UNIVERSITY OF EAST ANGLIA

THE NORWICH BUSINESS SCHOOL

Assessed coursework in financial modelling

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Q1) Financial News

Cost-of-living crisis:

The cost-of-living crisis represents the fall in ‘real’ income, caused by high inflation rates and energy prices (Hourston, 2022). US inflation is the highest it’s been since 1981 (Leswing, 2022). Economists think consumers are to be put off buying electronics and upgrading their phones until the economy improves (Leswing, 2022). Demand for Apple’s products will decrease, resulting in less sales. This would show on Apple’s quarterly reports, causing share price to fall as investors may sell once they see declining profits.

However, Apple possibly may not be affected too much by decreasing consumer income. Apple tend to have high-end devices which are often bought by wealthier customers that may still have enough disposable income to purchase Apple products. Still, as inflation is so high it is likely that even this demographic would be affected by the high prices. (Balu and Randewich, 2023)

Lockdowns in China:

In Zhengzhou, China COVID-19 cases have been increasing since the lifting of a quasi-lockdown, because of this an industrial park containing Apple’s biggest iPhone factory, has entered a mini-lockdown. Reuters reported that the factory’s output could fall by 30% (Goh and Lee, 2022). Therefore, production of iPhones will decrease, making it harder for Apple to satisfy the demand.

The lack of COVID-19 prevention measures at this factory has created tensions in the workforce resulting in some employees leaving the factory. This has meant that bonuses have been used a way of retaining staff.

These costs for Apple will result in lower profits and Leswing (2022) has reported that shutdowns earlier in the year could cost $8 billion. Share price should fall due to this news and even further if Apple’s reports show hits in profits, as investors will want to sell before prices fall further.

Q2) Regressions Analysis

a) Model and Assumptions

Regression analysis tries to explain the variation in one variable by comparing it to one or more other variables (Brooks, 2019, p94). Specifically in the case of Apple, the variable whose variations we wish to explain (the dependent variable) is the returns of Apple and is denoted by Y_t, and the variable which we use to explain these variations (the independent variable) is returns of the S&P 500 and is denoted by $X_{1,t}$. The model to estimate Apple’s beta, β_1 is below:

$$Y_t = \beta_0 + \beta_1 X_{1,t} + u_t$$

Where, the coefficient, β_0, is returns of Apple if $X_1 = 0$ and u_t is an unpredictable random error term. Beta explains the risk that a company's stock shares with the market. In other words, how sensitive the stock is to movements in the market, whether that is up or down (Brealey, et al. 2022, p223). To estimate the beta, I will use the Ordinary Least Squares (OLS) method which places a line of best fit through the data minimising the sum of squared residuals. The residuals are the difference between the value of Y and the estimated value of Y for each value of X. (Brooks, 2019, p98)

I have made the following assumptions about u:

1) Expected value of $u = 0$,
2) Variance is the same for all values of X_t,
3) Errors are independent of each other,
4) X_t is non-random,
5) And u is normally distributed.

If assumptions 1-4 hold, the coefficients will have these desirable properties:

- 'Linear' – meaning they are linear combinations of Y,
- 'Unbiased' – the expected values of the estimators will be equal to their true values,
- 'Best' – meaning that they have the minimum variance among the class of linear unbiased estimators.

If assumption 5 holds, the coefficients are normally distributed allowing inferences to be made about the population coefficients from the sample coefficients found, using the finite amount of data we have available. (Brooks, 2019, p107)

<u>b) Results discussion</u>

The results of the estimated regression model are (test statistic shown in parentheses):

$$Y_t = 0.00 + 0.20X_{1,t} + u_t$$

$$t = (0.04) \ \ (9.98)$$

$$R^2 = 0.28$$

An R square value of 0.28 means that 28% of the variation in the returns of Apple is captured by the model. Therefore, the returns of the S&P 500 are of some use in modelling the returns of Apple, but it could be improved.

The test of significance approach compares a test statistic, t and a critical value to see whether to accept or reject the null hypothesis, H_0.

H_0, is that Apple's stock is market neutral:

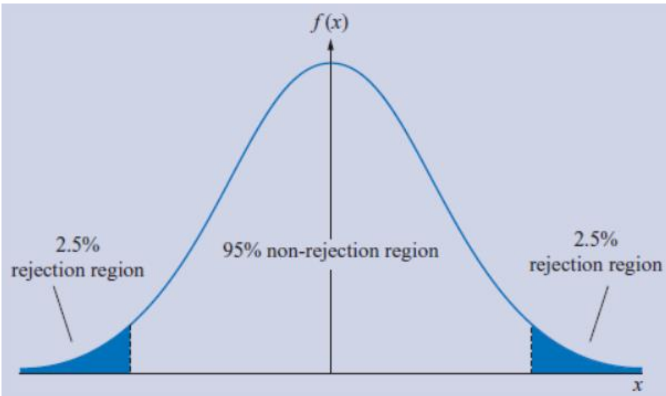
$$H_0: \beta_1 = 0$$

The alternative hypothesis, H_1, is therefore:

$$H_1: \beta_1 \neq 0$$

This is a two-sided test, and the significance level is 5%.

Figure 1: Rejection Regions for a 5% two-sided test (Brooks, 2019, p120)



The dotted lines in Figure 1 represent the critical values, which is approximately 2 and -2 by referring to t-tables, t has to be either side of these values for the null hypothesis to be rejected as shown here:

$$t < -2 \; or \; t > 2$$

As t for β_1 is 9.98 there is enough evidence to reject H_0 at the 5% level that Apple's stock is market neutral and accept H_1 that Apple's beta is not equal to zero.

Q3) Cost of Capital and Firm Valuation

a) Cost of Equity

The cost of equity is the rate of return that equity investors would need to invest in the firm. To estimate Apple's cost of equity, r_E, I will use the Capital Asset Pricing Model (CAPM). The CAPM "states that the expected rate of return equals the risk-free interest rate plus a risk premium that depends on beta and the market risk premium" (Brealey, et al. 2022, p248) as shown here:

$$r_E = r_f + \beta(\mathbb{E}[r_m] - r_f)$$

The risk-free rate, r_f, is given as 1.6%, the systematic risk of Apple, β, I calculated as 0.20 and the market premium, $(\mathbb{E}[r_m] - r_f)$, is given as 5.6%. Therefore, r_E is 5.92%.

b) Cost of Debt

Cost of debt, r_D, is effectively the interest rate that a firm pays on its debts from new borrowing (Brealey, et al. 2022, p520) whilst also considering risk of default. The formula is:

$$r_D = r_f + ds$$

First, we need to find the default spread of Apple, ds which provides us with a measure of how likely a company is to default.

