Fund structures and performance measures

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Fund balance sheet and net asset value

Funds have a relatively simple balance sheet:

- Assets: Investments, and cash needed for operations.
  - Most commonly, other companies' liabilities or equity.
  - Total amount is called assets under management (AUM).
  - Most companies report asset values based on cost, but funds attempt to report market values. See next slide.
- Liabilities: Accrued expenses, and possibly borrowing.
- Equity: Shares sold to investors.

The fund's equity value is called its net asset value or NAV. The equity value per share can be called "NAV per share," or can also just be called "NAV."

$$\text{NAV per share} = \frac{\text{Assets} - \text{Liabilities}}{\text{Shares outstanding}}$$

You can usually tell from context whether NAV refers to a whole-fund measure or a per-share measure. I will always try to be clear about this.

Asset values and marking to market

- Most companies follow cost accounting: The book value of an asset is the price that was paid to acquire it.
- But funds attempt to report their assets at market value, which they recalculate every day based on recent sale prices.
- The goal is for NAV to reflect a fair selling price for one share.
- For very liquid assets like public stocks, this is straightforward. For funds holding these assets, NAV closely tracks market value.
- For illiquid assets like corporate bonds and real estate, it is much more difficult to say what the true market value is, and there is no guarantee that NAV is close to that value.

Investment returns and distributions

- Many funds are technically corporations, but can avoid taxes, as long as they “pass through” all income from investments.
- This income includes, stock dividends, bond coupons, and also capital gains realized from the sale of securities.
- Any such income must be distributed equally to all shareholders in the fund, at regular intervals.
- Many investors elect to receive these distributions in the form of more shares, effectively reinvesting them back into the fund.
- But the distribution is still taxable! This can create unwanted and inconvenient tax events for the investor.

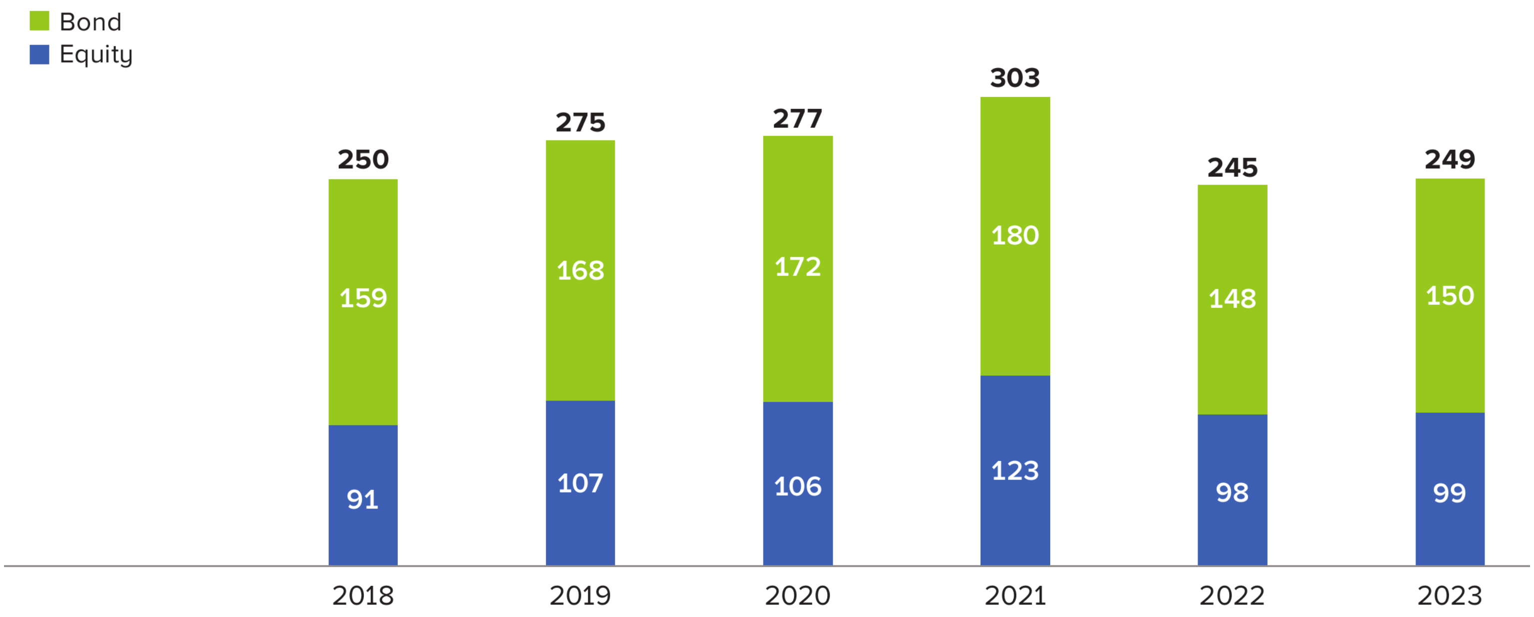
Structure of a closed-end fund

- A closed-end fund sells shares when it initially opens, and uses the proceeds to form its investment portfolio.
- At some future date the fund will liquidate and close (though this date is not necessarily fixed in advance).
- Until then, the number of shares generally does not change. The only way to invest is to buy shares from an existing investor. The only way to divest is to sell to another investor.
- Investor demand affects the share price but not the fund's AUM.

