Chapter 12: Estimating the Cost of Capital

Fundamental question: Where do we get the numbers to estimate the cost of capital?

=> How do we implement the CAPM discussed in chapter 10?

12.1 The Equity Cost of Capital

Cost of capital: best expected return available in the market on investments with similar risk

\[ r_i = r_f + \beta_i \times (E(R_{Mkt}) - r_f) \]  

(12.1)

Notes:

1) Equation 12.1 and variables in it are identical to what is at the end of Ch 10 notes
2) Risk premium for security \( i \): \( \beta_i \times (E(R_{Mkt}) - r_f) \)

Concept checks: 1

12.2 The Market Portfolio

A. Constructing the Market Portfolio

\[ MV_i = NSO_i \times P_i \]  

(12.2)

where:

\( MV_i \) = market value of \( i \)
\( NSO_i \) = number of shares of \( i \) outstanding
\( P_i \) = price of \( i \) per share

\[ x_i = \frac{MV_i}{TMV} \]  

(12.3)

where:

\( x_i \) = portfolio weight of security \( i \) = % of portfolio invested in security \( i \)
\( TMV \) = total market value of all securities in portfolio
Ex. Assume the market consists of five stocks: Alphabet, Ford, GE, Kellogg, and Wal-Mart. The number of outstanding shares and current stock price for each firm are as follows:

<table>
<thead>
<tr>
<th>Name</th>
<th>Shares (Billions)</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alphabet</td>
<td>0.4</td>
<td>650</td>
</tr>
<tr>
<td>Ford</td>
<td>4</td>
<td>15.05</td>
</tr>
<tr>
<td>GE</td>
<td>10</td>
<td>40</td>
</tr>
<tr>
<td>Kellogg</td>
<td>0.26</td>
<td>80</td>
</tr>
<tr>
<td>Wal-Mart</td>
<td>3.7</td>
<td>70</td>
</tr>
</tbody>
</table>

Assume also that you want to create a passive, value-weighted portfolio with $100,000 that mimics market. How much do you need to invest in each company’s shares? How many shares do you need to buy?

<table>
<thead>
<tr>
<th>Name</th>
<th>Shares (Billions)</th>
<th>Price</th>
<th>Market Cap (Billions)</th>
<th>Investment</th>
<th>Shares</th>
<th>Percent of Shares</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alphabet</td>
<td>0.4</td>
<td>650</td>
<td>260</td>
<td>$26,000.00</td>
<td>40</td>
<td>0.26</td>
</tr>
<tr>
<td>Ford</td>
<td>4</td>
<td>15.05</td>
<td>60.2</td>
<td>$6,020.00</td>
<td>400</td>
<td>0.0602</td>
</tr>
<tr>
<td>GE</td>
<td>10</td>
<td>40</td>
<td>400</td>
<td>$40,000.00</td>
<td>1000</td>
<td>0.4</td>
</tr>
<tr>
<td>Kellogg</td>
<td>0.26</td>
<td>80</td>
<td>20.8</td>
<td>$2,080.00</td>
<td>26</td>
<td>0.0208</td>
</tr>
<tr>
<td>Wal-Mart</td>
<td>3.7</td>
<td>70</td>
<td>259</td>
<td>$25,900.00</td>
<td>370</td>
<td>0.259</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>1000</strong></td>
<td></td>
<td><strong>$100,000.00</strong></td>
<td><strong>370</strong></td>
<td><strong>Percent of Shares</strong></td>
<td></td>
</tr>
</tbody>
</table>

**Q:** What changes do you need to make if the price per share of: Alphabet rises to $800, Ford falls to $13, GE falls to $30, Kellogg rises to $95, and Wal-Mart rises to $85?

<table>
<thead>
<tr>
<th>Name</th>
<th>Shares (Billions)</th>
<th>Price</th>
<th>Market Cap (Billions)</th>
<th>Investment</th>
<th>Shares</th>
<th>x(i) for Portfolio</th>
<th>Percent of Shares</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alphabet</td>
<td>0.4</td>
<td>800</td>
<td>320</td>
<td>$32,000.00</td>
<td>40</td>
<td>0.32</td>
<td>0.00001%</td>
</tr>
<tr>
<td>Ford</td>
<td>4</td>
<td>13</td>
<td>52</td>
<td>$5,200.00</td>
<td>400</td>
<td>0.052</td>
<td>0.00001%</td>
</tr>
<tr>
<td>GE</td>
<td>10</td>
<td>30</td>
<td>300</td>
<td>$30,000.00</td>
<td>1000</td>
<td>0.3</td>
<td>0.00001%</td>
</tr>
<tr>
<td>Kellogg</td>
<td>0.26</td>
<td>95</td>
<td>24.7</td>
<td>$2,470.00</td>
<td>26</td>
<td>0.0247</td>
<td>0.00001%</td>
</tr>
<tr>
<td>Wal-Mart</td>
<td>3.7</td>
<td>85</td>
<td>314.5</td>
<td>$31,450.00</td>
<td>370</td>
<td>0.3145</td>
<td>0.00001%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>1011.2</strong></td>
<td></td>
<td><strong>$101,120.00</strong></td>
<td><strong>Percent of Shares</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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Note: No need to rebalance value-weighted portfolio as stock prices change. But must rebalance if a firm issues or repurchases shares (so own same percent of each firm’s outstanding shares as before the issue/repurchase…0.00001% in example).
B. Market Indexes