As we don't know Apple's credit rating, I will use a synthetic credit rating by finding the Interest Coverage Ratio (ICR) of the company to measure its ability to meet interest payments in the long run from its earnings before interest and tax (EBIT). I will then compare the ICR to similar rated firms to see what credit rating it would be (Damodaran, 2009, p48). The formula is:

$$\text{ICR} = \frac{\text{EBIT}}{\text{Interest expense}}$$

I obtained Apple's EBIT and Interest expense from Apple's 2021 Income Statement on Yahoo! Finance which is \$111,852,000 and \$2,645,000 respectively (in thousands), resulting in ICR being 42.29.

Table 1: Default Spreads

ICR between		Rating is	Spread is
>	≤		
-100000	0.199999	D2/D	20.00%
0.2	0.649999	C2/C	16.00%
0.65	0.799999	Ca2/CC	12.00%
0.8	1.249999	Caa/CCC	9.00%
1.25	1.499999	B3/B-	7.50%
1.5	1.749999	B2/B	6.50%
1.75	1.999999	B1/B+	5.50%
2	2.25	Ba2/BB	4.25%
2.25	2.49999	Ba1/BB+	3.25%
2.5	2.999999	Baa2/BBB	2.25%
3	4.249999	A3/A-	1.75%
4.25	5.499999	A2/A	1.25%
5.5	6.499999	A1/A+	1.10%
6.5	8.499999	Aa2/AA	1.00%
8.5	100000	Aaa/AAA	0.75%

Table 1 shows that the ICR falls between 8.50 and 100000 giving Apple a credit rating of AAA and $ds =$ 0.75%. Therefore, adding this to the r_f, of 1.6%, r_D equals 2.35%.

c) WACC

The Weighted Average Cost of Capital (WACC) measures a company's cost of capital by including both forms of financing (debt and equity). It takes a weighted average of the r_E and the after-tax cost of debt, $r_D(1 - T_c)$, to capture interest tax shields (Brealey, et al. 2022, p519). The WACC formula is:

$$WACC = r_E \times \frac{E}{E + D} + r_D(1 - T_c) \times \frac{D}{D + E}$$

Table 2: Key Inputs for the WACC

Section A: Cost of Equity (CoE, in %) and Cost of Debt (CoD, in %)	
CoE using the CAPM	5.92
Pre-tax CoD	2.35
Tax Rate	28
After-tax CoD	1.69
Section B: Market Value of Equity Calculation (from Yahoo! Finance)	
Share Price (in $)	163.82
Shares Outstanding (in 000's)	15,910,000
Market Value of Equity (in $000's)	2,606,376,200
Section C: Market Value of Capital (in $000s)	
Market Value of Debt (Yahoo! Finance)	124,719,000
Market Value of Equity (in $000's)	2,606,376,200
Total Capital (in $000's)	2,731,095,200
Section D: Proportion of Debt and Equity (in %)	
Proportion of Debt	4.57
Proportion of Equity	95.43

Table 2 section B shows that:

$$market\ value\ of\ equity = share\ price\ \times shares\ outstanding$$

The share price is the dividend-adjusted closing price from 1st of December 2021 and the shares outstanding is from the statistics page on Yahoo! Finance. As shown in Table 2, r_E is 5.92%, $r_D(1 - T_c)$ is 1.69%, the proportion of equity, $\frac{E}{E+D}$, is 95.43%, the proportion of debt, $\frac{D}{D+E}$, is 4.57%. Therefore, the WACC for Apple is 5.73%.

<u>d) Firm Valuation</u>

To value Apple I will use the Discounted Cash Flow (DCF) method which involves forecasting the future free cash flows (FCF) and then discounting them back to present value at a discount rate. I will be using the WACC (5.73%) because Apple's FCFs include cash flows from both debt and equity (Brealey et al, 2022, p523). FCFs are "the amount of cash available for pay out to all shareholders" (Brealey et al, 2022, p105) which is calculated using the formula below:

$$FCF = cash\ flows\ from\ operating\ activities$$
$$-\ capital\ expenditures\ (CAPEX)$$
$$+After - tax\ interest$$

Where,

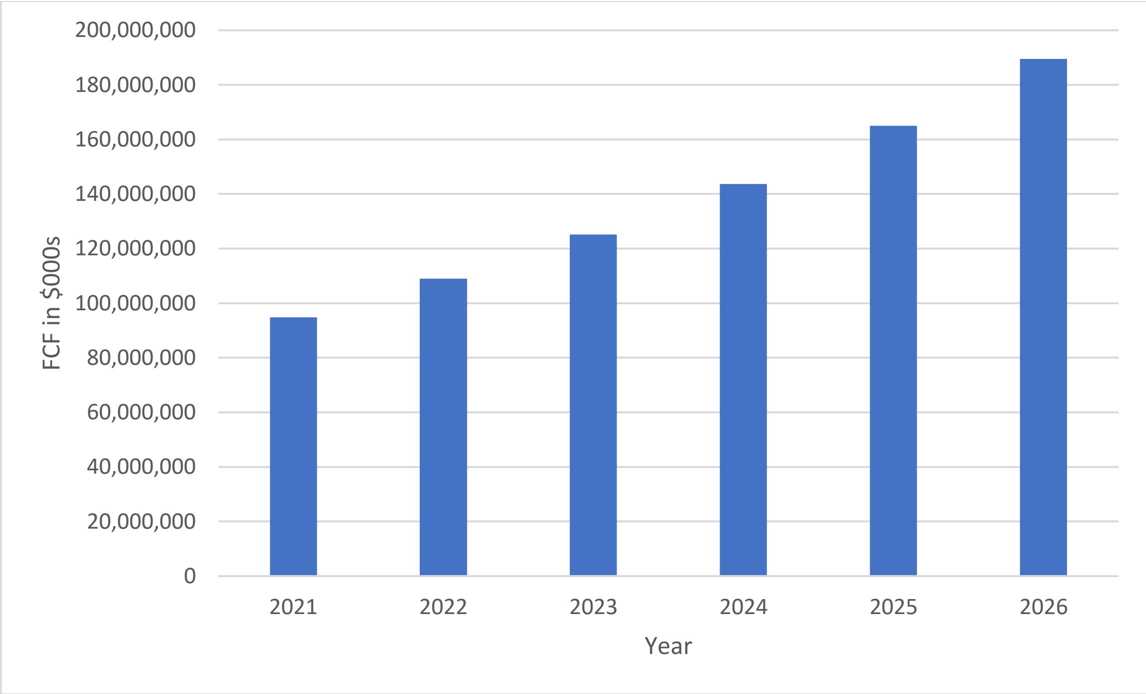
$$After - tax\ interest = (1 - T_c) \times Interest\ expense$$

Table 3: Apple's Current year Free Cash Flow

Section A: After-tax interest on debt	
Interest Expense (in $000's)	2,645,000
Tax (in %)	28
After-tax interest expense (in $000's)	1,904,400
Section B: Current Year Free Cash Flow (in $000's)	
Cash Flow from Operations	104,038,000
CAPEX	-11,085,000
Add back after-tax interest on debt	1,904,400
Free Cash Flow	**94,857,400**

Table 3 section A shows the after-tax interest using the interest expense from Yahoo! Finance. Section B shows the FCF for the current year, 2021, using the cash flow from operations and CAPEX from Yahoo! Finance. Apple is experiencing a high growth period. Therefore, to forecast future FCFs I will use a short-term FCF growth rate, g_s, given as 14.85% to reflect the high growth period and a long-term FCF growth rate, g_l, given as 1.4% to reflect stability after this period. The increase in the FCFs can be seen in figure 2 below.