Closed-end funds are often exchange-traded, but are not ETFs.

Closed-end funds are a relatively small market

AUM of closed-end funds, year-end, billions of dollars (source: ICI factbook):



Return to investing in a CEF

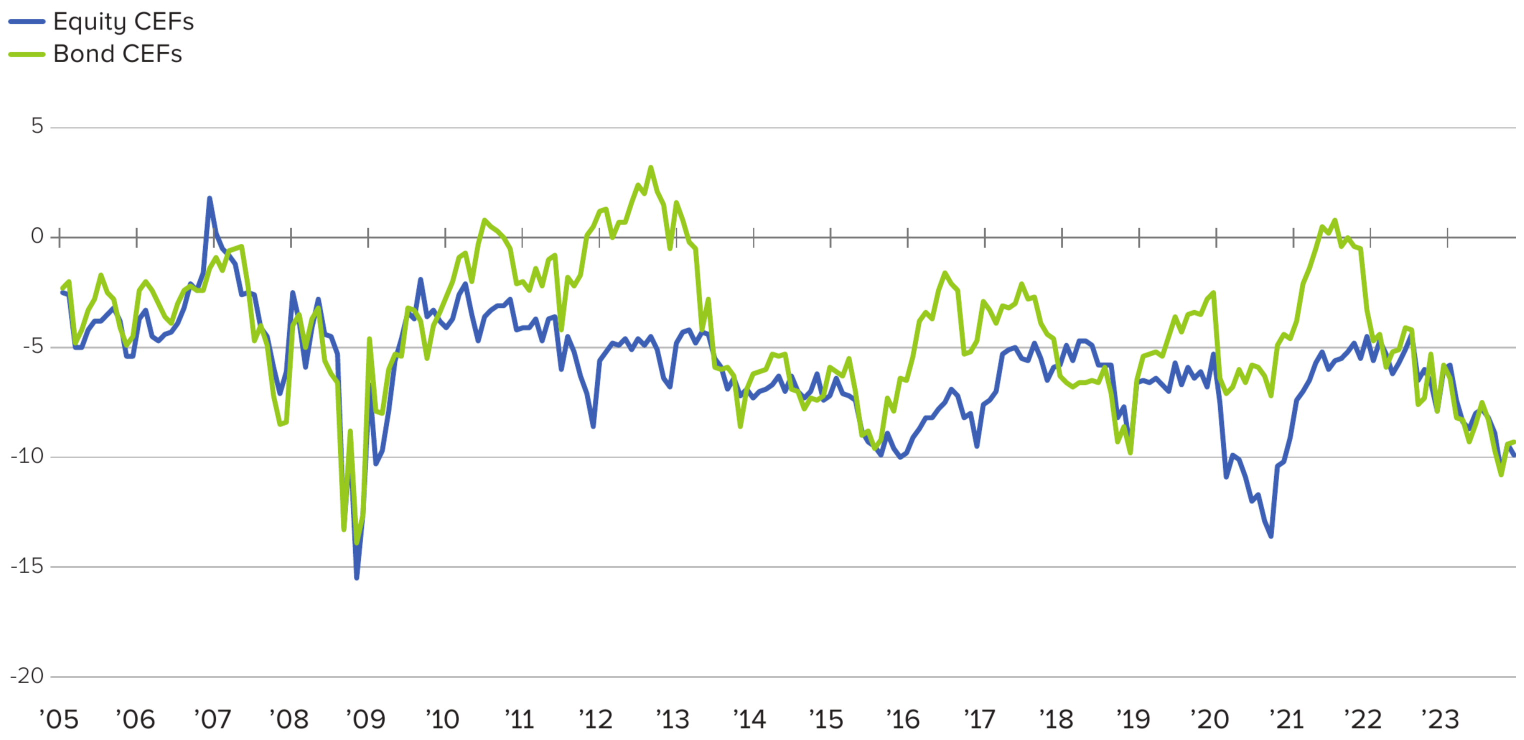
You buy and sell CEF shares at market prices, so the return to investing is calculated the same way as with a company's stock:

$$\text{CEF return} = \frac{P_1 + \text{Distributions}}{P_0} - 1$$

The share price is often quite different from the fund's NAV.

- Usually shares trade at a discount to NAV. (See next slide.)
- The exact reason for this is not universally agreed.
- Presents a problem for a CEF that attempts to index.

CEF premiums and discounts of share price to NAV (%)



Structure of a mutual fund (open-end fund)