1. Examples of Market Indexes

   Major U.S. stock indexes: S&P 500 index, Nasdaq Composite Index (value-weighted index of more than 3000 common stocks listed on the Nasdaq stock exchange), and Dow Jones Industrial Average

   Problems with DJIA: only 30 stocks, price- rather than value-weighted.

   Note: I will use the S&P500 as a proxy for the market

2. Investing in a Market Index

   Main ways to invest in a market index: index mutual funds, exchange-traded funds

   Note: In my 403B (the non-profit equivalent to a 401k), I hold several Vanguard funds:

   - Total Stock Market Index (basically tracks the Wilshire 5000)
   - Value Index (tracks value stocks in the S&P500),
   - Total International Stock Index (tracks all non-US stocks)
   - Small-Cap Value Index (tracks an index of small-cap value stocks)
   - Short-Term Investment Grade (a short-term bond fund)

   Reasons: I overweight value stocks because historically they have outperformed growth stocks with less risk. Based on my theoretical retirement date, I should hold some bonds, but I want to avoid long-term bonds since they will get hammered when interest rates eventually rise.

   Value stock: slower growing firms with low PE ratios, high dividend yields, and low market to book ratios.

C. The Market Risk Premium

1. Determining the Risk-Free Rate

   Notes:

   1) I will use the yield on 10-year Treasuries as the risk-free rate.
   2) Treasuries are subject to interest rate risk unless select a maturity equal to our investment horizon AND buy a U.S. Treasury Strip (pays no coupons). Otherwise, the coupons create interest rate risk as reinvest at an unknown rate.
2. The Historical Risk Premium

=> market risk premium over 10-year Treasuries:
   1926 – 2012 = 5.9%
   1962 – 2012 = 3.8%

Problems:

1) hard to know which past to use
2) difficult to have confidence in past since large standard errors
3) future may not be like the past

3. A Fundamental Approach

Key => using current dividend yield and expected growth to estimate expected return on market

\[ r_{Mkt} = \frac{D_1}{P_0} + g \]  \hspace{1cm} (12.4)

Note: This is essentially equation (9.7), so we don’t really need it.

Research: market risk premium estimated as being in 3 – 5% range.

Concept Check: all

12.3 Beta Estimation

A. Using Historical Returns

=> beta depends on how sensitive firms profit are to economy
B. Identifying the Best-Fitting Line

1. beta equals slope of best-fitting line of excess returns on stock vs. excess returns on market

   excess returns: return – risk-free rate

   Ex. Assume you plot the excess monthly returns of Apple against the excess returns on the S&P500 (see data at end of these notes) for 2016 – 2018.


   Note: beta is approximately 1.12 based on the 3-years of monthly data
   Note: Beta listed on Yahoo! Finance (as of 1/3/2019) = 1.13

2. deviations from line due to risk specific to the company

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C. Using Linear Regression

\[
(R_i - r_f) = \alpha_i + \beta_i(R_{Mkt} - r_f) + \varepsilon_i \tag{12.5}
\]

where:

- \(\alpha_i\) = intercept term of regression
- \(\beta_i\) = beta of stock
- \(\varepsilon_i\) = error term = risk unrelated to the market

\[
E[R_i] = r_f + \beta_i(E[R_{Mkt}] - r_f) + \alpha_i \tag{12.6}
\]
Using Excel: Use the SLOPE() function to get $\beta$. Excess returns for the stock go in as the “y” variable and excess returns for the market go in for the “x” variable. In the same way, you can use the INTERCEPT() function to get $\alpha$.

Note: If use SLOPE() function on excess return data at end of notes, also get beta of 1.0624.