Figure 2: Apple's Forecasted FCF's for the next 5 years



$$EV = \underbrace{\sum_{t=1}^{N} \frac{FCF_0(1+g_s)^t}{(1+WACC)^t}}_{\text{= Discounted FCFs}} + \frac{1}{(1+WACC)^N} \times \underbrace{\frac{FCF_0(1+g_s)^N(1+g_l)}{(WACC-g_l)}}_{\text{= horizon value}}$$

Above is the formula for the present value of a firm's future cash flows (or enterprise value, EV) up to and including the horizon value, which is the value of Apple at the end of the high growth period. The current year FCF, FCF_0, is $94,857,400 (in thousands) and the number of years in the projection period, N is 5. Therefore, the EV is $3,975,672,468 (in thousands).

To get the DCF firm value:

$$DCF\ Firm\ value = EV + current\ cash\ and\ marketable\ securities$$

I found current year cash and marketable securities in the balance sheet on Yahoo! Finance as $34,940,000 giving a DCF firm value of $4,010,612,468 (both numbers in thousands). To calculate a share price valuation, we need to find the equity value of the firm:

$$Market\ value\ of\ equity = DCF\ firm\ value - market\ value\ of\ debt$$

I found the market value of debt in the balance sheet on Yahoo! Finance as $124,719,000 leaving the equity value as $3,885,893,468 (both numbers in thousands).

The per-share equity valuation is:

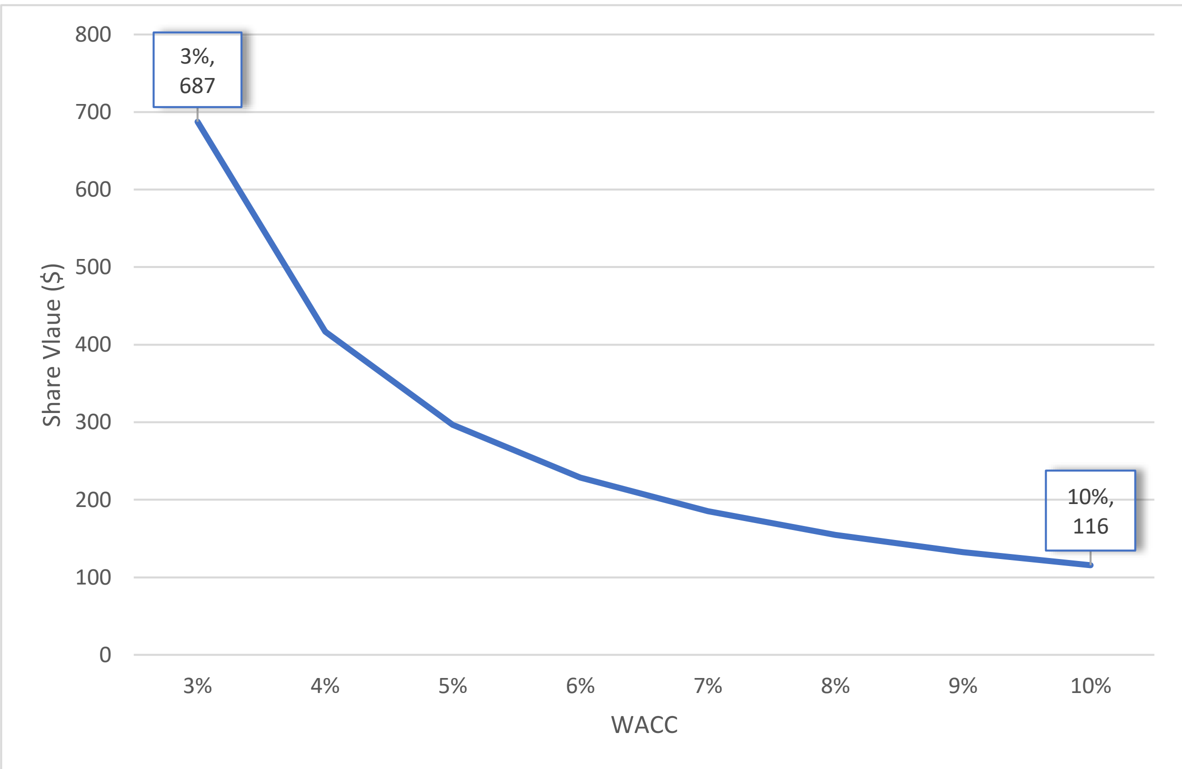
$$Per - share\ equity\ valuation = equity\ valueshares\ outstanding$$

Where, shares outstanding are 15,910,000 (in thousands) giving a per-share equity valuation of $244.24. I would recommend to a potential investor to buy shares as my valuation is greater than the current share price of $163.82, so Apple is undervalued. However, I made assumptions throughout the model, and they should perform sensitivity analysis around the assumptions and inputs for example the short-term growth rate. (Damodaran, 2009)

e) Relationship between WACC and firm value

The WACC is discounting Apple's FCFs to present value so, assuming cash flows to Apple remain constant and only the WACC changes, Apple's value will increase as the WACC decreases (negative correlation) (Antwi et al, 2012), shown by Figure 3 below. At a 3% WACC the share price is $687 and as the WACC increases towards 10% the share price slopes down to $116. Looking at the shape of the graph it shows the relationship is also exponential, as the WACC increases by a marginal percentage, the decrease in share value gets marginally smaller.

Figure 3: Relationship between WACC and Apple's Share Value



Q4) Optimal Capital Structure

a) Optimal Capital Structure

A firm's capital structure is the mix of debt and equity used to finance its operations. One that uses debt and equity is said to be using financial leverage. An unlevered firm is one that finances its company wholly through equity. A company can change its cost of capital by changing its capital structure. The lower a company's cost of capital is the higher the firm's value will be. Therefore, the optimal capital structure for a firm will be when the cost of capital is minimised (Brealey et al, 2022, p478). To find the optimal capital structure for Apple I will be using the cost of capital approach which attempts to calculate realistic estimates of the cost of debt and equity at different debt levels.