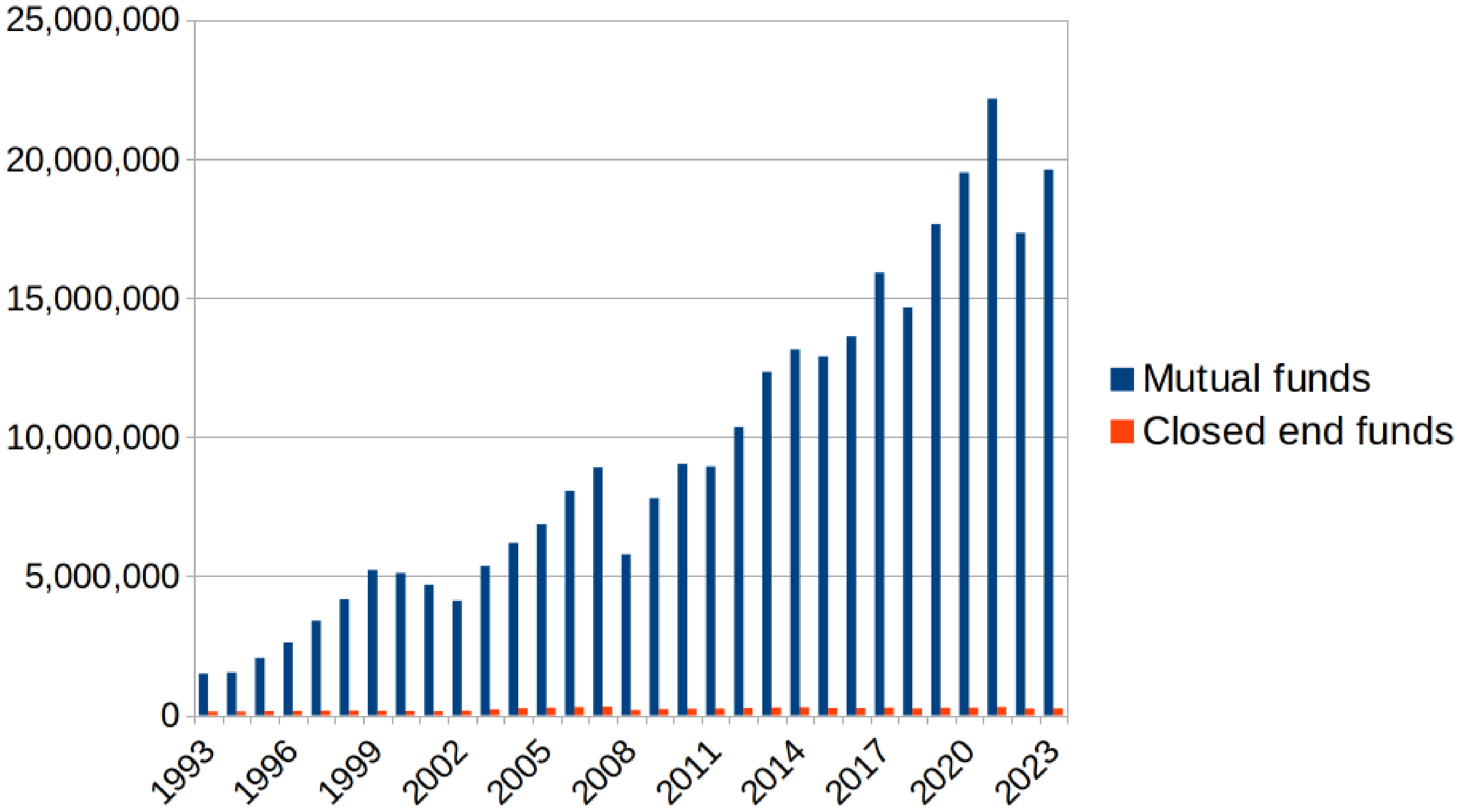
We will use “mutual fund” and “open-end fund” interchangeably.
(This is almost a universal standard, at least in the United States.)

In a mutual fund:

- Investors do not trade shares with each other.
- Instead, the fund sponsor sells (issues) shares directly to investors, and repurchases (redeems) them directly from investors.
- These trades are processed after markets close each day, at the new NAV calculated based on closing prices that day.
- The fund keeps some cash on hand to meet redemptions. Cash is replenished by share issuance to new investors, or else by selling securities and shrinking the fund.

Most investment is through mutual funds

AUM of mutual funds and closed-end funds, millions of dollars (source: ICI factbook):



Mutual fund fees and investment returns

Types of fees:

- Loads: Commission on initial investment (“front-end load”), and fees for existing the investment (“back-end load”).
- Operating expenses and “12b-1 charges”: Cover the ongoing costs of running the fund, including commissions, salaries, marketing and distribution costs. These are deducted from NAV.

Because you trade at NAV, the return to investing, ignoring loads, is

$$\text{Mutual fund return} = \frac{NAV_1 + \text{Distributions}}{NAV_0} - 1$$

All categories of fees have fallen over time.

Weaknesses of closed-end and mutual fund structures

CEF and mutual fund structures each have important weaknesses:

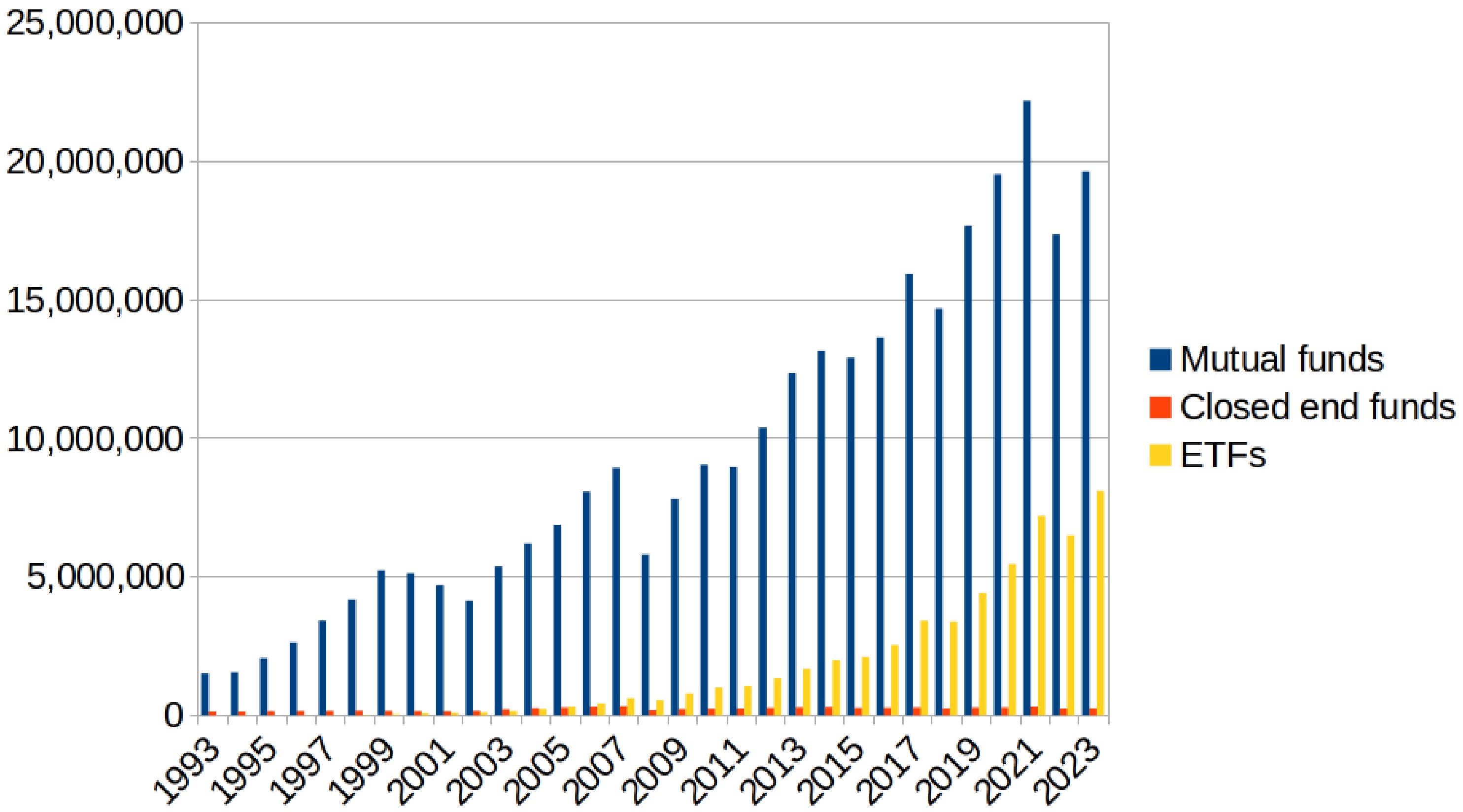
- CEF: Cannot grow, and cannot reliably track an index.
- Mutual fund: Cannot offer intraday exchange-based trading, and require cash management which contributes to fund costs.

For this course, you should understand the above issues, and how the ETF structure solves them.

In fact, the ETF structure also solves several other important issues. I will not ask you to study beyond what is described in this document, but would be glad to provide more information for those interested.

Growth of ETFs

AUM of mutual funds, CEFs, and ETFs, millions of dollars:



ETF structure: Basics

To the investor, an ETF resembles a closed-end fund:

- Shares in the ETF are traded on an exchange.
- Investors enter or leave the fund by trading those shares, not by interacting with the fund itself.

Many people mistakenly believe an ETF is an example of a CEF.

But unlike a closed-end fund, an ETF can grow and shrink.

- Shares can be issued if investor demand grows,
- and they can be redeemed back if demand falls.

The details of this process are the key to the ETF structure.

Share issuance/redemption: Authorized participants

The ETF designates certain “authorized participants” (APs).

- Usually banks, broker-dealers, and other financial institutions.
- APs can obtain new fund shares (“creation” or “issuance”), or can return existing shares back to the fund (“redemption”).
- This is how the fund grows and shrinks in response to demand.

For APs, unlike other investors, the ETF resembles an open-end fund.

