the Table 8 below, for the year 2012 we report expense ratios and average tracking errors for the ETFs and index funds. The data in the table suggest that while the expense ratios for these widely held and traded index funds and ETFs are very low, ETF in general have lower expense ratios. We also observe that the tracking errors for the ETFs in our sample are lower than the tracking errors for the index funds. Although we don't have high frequency data to calculate intraday liquidity costs of the ETF, the observed bid-ask spread for all the ETFs in our sample is very low and relatively insignificant as compared to expense ratios and tracking errors. In total, this data appears to give an advantage to ETFs in terms of the total cost to the investors. Since the observed tracking errors is significant portion of the total costs to the investors, therefore for the investors who are debating to choose either ETFs or Index funds to meet their investment objective, it is critical to quantify tracking errors of these competing investment products.

Table 8: Expense Ratios for ETFs and Index Funds

ETFs	Index Funds	Expense Ratios (2012)		Average Tracking Error (2012)	
		ETFs	Index Funds	ETFs	Index Funds
IVV	VFINX	0.07%	0.17%	0.09%	0.04%
QQQQ	RYOCX	0.20%	1.26%	0.06%	0.05%
IWD	VEIPX	0.21%	0.30%	0.08%	0.21%
IWF	VGEQX	0.20%	0.54%	0.07%	0.18%
VTI	VTSMX	0.05%	0.17%	0.11%	0.12%
IWW	VUVLX	0.25%	0.29%	0.10%	0.21%
IWZ	VMRGX	0.25%	0.40%	0.13%	0.13%
IJH	VIMSX	0.15%	0.24%	0.08%	0.10%
IWS	VASVX	0.28%	0.38%	0.03%	0.16%
IWP	VMGRX	0.25%	0.54%	0.07%	0.04%
IWM	NAESX	0.24%	0.24%	0.10%	0.18%
IWO	VEXPX	0.25%	0.49%	0.06%	0.16%
	Average	0.20%	0.42%	0.08%	0.13%

6. CONCLUSION

In this paper we empirically examine efficiency and performance of exchange traded funds (ETF) and index funds in tracking the underlying index. We use twelve matched samples of ETFs and Index funds tracking widely followed index representing large-cap, broad-market, mid-cap and small-cap segments of equity markets in the US. Our results document gradual and consistent decrease in the tracking errors of ETFs, which bodes well for the ETF industry as it continue to challenge dominance of the mutual funds as the investment vehicle of choice. Our results suggests that for large-cap and broad-market indices, index funds perform relatively better than the corresponding ETFs in terms of tracking errors. In contrast, for indices tracking narrower indices tracking mid-cap indices, small-cap indices and a segment of large-cap indices, ETFs exhibit lower tracking errors compared to corresponding index funds. These results support empirical and theoretical predictions in Guedj and Huang (2008). They argue that ETFs are better suited for narrower and less liquid underlying indexes. This is due to the “in kind redemption” feature of ETFs, which help them avoid flow-induced trading costs. ETFs are able to avoid trading related costs due to fund flows as they don’t need to purchase or liquidate the underlying assets. Our results also document significant increase in tracking errors for both ETFs and index funds when market volatility is high, however their relative performance do not change. The volatility of daily returns for ETFs is lower than the volatility of

daily returns of their underlying index and that of corresponding index funds during the entire sample period. Finally, our results suggest that if we include all the costs (expense ratios and trading costs) to the investors ETFs in general are than the corresponding index funds.

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