To estimate the cost of equity we need to realise that as a firm increases leverage, investors in the company's equity take on more risk in the firm. Therefore, a higher leverage should increase the beta of the firm. Damodaran (1994) argues that if beta of debt is zero and that debt has a tax benefit, then we can use the formula below to estimate the beta of an unlevered firm:

$$\beta_U = \frac{\beta_L}{(1 + (1 - T_C)\frac{D}{E})}$$

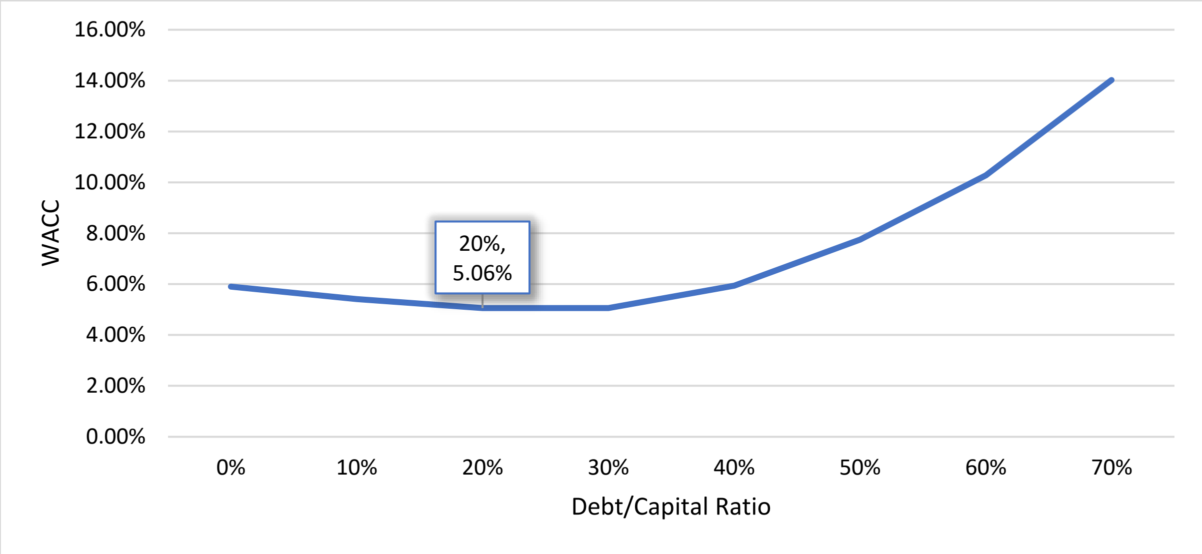
The beta of Apple at their current leverage, β_L, I estimated as 0.20, T_c is 28%, debt, D, is \$124,719,000 (in thousands), equity, E, is \$2,606,376,200 (in thousands) leaving the unlevered beta of Apple, β_U, at 0.19. I then rearranged this formula to estimate all other betas at the given debt levels:

$$\beta_L = \beta_U(1 + (1 - T_C)\frac{D}{E})$$

Once I have found the beta for Apple at the different debt levels, I can use the CAPM formula to find the cost of equity. I have also accounted for the tax benefit by multiplying each pre-tax cost of debt I was given by $(1 - T_C)$.

I can then weight these figures to find the WACC. Figure 4 shows the minimal value of WACC was found to be 5.06% at the debt/capital ratio of 20%. This is the WACC that maximises the firm value provided cash flows to the firm remain constant because minimising the WACC of a firm will maximise the firm value (Antwi et al, 2012).

Figure 4: Optimal WACC and Debt/Equity Ratio for Apple



b) Benefits of debt financing

Whether to borrow or not involves a trade-off between the benefits and costs of debt. The main benefit of debt financing is the tax shield you gain on your interest expenses, meaning a company can reduce its tax liability by T_c (Graham, 2000). Also, lender's expect lower returns than investors and therefore take on less risk, meaning $r_D < r_E$. Furthermore, debt financing disciplines a company's management because they have to find profitable projects to pay the debt off. Moreover, companies can operate around these regular interest payments, helping with cash flow.

However, debt financing has disadvantages. Companies with volatile demand may find it harder to meet interest payments, increasing the possibility of financial distress. Moreover, having to pay back a loan limits the funds available to be flexible if new business opportunities arise, making the company rigid. Also, interest rates fluctuate in high inflationary periods, reducing the attractiveness of debt financing.