Share issuance/redemption: In-kind transactions

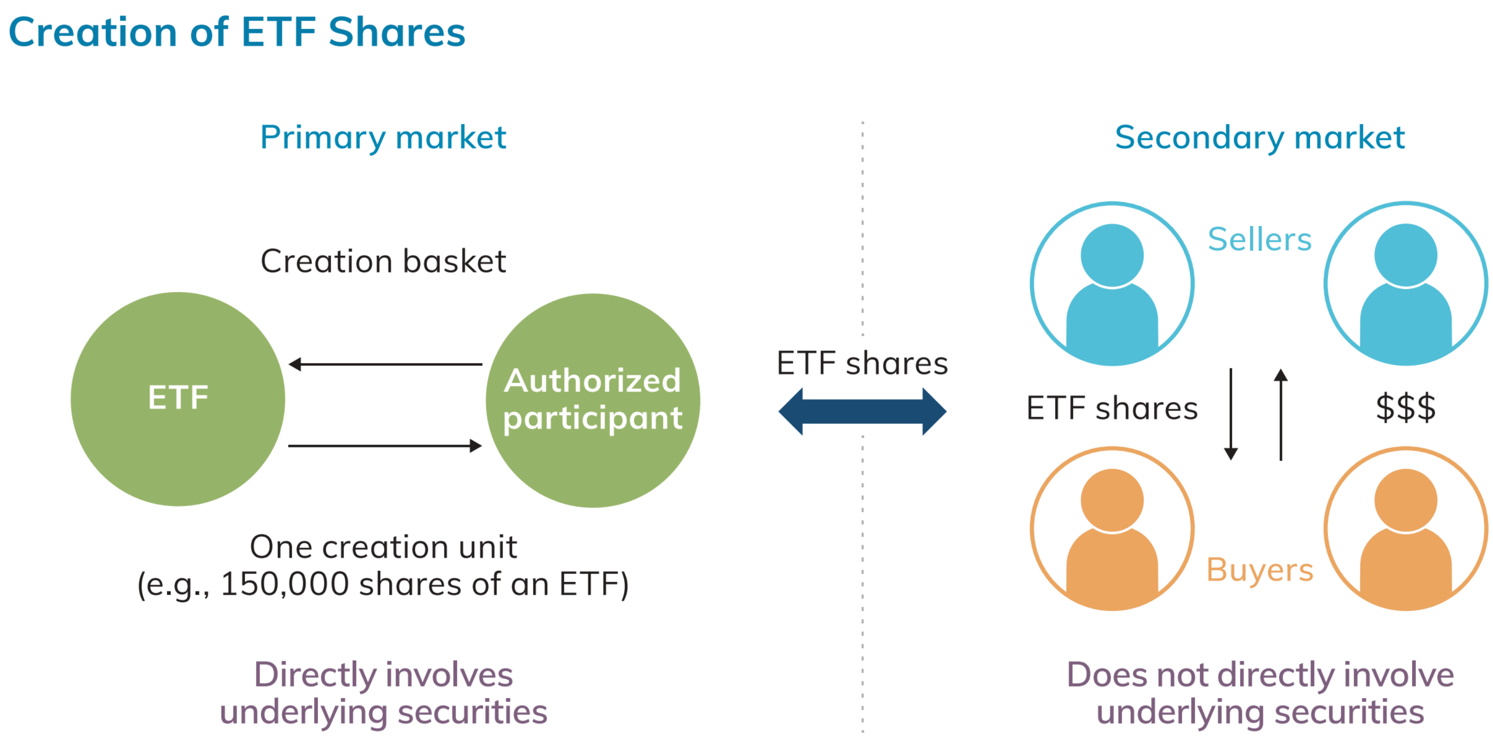
Critically, share issuance and redemption are in-kind, not in cash.

- With an open-end fund, a new investor exchanges cash for fund shares, then the fund invests that cash in securities.
- To create ETF shares, the AP assembles securities on their own, then gives them directly to the ETF in exchange for new shares.
- When redeeming shares, the AP receives securities, not cash.

To facilitate this, the ETF continually announces its holdings.

- This way, APs always know the ingredients of a "creation unit."
- This is why ETFs are best for transparent investment strategies.

Share issuance and redemption



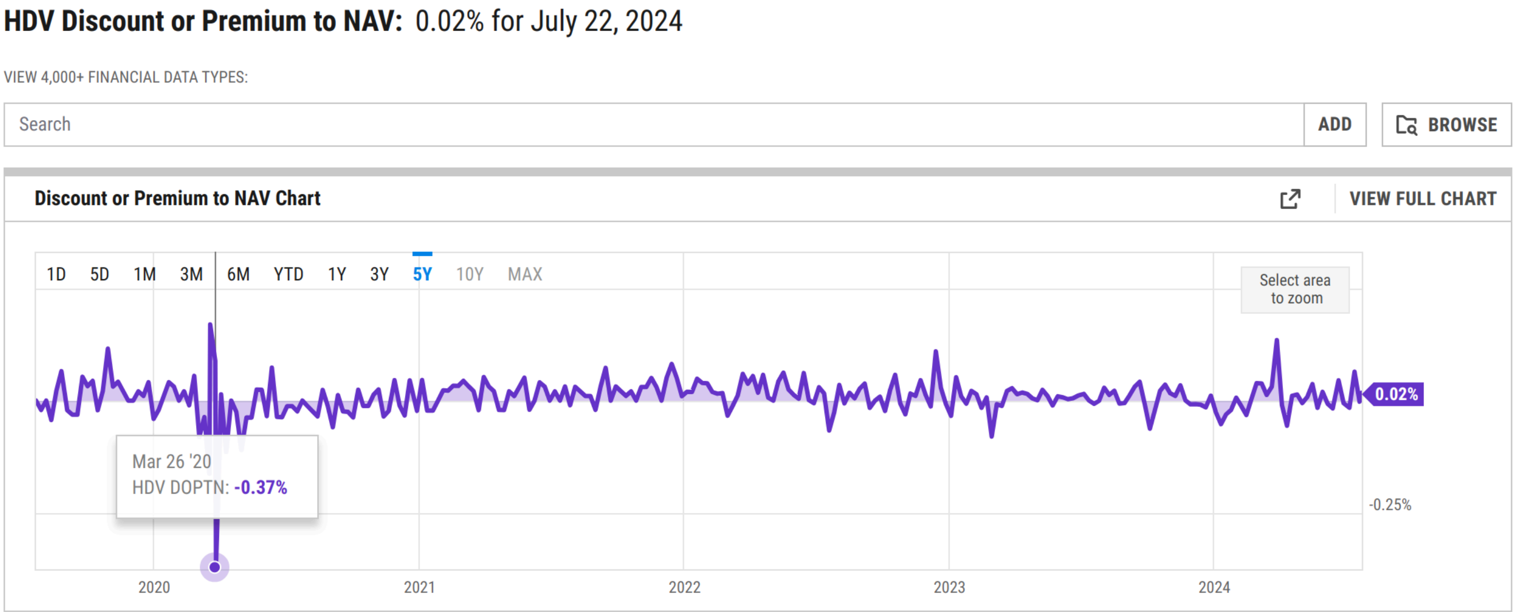
Issuance and redemption prevent large tracking errors