Ex. Calculate Apple’s equity cost of capital if the risk-free rate equals 3% and the market risk premium equals 6%.

$$r_e = 0.03 + 1.0624(0.06) = 0.094$$

Concept Check: 1

12.4 The Debt Cost of Capital

Note: Both methods in this chapter give only an approximate debt cost of capital.

A. Debt Yield Versus Returns

Key: if chance of default, yield to maturity overstates the expected return on the bond

$$r_d = (1 - p)y + p(y - L) = y - pL$$  \hspace{1cm} (12.7)

where:

- $y$ = yield to maturity on debt
- $p$ = probability of default
- $L$ = expected loss per dollar of debt if default
- $r_d$ = debt cost of capital

Note: Table 12.2 will be included in formula sheet

Table 12.2: Percent Annual Default Rates by Debt Rating

<table>
<thead>
<tr>
<th>Rating</th>
<th>AAA</th>
<th>AA</th>
<th>A</th>
<th>BBB</th>
<th>BB</th>
<th>B</th>
<th>CCC</th>
<th>CC-C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ave.</td>
<td>0.0</td>
<td>0.1</td>
<td>0.2</td>
<td>0.5</td>
<td>2.2</td>
<td>5.5</td>
<td>12.2</td>
<td>14.1</td>
</tr>
<tr>
<td>Recession</td>
<td>0.0</td>
<td>1.0</td>
<td>3.0</td>
<td>3.0</td>
<td>8.0</td>
<td>16.0</td>
<td>48.0</td>
<td>78.0</td>
</tr>
</tbody>
</table>
Ex. Assume that Kortly Inc. bond trade at a yield to maturity of 9%. The bonds have a B rating and the expected loss in the event of default is 60%. What is the expected return on Kortly debt?

\[ r_d = .09 - .055(.6) = .057 \]

=> once consider possible loss from default, expected return only equals 5.7%.

B. Debt Betas

=> difficult to calculate because of infrequent trading

=> can use data on average debt beta for bond rating and maturity

Note: The betas by maturity are for bonds rated BBB or above.

Table 12.3: Average Debt Betas

<table>
<thead>
<tr>
<th>By Rating</th>
<th>A above</th>
<th>BBB</th>
<th>BB</th>
<th>B</th>
<th>CCC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Avg. Beta</td>
<td>&lt;.05</td>
<td>.10</td>
<td>.17</td>
<td>.26</td>
<td>.31</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>By Maturity</th>
<th>1-5 Yr</th>
<th>5-10 Yr</th>
<th>10-15Yr</th>
<th>&gt; 15Yr</th>
</tr>
</thead>
<tbody>
<tr>
<td>Avg. Beta</td>
<td>0.01</td>
<td>0.06</td>
<td>0.07</td>
<td>0.14</td>
</tr>
</tbody>
</table>

Note: Table 12.3 will be included in the formula sheet

12.5 A Project’s Cost of Capital

Key issue => can’t directly estimate beta of project because not traded

=> use cost of capital form firms in same line of business as project

A. All-Equity Comparables

Optimal: firm in single line of business that is finance only with equity

B. Levered Firms as Comparables

Key => return on assets equals return on portfolio of firm’s debt and equity
C. The Unlevered Cost of Capital

\[ r_u = \left( \frac{E}{E+D} \right) r_e + \left( \frac{D}{E+D} \right) r_d \]  

(12.8)

where:

\( r_u = \) unlevered cost of capital = expected return required by the firm’s investors to hold the firm’s underlying assets = weighted average of firm’s equity and debt costs of capital
\( E = \) total market value of equity
\( D = \) total market value of debt
\( r_e = \) equity cost of capital
\( r_d = \) debt cost of capital

Ex. Assume Jaxter Inc. has $4 million of outstanding debt and $10 million of outstanding equity. Assume that the Jaxter’s debt has a yield to maturity of 12%. Assume also that you estimate that there is a 3% chance that Jaxter will default and that the loss in default will equal 40%. Finally, assume that the equity cost of capital equals 16%. Calculate Jaxter’s unlevered cost of capital.

\[ r_d = .12 - .03(.4) = .108 \]

\[ r_u = \left( \frac{10}{10+4} \right) .16 + \left( \frac{4}{10+4} \right) .108 = .145 \]

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1. Unlevered Beta

\[ \beta_u = \left( \frac{E}{E+D} \right) \beta_e + \left( \frac{D}{E+D} \right) \beta_d \]  

(12.9)

where:

\( \beta_u = \) unlevered beta
\( \beta_e = \) equity beta
\( \beta_d = \) debt beta
Ex. Assume that Manstor Corp.’s equity has a beta of 1.1 and that its debt has a debt rating of BBB. Calculate Manstor’s unlevered beta if it has 3,000,000 outstanding shares that trade at a price of $30 per share and has $25 million of outstanding debt.

\[ \beta_d = 0.10 \]
\[ E = 3,000,000 \times 30 = 90 \text{ million} \]

\[ \beta_u = \left( \frac{90}{90+25} \right) 1.1 + \left( \frac{25}{90+25} \right) 0.1 = 0.883 \]

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2. Cash and Net Debt

Key => want to estimate risk of underlying assets

=> cash is risk-free and reduces risk of firm
=> estimate risk of firm’s enterprise value (underlying business operations)
=> can use net debt instead of debt when calculating unlevered cost of capital or unlevered beta

Note: The following is the same as equation (2.17).

\[ ND = D - EC \]

(12.10)

where:

\[ ND = \text{net debt} \]
\[ D = \text{debt} \]
\[ EC = \text{excess cash and short-term investments} \]

Note: often difficult to determine what portion of a firm’s cash is “in excess of operating needs”.

D. Industry Asset Betas

=> use average betas or average cost of capital for firms in same industry as project

=> reduces estimation error

Concept Check: 2
12.6 Project Risk Characteristics and Financing

A. Differences in Project Risk

Key issues:

1) firm asset beta reflects risk of average asset in firm
2) identify “pure play” comparables for projects
3) adjust for differences in operating leverage by discounting fixed costs at risk-free risk-free or calculating beta of project’s cash flows by recognizing fixed costs as having a zero beta.

See example 12.8

4) execution risk should be factored into estimates of cash flow

=> new investments by firm likely riskier than assets of established firms
=> risk tends to be firm-specific and thus diversifiable
=> does not affect betas or cost of capital

=> does affect expected cash flows

Q: In Example 2.8, why is the net present value of the project lower if the beta of revenues is 1.0 but all costs are fixed?

B. Financing and the Weighted Average Cost of Capital

let:

\[ r_{at} = \text{effective after-tax interest rate} \]
\[ r_d = \text{pre-tax interest rate} \]
\[ \tau_c = \text{corporate tax rate} \]

1. Perfect Capital Markets:

=> no taxes, transaction costs, or other frictions

=> all financing transactions are zero-NPV

\[ r_{wacc} = \left( \frac{E}{E+D} \right) r_E + \left( \frac{D}{E+D} \right) r_d \]  \hspace{1cm} (12.8)

2. Taxes – A Big Imperfection

Key issue => interest is tax deductible for companies

\[ r_{at} = r_d (1 - \tau_c) \]  \hspace{1cm} (12.11)
Ex. Assume the yield to maturity on Lexing Inc’s debt equals 8% and that there is a 10% chance that Lexing will default and the loss in case of default will equal 25%. Calculate Lexing’s effective after-tax interest rate if the corporate tax rate equals 35%.

\[ r_d = 0.08 - 0.1(0.25) = 0.055 \]
\[ r_{at} = 0.055(1 - 0.35) = 0.03575 \]

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Note: Equation (12.11) is the same as equation (5.8)

3. The Weighted Average Cost of Capital

\[ r_{wacc} = \left( \frac{E}{E+D} \right) r_e + \left( \frac{D}{E+D} \right) r_d (1 - \tau_c) \]  \hspace{1cm} (12.12)

Notes:

1) incorporates tax shield from debt financing into NPV
2) can use \( r_u \) to evaluate all-equity financed projects and \( r_{wacc} \) to evaluate projects with same financing as the firm.
3) corporate taxes are not the only market imperfection related to financing choices

\[ r_{wacc} = r_u - \left( \frac{D}{E+D} \right) \tau_c r_d \]  \hspace{1cm} (12.13)

=> WACC equals unlevered cost of capital less tax savings of debt
=> lower cost of capital increases NPV
Ex. Assume that Waldy has 100,000 outstanding shares and that these shares have a market value of $40 per share. Assume also that Waldy has $500,000 of outstanding debt that is risk free. Assume that the risk-free rate equals 4% and that the expected return on the market equals 9%. If Waldy’s stock has a beta of 1.3 and the corporate tax rate equals 21%, calculate Waldy’s weighted average cost of capital?