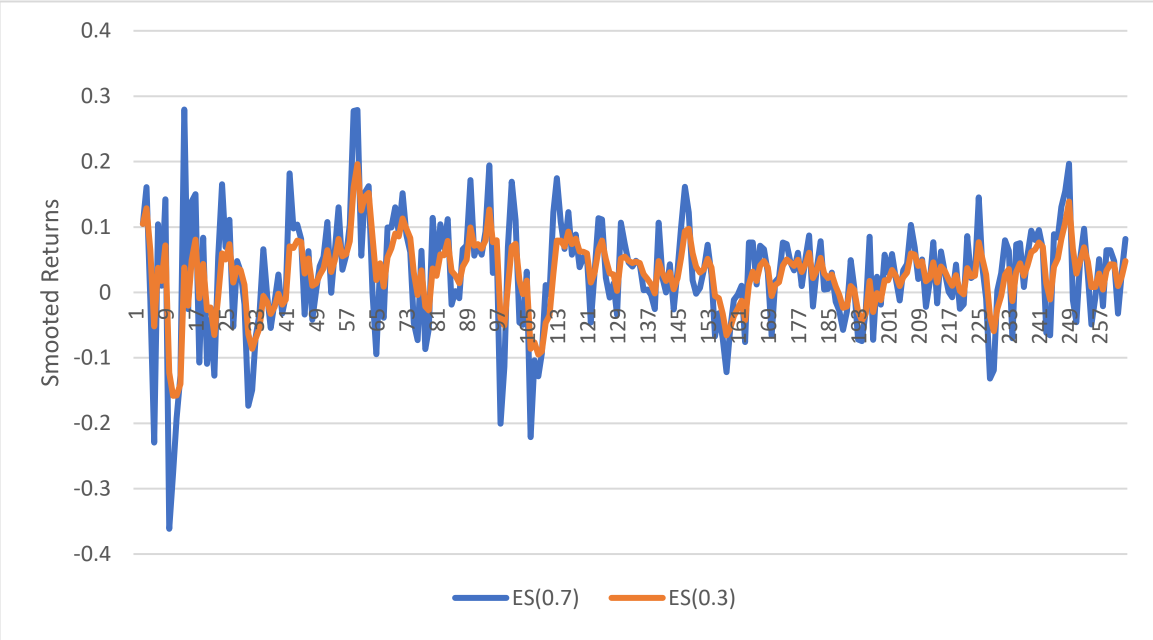
Q5) Forecasting

a) Exponential Smoothing

Exponential smoothing (ES) is a modelling technique that uses previous values of a time series to generate forecasts. It gives recent observations more weight in forecasting future values compared to older observations. This is called a "geometrically declining weighting scheme". A smoothing constant is used to control the weightings assigned to which observations and takes values between 0 and 1 denoted by α. As $\alpha > 0$, the effect of each observation declines as you move through the model and forward in time. Also, $\alpha + (1 - \alpha) = 0$, so the next value in the model will be a weighted average of the current observation and the previous smoothed value (Brooks, 2019, chapter 6.9). I will provide two models, one $\alpha = 0.7$, ES(0.7) and the other $\alpha = 0.3$, ES(0.3). I am using time series of monthly returns of Apple's stock which I calculated from the monthly dividend-adjusted closing prices from January 2000 to December 2021 on Yahoo! Finance.

Figure 5 shows the two smoothed series on the same graph. The y axis shows the smoothed returns in decimals and the x axis shows each observation from 1 (01/03/2000) to 261 (12/12/2021). The blue line is ES(0.7) and the orange line is ES(0.3).

Figure 5: Effect of a change in smoothing constant



ES(0.7) has higher and more volatile spikes in its data compared to ES(0.3). This is because the closer α is to 1, the more sensitive the model is to new information causing these spikes. Therefore, as ES(0.3) has a lower α it looks more dampened when graphed. This is called the damping factor which is calculated by $(1 - \alpha)$, giving ES(0.7) and ES(0.3) a damping factor of 0.3 and 0.7 respectively.

<u>b) Regression</u>

This regression model includes the use of 'lagged returns' which are returns from a previous period. In this model I am trying to predict the monthly returns of Apple, Y_t, by the current, X_t, and 1 month lagged returns of the S&P 500, X_{t-1}, as shown below:

$$Y_t = \phi_0 + \phi_1 X_t + \phi_2 X_{t-1} + u_t$$

Where, ϕ_0 is the intercept coefficient, ϕ_1 and ϕ_2 represent the coefficients for X_t and X_{t-1} respectively and u_t is an unobservable error term. (Brooks, 2019, p254-255)

The results show the estimated regression model to be:

$$Y_t = 0.02 + 1.39X_t + 0.04X_{t-1} + u_t$$

$$R^2 = 0.28$$

The R square shows that 28% of the variation in the returns of Apple is captured by the model, therefore the model is of some use. Furthermore, the estimated model shows that X_t is more useful in predicting Y_t than X_{t-1}. This is because for every marginal increase in the X_t there is a 1.39 increase Y_t. Whereas, for every marginal increase in X_{t-1} there is a 0.04 increase in Y_t which shows that this predictor variable doesn't have as much of an effect on Y_t.

c) MSE

The mean squared error (MSE) is a technique used to determine whether a forecast is accurate or not, using the formula:

$$MSE = \frac{1}{T}\sum_{t=1}^{T} e_t^2$$

It takes the difference between the forecasted value and the actual value leaving you with the forecast error, e. However, e could be positive or negative depending on whether the forecast was low or high respectively which would cause the errors to cancel if summed. Therefore, it squares the errors to make them all positive which gives us the squared error at time t, e_t^2. As shown above it sums these errors and finds the average to give the MSE. The number of observations in the model, T, is 261 starting from 1/3/2020, as that's the first date we have a value for all three models and ending at 12/12/2021. This figure isn't very useful on its own but by comparing all three models' MSEs and seeing which one is closer to 0, I can decide which model's predictive performance is better. (Brooks, 2019, p284)

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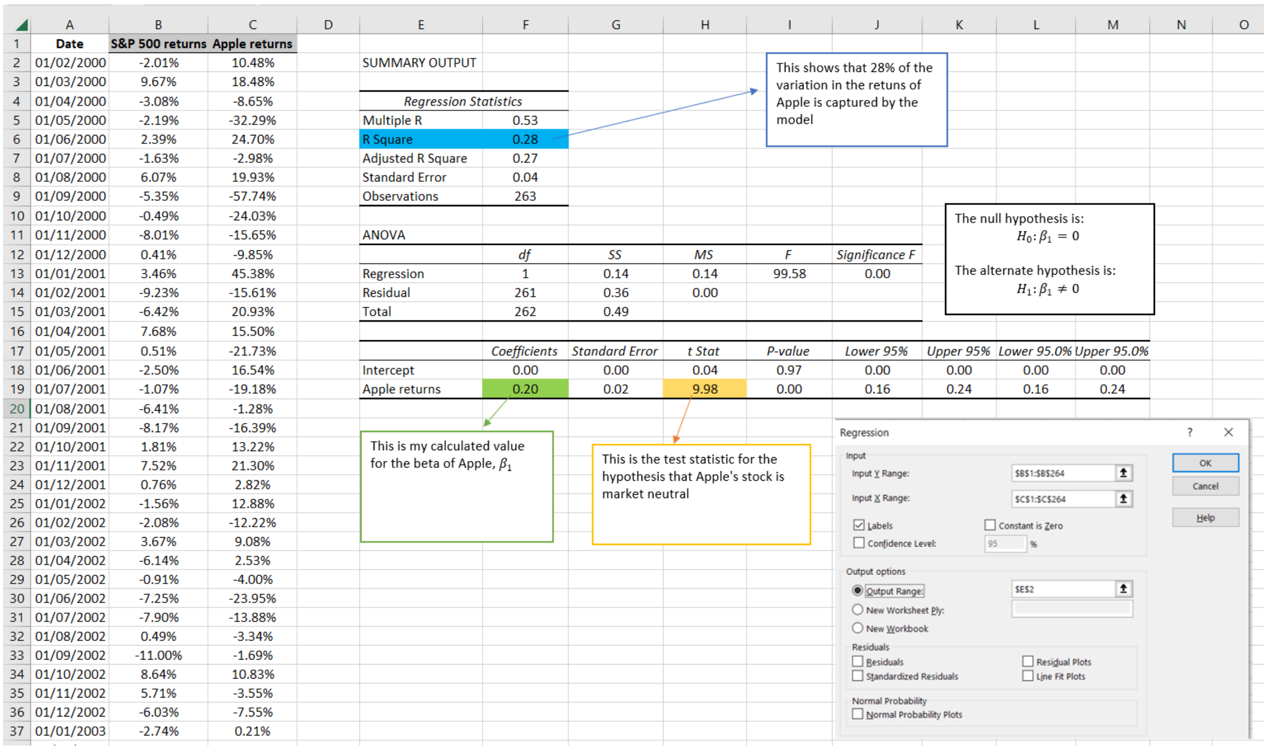
Table 4: MSE of the different Models