The issuance/redemption process keeps the ETF's share price close to the fair value of the securities that it holds:

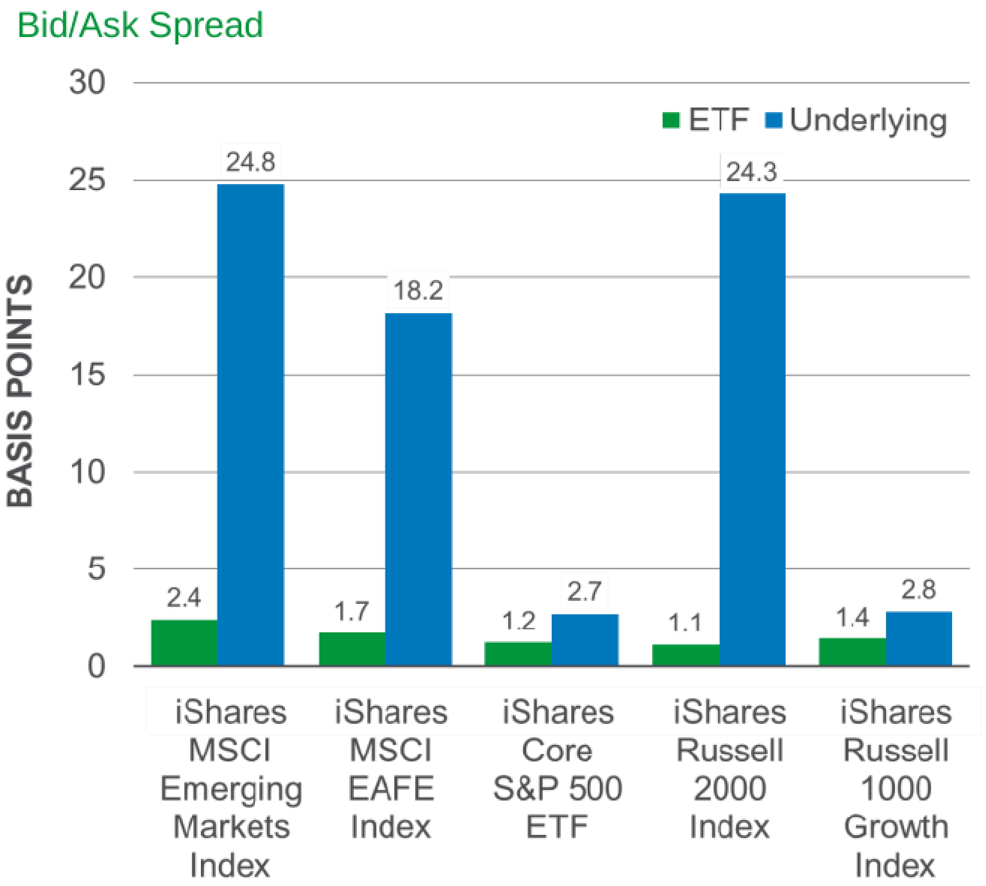
- If investor demand starts to push the ETF share price upward, APs respond by buying the underlying securities, obtaining new ETF shares, and selling those shares to investors.
- If investors lose interest in the fund, the share price falls. APs buy ETF shares for cheap and exchange them for securities.
- In either case, the share price will not go far from fair value. Instead, this pressure is absorbed by the fund changing size.

These actions generate profits for APs, so we can expect that they will play along, without concerns about commitment or enforcement.

Premiums and discounts to NAV



ETFs are often more liquid than their underlying assets



Sources: BLK, TRACE, Bloomberg as of 4/19/2013. Values are the average since 3/1/2013.

ETF advantages: Costs

In-kind redemption/creation also allows an ETF to operate at lower costs than a mutual fund following the same strategy.

- If a mutual fund investor wants to get out, they redeem their shares back to the fund itself. The fund must hold cash on hand to meet redemptions. If new issuance does not replenish that cash, they must sell securities to do so. All of this takes attention and effort, generating costs.
- If an ETF investor wants to get out, they just sell their shares on the exchange. If enough investors do so, this puts downward pressure on the price, and the AP will start redeeming shares. But those transactions do not involve cash, so they are easier to manage from the fund's perspective.