\[ E = 100,000 \times 40 = 4,000,000 \]

\[ r_e = .04 + 1.3 \times (.09 - .04) = .105 \]

\[ r_{wacc} = \left(\frac{4,000,000}{4,000,000 + 500,000}\right) \times 1.05 + \left(\frac{500,000}{4,000,000 + 500,000}\right) \times .04 (1 - .21) = .0968 \]

or:

\[ r_u = \left(\frac{4,000,000}{4,000,000 + 500,000}\right) \times 1.05 + \left(\frac{500,000}{4,000,000 + 500,000}\right) \times .04 = .09778 \]

\[ r_{wacc} = .09778 - \left(\frac{500,000}{4,000,000 + 500,000}\right) \times .21 \times .04 = .0968 \]

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12.7 Final Thoughts on Using the CAPM

1) CAPM based on estimates, but so are cash flows
2) errors in model tend to be smaller than if use other models
3) using CAPM forces managers to think about cost of capital
4) using CAPM forces managers to think about risk in correct way

Concept Check: 2

Appendix: Practical Considerations When Forecasting Beta

A. Time Horizon

=> too short a horizon: unreliable estimates
=> too long a horizon: older data no longer reflects firm’s current risk

B. The Market Proxy

=> S&P 500 is usual proxy, but others are used

=> especially when evaluating international investments
=> match market risk premium with market proxy used
C. Beta Variation and Extrapolation

=> betas tend to regress towards 1.0 over time
=> adjusted betas take weighted average of computed beta and 1.

D. Outliers

=> beta estimates sensitive to outliers (especially large or small returns)

Comment: knowing which returns to exclude as outliers is tricky. Notice in Figure 12A.2 that Genentech had other returns that were higher and lower than those excluded.

E. Other considerations

=> be aware of changes in firm
=> forecasting is more art than science

Comment: this is generally true for finance as a whole
### Data Appendix: Price Data for Apple and S&P500 and Yield on 10-year Treasuries

<table>
<thead>
<tr>
<th>Date</th>
<th>Last Trade</th>
<th>Prices</th>
<th>Yield</th>
<th>10y(mo)</th>
<th>Returns</th>
<th>Excess Returns</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>S&amp;P500</td>
<td>Apple</td>
<td>10y(Tr)</td>
<td>S&amp;P500</td>
<td>Apple</td>
</tr>
<tr>
<td>12/31/2018</td>
<td>12/31/2018</td>
<td>2506.85</td>
<td>157.74</td>
<td>2.686</td>
<td>0.0022</td>
<td>-0.0918</td>
</tr>
<tr>
<td>11/30/2018</td>
<td>11/30/2018</td>
<td>2760.17</td>
<td>178.58</td>
<td>3.013</td>
<td>0.0025</td>
<td>0.0179</td>
</tr>
<tr>
<td>10/31/2018</td>
<td>10/31/2018</td>
<td>2711.74</td>
<td>218.10</td>
<td>3.159</td>
<td>0.0026</td>
<td>-0.0694</td>
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<td>9/30/2018</td>
<td>9/28/2018</td>
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<td>3.056</td>
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<td>0.0043</td>
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<td>8/31/2018</td>
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<td>0.0303</td>
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<td>7/31/2018</td>
<td>7/31/2018</td>
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<td>188.97</td>
<td>2.964</td>
<td>0.0024</td>
<td>0.0360</td>
</tr>
<tr>
<td>6/30/2018</td>
<td>6/29/2018</td>
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<td>183.82</td>
<td>2.849</td>
<td>0.0023</td>
<td>0.0048</td>
</tr>
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<td>5/31/2018</td>
<td>5/31/2018</td>
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<td>4/30/2018</td>
<td>4/30/2018</td>
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<td>3/31/2018</td>
<td>3/29/2018</td>
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<td>165.97</td>
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<td>0.0023</td>
<td>-0.0389</td>
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<tr>
<td>2/28/2018</td>
<td>2/28/2018</td>
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<td>176.20</td>
<td>2.868</td>
<td>0.0024</td>
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<td>1/31/2018</td>
<td>1/31/2018</td>
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<td>164.95</td>
<td>2.72</td>
<td>0.0022</td>
<td>0.0360</td>
</tr>
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<td>12/31/2017</td>
<td>12/29/2017</td>
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<td>166.73</td>
<td>2.405</td>
<td>0.0020</td>
<td>0.0098</td>
</tr>
<tr>
<td>11/30/2017</td>
<td>11/30/2017</td>
<td>2647.58</td>
<td>169.31</td>
<td>2.417</td>
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Notes:
1) Last Trade = last trading day of each month. Prices are Yahoo’s Adjusted Close which adjusts for dividends
2) 10y(mo) = return per month on 10-year Treasuries (to match monthly stock returns)
3) Returns = (price(current) – price (prior))/price(prior)
4) Excess returns = returns – 10y(mo)