Model	MSE
ES(0.7)	0.020
ES(0.3)	0.016
Regression	0.010

Table 4 shows the regression model has the lowest MSE compared to both exponential smoothing models. This is because it has the lowest average error from the actual values meaning it was the closest to predicting the actual returns of Apple. Therefore, the regression model is the best model for predicting the returns of Apple. However, the other models are still good at forecasting the returns of Apple as their MSEs are still close to 0 meaning there is not much error. Furthermore, it can be said that ES(0.3) had better predictive performance than ES(0.7) as $0.016 < 0.020$.

Appendixes (screenshots of excel models to see the structure):

Appendix 1: Regression



Date	S&P 500 returns	Apple returns
01/02/2000	-2.01%	10.48%
01/03/2000	9.67%	18.48%
01/04/2000	-3.08%	-8.65%
01/05/2000	-2.19%	-32.29%
01/06/2000	2.39%	24.70%
01/07/2000	-1.63%	-2.98%
01/08/2000	6.07%	19.93%
01/09/2000	-5.35%	-57.74%
01/10/2000	-0.49%	-24.03%
01/11/2000	-8.01%	-15.65%
01/12/2000	0.41%	-9.85%
01/01/2001	3.46%	45.38%
01/02/2001	-9.23%	-15.61%
01/03/2001	-6.42%	20.93%
01/04/2001	7.68%	15.50%
01/05/2001	0.51%	-21.73%
01/06/2001	-2.50%	16.54%
01/07/2001	-1.07%	-19.18%
01/08/2001	-6.41%	-1.28%
01/09/2001	-8.17%	-16.39%
01/10/2001	1.81%	13.22%
01/11/2001	7.52%	21.30%
01/12/2001	0.76%	2.82%
01/01/2002	-1.56%	12.88%
01/02/2002	-2.08%	-12.22%
01/03/2002	3.67%	9.08%
01/04/2002	-6.14%	2.53%
01/05/2002	-0.91%	-4.00%
01/06/2002	-7.25%	-23.95%
01/07/2002	-7.90%	-13.88%
01/08/2002	0.49%	-3.34%
01/09/2002	-11.00%	-1.69%
01/10/2002	8.64%	10.83%
01/11/2002	5.71%	-3.55%
01/12/2002	-6.03%	-7.55%
01/01/2003	-2.74%	0.21%

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.53
R Square	0.28
Adjusted R Square	0.27
Standard Error	0.04
Observations	263

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	0.14	0.14	99.58	0.00
Residual	261	0.36	0.00		
Total	262	0.49			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	0.00	0.00	0.04	0.97	0.00	0.00	0.00	0.00
Apple returns	0.20	0.02	9.98	0.00	0.16	0.24	0.16	0.24

Appendix 2: WACC

Inputs for Cost of Equity (CAPM)		
Market risk premium	5.60%	<--- Given in Brief
Beta of stock	0.20	<--- ='Regression'!F19
Risk free rate	1.60%	<--- Given in Brief
Cost of Equity	5.92%	<--- =B2+B3*B4
Inputs for Cost of Debt		
EBIT	111,852,000	<--- from Yahoo! Finance 2021 Income Statement (in thousands)
Interest Expense	2,645,000	<--- from Yahoo! Finance 2021 Income Statement (in thousands)
Intrest Coverage Ratio	42.29	<--- =B9/B10
Risk free rate	1.60%	<--- =B4
Default spread	0.75%	<--- =LOOKUP(B6,E15:H29)
Cost of Debt	2.35%	<--- =B13+B14
Inputs for WACC Calculation		
Share Price	163.82	<--- from Yahoo! Finance on 1st December 2021
Shares Outstanding	15,910,000	<--- from Yahoo! Finance Statistics (in thousands)
Market Value of Equity	2,606,376,200	<--- =B19*B18
Market Value of Debt	124,719,000	<--- from Yahoo! Finance Balance Sheet for 2021 (in thousands)
Proportion of Equity	95%	<--- =B20/(B20+B21)
Proportion of Debt	5%	<--- =B21/(B21+B20)
Cost of Equity	5.92%	<--- =B6
Cost of Debt	2.35%	<--- =B15
Tax Rate	28%	<--- Given in brief
WACC	**5.73%**	<--- =B22*B24+B23*(1-B26)*B25

The Capital Asset Pricing Model (CAPM) formula is:

$$r_E = r_f + \beta(\mathbb{E}[r_m] - r_f)$$

Where, r_f is the risk-free rate and $\beta(\mathbb{E}[r_m] - r_f)$ is the market risk premium

The cost of debt is calculated by:

$$r_D = r_f + ds$$

Where, ds is the default spread

Defualt Spreads

ICR between		Rating is	Spread is
>	≤		
-100000	0.2	D2/D	20.00%
0.2	0.65	C2/C	16.00%
0.65	0.8	Ca2/CC	12.00%
0.8	1.25	Caa/CCC	9.00%
1.25	1.5	B3/B-	7.50%
1.5	1.75	B2/B	6.50%
1.75	2	B1/B+	5.50%
2	2.25	Ba2/BB	4.25%
2.25	2.49999	Ba1/BB+	3.25%
2.5	3	Baa2/BBB	2.25%
3	4.25	A3/A-	1.75%
4.25	5.5	A2/A	1.25%
5.5	6.5	A1/A+	1.10%
6.5	8.5	Aa2/AA	1.00%
8.5	100000	Aaa/AAA	0.75%

The WACC is worked out as follows:

$$WACC = r_E \times \frac{E}{E+D} + r_D \times (1 - T_c) \times \frac{D}{D+E}$$

Where, r_E is the cost of equity, r_D is the cost of debt, $\frac{E}{E+D}$ is the proportion of equity, $\frac{D}{D+E}$ is the proportion of debt and T_c is the tax rate.