ETF expense ratios

Index ETF Expense Ratios Vary Across Investment Objectives

Percent, 2018

Investment objective	10th percentile	Median	90th percentile	Asset-weighted average	Simple average
Index equity ETFs	**0.13**	**0.47**	**0.95**	**0.20**	**0.49**
Growth	0.07	0.30	0.64	0.19	0.36
Sector	0.13	0.50	0.95	0.26	0.56
Value	0.08	0.30	0.64	0.21	0.34
Blend	0.10	0.35	0.95	0.12	0.43
World	0.25	0.53	0.82	0.30	0.54
Index hybrid ETFs	**0.56**	**0.68**	**0.95**	**0.60**	**0.70**
Index bond ETFs	**0.07**	**0.20**	**0.50**	**0.16**	**0.28**
Corporate	0.06	0.10	0.25	0.09	0.15
World	0.24	0.41	0.50	0.31	0.40
Government	0.07	0.15	0.95	0.14	0.31
High-yield	0.25	0.41	0.63	0.45	0.43
Municipal	0.18	0.25	0.35	0.23	0.25

Other "exchange-traded" products

I will always use "ETF" to mean the structure described above.

- This is the most common meaning of the term, and it applies to the best-known examples, such as equity or bond index ETFs.

But the general label "exchange-traded product" (ETP) has also been applied to other structures that do not fit this description.

- For example, exchange-traded notes (ETN) are essentially derivative contracts (technically unsecured debt) issued by investment banks. Although these are exchange-traded, they have nothing in common with an ETF.

So be careful about the meaning of these labels outside class!

Examples of calculating fund performance measures

The rest of these slides illustrate performance measures that you will need to calculate in Homework 1.

We will examine two prominent mutual funds:

- VFINX: A famous Vanguard index fund that simply tries to track the S&P 500 index.
- FMAGX: A famous active equity mutual fund, which delivered outstanding returns during the 1980s under Peter Lynch.

We will also add in the S&P 500 index for comparison.

We will start our analysis in 1991, shortly after Lynch left Magellan.

(Note: I have already downloaded all the data. See notebook online for the code if you are interested. I end the data in 2017 to avoid a minor complication due to Magellan's 10-for-1 split in 2018.)

Calculating fund returns

I have already loaded each fund's monthly NAVs and distributions into a Python data frame with its name. Now let's use the formulas from class to calculate each fund's monthly return:

In [6]:
```
FMAGX['returns'] = (
    (FMAGX['mnav'] + FMAGX['dis_amt']) / FMAGX['mnav'].shift() - 1
)
VFINX['returns'] = (
    (VFINX['mnav'] + VFINX['dis_amt']) / VFINX['mnav'].shift() - 1
)
```

- In each of the frames VFINX and FMAGX, there are columns called 'mnav' and 'dis_amt' for the month-end NAV and the during-month distribution. We access each column by putting its name in brackets.
- Python understands that when we put a column name in a formula, it means "apply this formula to every row in the column".
- The shift() says to move back in time by one step.

Here are the returns for the first six months. (NaN means "Not a Number".)

In [7]:
```
print( FMAGX[['mnav','dis_amt','returns']][0:6] )
```

```
          mnav  dis_amt   returns
month
1990-12  53.93     1.02       NaN
1991-01  57.70     0.00  0.069905
1991-02  62.71     0.00  0.086828
1991-03  64.84     0.00  0.033966
1991-04  65.08     0.00  0.003701
1991-05  66.71     2.01  0.055931
```

In [8]:
```
print( VFINX[['mnav','dis_amt','returns']][0:6] )
```

```
          mnav  dis_amt   returns
month
1990-12  31.24     0.68       NaN
1991-01  32.59     0.00  0.043214
1991-02  34.92     0.00  0.071494
1991-03  35.51     0.25  0.024055
1991-04  35.58     0.00  0.001971
1991-05  37.10     0.00  0.042721
```

In Python, a number in brackets gets an item from a list. Two numbers mean, get the whole range. You count from 0, not 1, and the last number in a range is left out. So [0:6] means "get #0 through #5", that is, the first 6 rows.

Cumulative investment returns over time:

We can calculate the cumulative return of any investment up to any date t as follows:

- calculate the *gross* return each month, which is just 1 plus the *net* return.
  (When not specified, "return" typically means net return.)
- multiply together all the gross returns up to date t.
  In Python we can use the function cumprod() which means "cumulative product".
  In Excel, we can use the product() function.

This calculation will tell us the value at date t of a single dollar invested at the first date of our data, assuming that we reinvest all distributions, dividends, or coupon payments.

Let's first apply that calculation to the two funds in our data:

In [9]:
```
FMAGX['cumulative return'] = (1+FMAGX['returns']).cumprod()
VFINX['cumulative return'] = (1+VFINX['returns']).cumprod()
```

In [10]:
```
print(VFINX[['returns','cumulative return']][0:6])
```

```
          returns  cumulative return
month
1990-12       NaN                NaN
1991-01  0.043214           1.043214
1991-02  0.071494           1.117798
1991-03  0.024055           1.144686
1991-04  0.001971           1.146943
1991-05  0.042721           1.195941
```

In [11]:
```
print(FMAGX[['returns','cumulative return']][0:6])
```

```
          returns  cumulative return
month
1990-12       NaN                NaN
1991-01  0.069905           1.069905
1991-02  0.086828           1.162804
1991-03  0.033966           1.202299
1991-04  0.003701           1.206749
1991-05  0.055931           1.274244
```

Now do the same for the S&P 500:

In [12]:
```
SP500['cumulative return'] = (1+SP500['vwretd']).cumprod()
print(SP500[['vwretd','cumulative return']][0:6])
```

```
           vwretd  cumulative return
month
1991-01  0.045001           1.045001
1991-02  0.071565           1.119786
1991-03  0.024355           1.147059
1991-04  0.002268           1.149660
1991-05  0.042930           1.199015
1991-06 -0.045357           1.144632
```

The column we used in the calculation above is called 'vwretd'. This column was pre-calculated for us in the dataset I downloaded earlier.