Appendix 3: Firm Valuation

Free Cash Flow (FCF) of Apple		
	Numbers in Thousands	
Cash Flow From Operations	104,038,000	<--- Yahoo! Finance 2021 Cash Flow Statement
Subtract CAPEX	-11,085,000	<--- Yahoo! Finance 2021 Cash Flow Statement
Add back after-tax interest on debt	1,904,400	<--- =B9*(1-B10)
Free Cash Flow	**94,857,400**	<--- =SUM(B4:B6)
Interest Expense	2,645,000	<--- =WACC!B10
Tax	28%	<--- =WACC!B26
Valuation of Apple		
Weighted average cost of capital, WACC	5.73%	<--- =WACC!B27
Short-term FCF growth	14.85%	<--- Analysts' Forecasts for next 5 years as per Table 2
Long-term FCF growth	1.40%	<--- =B18-0.2%
Risk-Free Rate	1.60%	<--- =WACC!B13

Year	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	
FCF	94,857,400	108,943,724	125,121,867	143,702,464	165,042,280	189,551,059	<--- =F21*(1+B15)
Teminal Value						4,443,224,222	<--- =G21*(1+B16)/(B14-B16)
Total	-	**108,943,724**	**125,121,867**	**143,702,464**	**165,042,280**	**4,632,775,281**	<--- =G21+G22

Valuation (current year, 2021)		
PV of FCFs	£3,975,672,468	<--- =NPV(B14,C23:G23)
Add year 2021 (current year) cash	34,940,000	<--- Yahoo! Finance 2021 Balance Sheet
Firm value	**£4,010,612,468**	<--- =B26+B27 (in thousands!)
Subtract market value of debt	-124,719,000	<--- =-WACC!B21
Equity value	£3,885,893,468	<--- =B28+B29
Per-share equity valuation	**£244.24**	<--- =B30/WACC!B19

This is greater than the current stock price of £163.82 so therefore the stock is undervalued and investors should buy

Forecasted FCFs for the first 5 years from 2021-2026, calculated by:

$$FCF_t(1 + g_s)^t$$

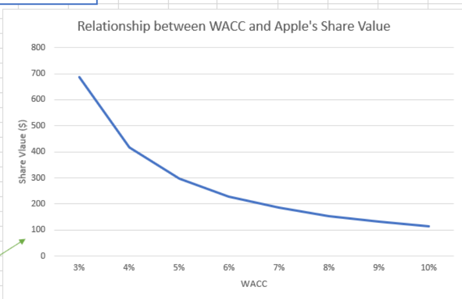
Where g_s is the short-term growth rate

Horizon value = present value of FCFs from year 2026 to infinity, calculated by:

$$\frac{FCF_{2026}(1 + g_l)}{(WACC - g_l)}$$

Where, g_l is the long term growth rate

WACC	share price ($)
	£244.24
3%	687
4%	417
5%	297
6%	229
7%	185
8%	155
9%	133
10%	116



Data Table ? ×

Row input cell:

Column input cell: B14

OK Cancel

For the data table the WACC, B14, is the input cell as this is what I am changing to see how it affects share value

Appendix 4: Optimal Capital Structure

Inputs for Unlevered Beta		
Beta	0.20	<--- =Regression'!F19
Tax rate	28%	<--- =WACC!B26
Market value of debt, D (in 000s)	124,719,000	<--- =WACC!B21
Market value of equity, E (in 000s)	2,606,376,200	<--- =WACC!B20
Unlevered beta	**0.19**	<--- =B2/(1+((1-B3)*(B4/B5)))
Risk free rate	1.60%	<--- =WACC!B13
Market risk premium	5.60%	<--- =WACC!B2

The formula for the unlevered beta, β_U, of a firm is:

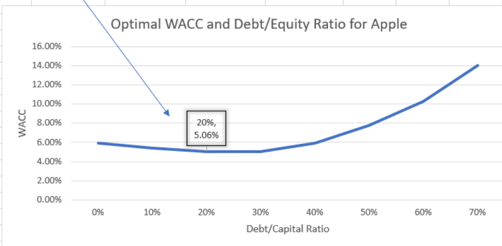
$$\beta_U = \frac{\beta_L}{(1+(1-T_C)\frac{D}{E})}$$

Where, β_L is the levered beta, T_C is the tax rate and $\frac{D}{E}$ is the debt to equity ratio.

The formula for the levered beta of a firm is:

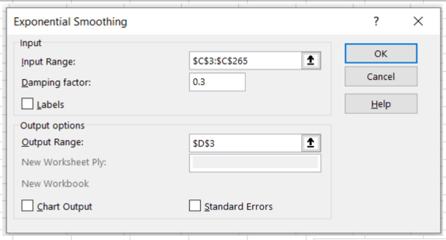
$$\beta_L = \beta_U(1+(1-T_C)\frac{D}{E})$$

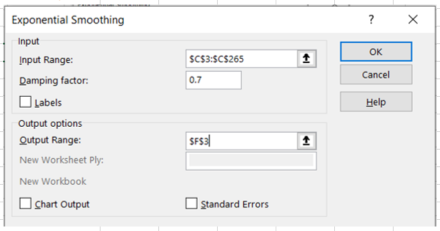
D/C ratio	E/C ratio	D/E ratio	Cost of Debt	Beta	Cost of Equity (CAPM)	After-Tax CoD	WACC	
0%	100%	0%	0.00%	0.19	5.91%	0.00%	5.91%	<--- =F12*B12+G12*A12
10%	90%	11%	1.00%	0.21	5.93%	0.72%	5.41%	
20%	80%	25%	2.00%	0.23	5.96%	1.44%	5.06%	<--- Lowest WACC
30%	70%	43%	4.00%	0.25	6.00%	2.88%	5.07%	
40%	60%	67%	8.00%	0.29	6.06%	5.76%	5.94%	
50%	50%	100%	13.00%	0.33	6.13%	9.36%	7.75%	
60%	40%	150%	18.00%	0.40	6.24%	12.96%	10.27%	
70%	30%	233%	24.00%	0.52	6.43%	17.28%	14.02%	