It records for each month the *total* return (including dividend payments) on the value-weighted portfolio of S&P 500 stocks. (Remember this is more than the growth of the S&P 500 index for that month!)

Cumulative returns of all three series over time:

In [14]:
```
cumulative_returns_figure
```

Out[14]:

Which fund would investors have preferred to be in during this time?
Why does VFINX seem to underperform the S&P 500 index?

Cumulative value of $1 invested:

The last number in the "cumulative return" column represents the total return on $1 invested at the beginning of our data, and held until the end, while reinvesting all dividends or other distributions.

In [15]:

```
print("Cumulative value of $1 invested from 1991 through 2017:")
print(f"  VFINX: ${VFINX['cumulative return'][-1] :.2f}")
print(f"  FMAGX: ${FMAGX['cumulative return'][-1] :.2f}")
```

```
Cumulative value of $1 invested from 1991 through 2017:
  VFINX: $13.77
  FMAGX: $11.74
```

Both funds would have multiplied your money many times over.
But as we saw in the figure, FMAGX significantly underperformed VFINX.

(In Python the [-1] means "get the last number in the list". In our case, December 2017.)

Arithmetic average returns:

The *arithmetic average return* on an investment is just the usual meaning of average.
We represent it with $\mu = \frac{r_1+r_2+\cdots+r_T}{T}$.
In Python, use mean(). In Excel, use AVERAGE().

We sometimes need to be clear that we are talking about the arithmetic average, because next we will see the *geometric* average, which is different.
But if I just say "average", I am talking about arithmetic average.

In [16]:
```
print("Arithmetic average monthly returns:")
print(f"VFINX:   {100*VFINX['returns'].mean() :.2f}%" )
print(f"FMAGX:   {100*FMAGX['returns'].mean() :.2f}%" )
print(f"S&P 500: {100*SP500['vwretd'].mean() :.2f}%")
```

```
Arithmetic average monthly returns:
VFINX:   0.90%
FMAGX:   0.87%
S&P 500: 0.92%
```

Notice that the arithmetic average of FMAGX is almost the same as that of VFINX. Yet, we saw that it had a much lower cumulative return. This tells us that arithmetic averages can be misleading. We will come back to this.

Geometric average returns:

The *geometric average return* on an investment is the cumulative return, raised to the power $\frac{1}{T}$, minus 1.

We label it with GM, so $GM = [(1+r_1) \times (1+r_2) \times \cdots \times (1+r_T)]^{1/T} - 1$.

In [17]:
```
T = len(VFINX)
VFINX_GM = VFINX['cumulative return'][-1] ** (1/T) - 1
FMAGX_GM = FMAGX['cumulative return'][-1] ** (1/T) - 1

print("Geometric average monthly returns:")
print(f"VFINX:   {100*VFINX_GM :.2f}%")
print(f"FMAGX:   {100*FMAGX_GM :.2f}%")
```

```
Geometric average monthly returns:
VFINX:    0.81%
FMAGX:    0.76%
```

- In Python, `x**y` means x^y. The `len()` function gets the length of a list.
- Both funds have a lower geometric than arithmetic average.
- The geometric average is a better measure of performance, because it is directly based on cumulative returns. We will say more about this in Module 2.

Volatility of monthly returns:

The volatility of a return is another name for the standard deviation of returns.

In Python we can use the std() function. In Excel, STDEV().

FMAGX had more volatility, for about the same (arithmetic) average return.

In [18]:
```
print("Monthly return volatilities:")
print(f"  VFINX: {100*VFINX['returns'].std() :.2f}%")
print(f"  FMAGX: {100*FMAGX['returns'].std() :.2f}%")
```

```
Monthly return volatilities:
  VFINX: 4.05%
  FMAGX: 4.63%
```

In Module 2, we will see that volatility causes true performance (geometric average) to be lower than what you would expect based on the arithmetic average return.

That is, volatility hurts performance.

Sharpe ratios:

The Sharpe ratio is the average of excess return, divided by its volatility.
We can write this as $SR = \frac{\mu}{\sigma}$.
Remember that both the numerator and denominator should use excess returns!

In [19]:
```
FMAGX['excess'] = FMAGX['returns'] - riskfree
VFINX['excess'] = VFINX['returns'] - riskfree

VFINX_Sharpe = VFINX['excess'].mean() / VFINX['excess'].std()
FMAGX_Sharpe = FMAGX['excess'].mean() / FMAGX['excess'].std()

print("Sharpe ratios:")
print(f"  VFINX: { VFINX_Sharpe :.5f}")
print(f"  FMAGX: { FMAGX_Sharpe :.5f}")
```

```
Sharpe ratios:
  VFINX: 0.16847
  FMAGX: 0.14241
```

In Module 2 we will be precise about exactly what the Sharpe ratio means.

A detail: In practice you should specify what frequency returns you used to calculate the Sharpe ratio. The numbers above are *monthly* Sharpe ratios.