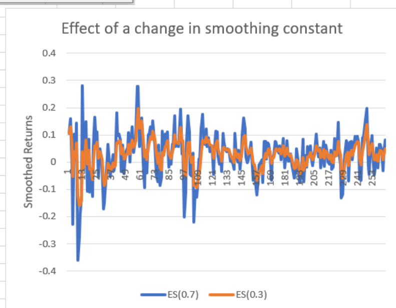


Appendix 5: Exponential Smoothing

Date	Price (APPL)	Return	ES(0.7)		ES(0.3)	
01/01/2000	0.79	-				
01/02/2000	0.87	0.10	#N/A		#N/A	
01/03/2000	1.03	0.18	0.10	<--- =C3	0.10	<--- =C3
01/04/2000	0.94	-0.09	0.16	<--- =0.7*C4+0.3*D4	0.13	<--- =0.3*C4+0.7*F4
01/05/2000	0.64	-0.32	-0.01		0.06	
01/06/2000	0.80	0.25	-0.23		-0.05	
01/07/2000	0.77	-0.03	0.10		0.04	
01/08/2000	0.93	0.20	0.01		0.02	
01/09/2000	0.39	-0.58	0.14		0.07	
01/10/2000	0.30	-0.24	-0.36		-0.12	
01/11/2000	0.25	-0.16	-0.28		-0.16	
01/12/2000	0.23	-0.10	-0.19		-0.16	
01/01/2001	0.33	0.45	-0.13		-0.14	
01/02/2001	0.28	-0.16	0.28		0.04	
01/03/2001	0.34	0.21	-0.03		-0.02	
01/04/2001	0.39	0.15	0.14		0.05	
01/05/2001	0.30	-0.22	0.15		0.08	
01/06/2001	0.35	0.17	-0.11		-0.01	
01/07/2001	0.29	-0.19	0.08		0.04	
01/08/2001	0.28	-0.01	-0.11		-0.03	
01/09/2001	0.24	-0.16	-0.04		-0.02	
01/10/2001	0.27	0.13	-0.13		-0.07	
01/11/2001	0.32	0.21	0.05		-0.01	
01/12/2001	0.33	0.03	0.17		0.06	
01/01/2002	0.38	0.13	0.07		0.05	
01/02/2002	0.33	-0.12	0.11		0.07	
01/03/2002	0.36	0.09	-0.05		0.02	
01/04/2002	0.37	0.03	0.05		0.04	
01/05/2002	0.35	-0.04	0.03		0.03	
01/06/2002	0.27	-0.24	-0.02		0.01	







Appendix 6: Lagged Regression

	Date	AAPL	APPL Return	S&P 500 Ret	S&P 500 Ret (-1)	Predcited
2	01/01/2000	0.79	-	-		
3	01/02/2000	0.87	0.10	-0.02	-	
4	01/03/2000	1.03	0.18	0.10	-0.02	0.15
5	01/04/2000	0.94	-0.09	-0.03	0.10	-0.02
6	01/05/2000	0.64	-0.32	-0.02	-0.03	-0.01
7	01/06/2000	0.80	0.25	0.02	-0.02	0.05
8	01/07/2000	0.77	-0.03	-0.02	0.02	0.00
9	01/08/2000	0.93	0.20	0.06	-0.02	0.10
10	01/09/2000	0.39	-0.58	-0.05	0.06	-0.05
11	01/10/2000	0.30	-0.24	0.00	-0.05	0.01
12	01/11/2000	0.25	-0.16	-0.08	0.00	-0.09
13	01/12/2000	0.23	-0.10	0.00	-0.08	0.02
14	01/01/2001	0.33	0.45	0.03	0.00	0.07
15	01/02/2001	0.28	-0.16	-0.09	0.03	-0.11
16	01/03/2001	0.34	0.21	-0.06	-0.09	-0.07
17	01/04/2001	0.39	0.15	0.08	-0.06	0.12
18	01/05/2001	0.30	-0.22	0.01	0.08	0.03
19	01/06/2001	0.35	0.17	-0.03	0.01	-0.02
20	01/07/2001	0.29	-0.19	-0.01	-0.03	0.00
21	01/08/2001	0.28	-0.01	-0.06	-0.01	-0.07
22	01/09/2001	0.24	-0.16	-0.08	-0.06	-0.10
23	01/10/2001	0.27	0.13	0.02	-0.08	0.04
24	01/11/2001	0.32	0.21	0.08	0.02	0.12
25	01/12/2001	0.33	0.03	0.01	0.08	0.03
26	01/01/2002	0.38	0.13	-0.02	0.01	0.00
27	01/02/2002	0.33	-0.12	-0.02	-0.02	-0.01
28	01/03/2002	0.36	0.09	0.04	-0.02	0.07
29	01/04/2002	0.37	0.03	-0.06	0.04	-0.06
30	01/05/2002	0.35	-0.04	-0.01	-0.06	0.00
31	01/06/2002	0.27	-0.24	-0.07	-0.01	-0.08
32	01/07/2002	0.23	-0.14	-0.08	-0.07	-0.09
33	01/08/2002	0.22	-0.03	0.00	-0.08	0.02
34	01/09/2002	0.22	-0.02	-0.11	0.00	-0.13
35	01/10/2002	0.24	0.11	0.09	-0.11	0.14
36	01/11/2002	0.24	-0.04	0.06	0.09	0.10
37	01/12/2002	0.22	-0.08	-0.06	0.06	-0.06
38	01/01/2003	0.22	0.00	-0.03	-0.06	-0.02
39	01/02/2003	0.23	0.05	-0.02	-0.03	-0.01
40	01/03/2003	0.22	-0.06	0.01	-0.02	0.03
41	01/04/2003	0.22	0.01	0.08	0.01	0.13
42	01/05/2003	0.27	0.26	0.05	0.08	0.09
43	01/06/2003	0.29	0.06	0.01	0.05	0.04
44	01/07/2003	0.32	0.11	0.02	0.01	0.04

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.53
R Square	0.28
Adjusted R Square	0.27
Standard Error	0.10
Observations	262

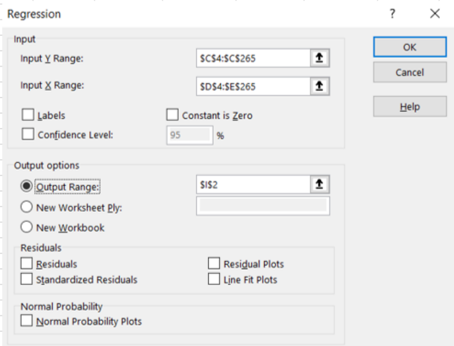
This shows that 28% of the variation in the retuns of Apple is captured by the model

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	2	0.95	0.48	50.07	0.00
Residual	259	2.47	0.01		
Total	261	3.42			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	0.02	0.01	3.15	0.00	0.01	0.03	0.01	0.03
S&P 500 Ret	1.39	0.14	9.98	0.00	1.12	1.66	1.12	1.66
S&P 500 Ret (-1)	0.04	0.14	0.26	0.80	-0.24	0.31	-0.24	0.31

This shows that the current S&P 500 returns are more useful in prediciting the returns of Apple compared to the 1 month lagged returns.



Appendix 7: MSE

	Date	Ret	ES(0.7)	ES(0.3)	Regression(R)	SE_ES(0.7)		SE_ES(0.3)		SE_R	
2	01/03/2000	0.185	0.105	0.105	0.153	0.006	<--- =(B2-C2)^2	0.006	<--- =(B2-D2)^2	0.001	<--- =(B2-E2)^2
3	01/04/2000	-0.087	0.161	0.129	-0.020	0.061		0.046		0.004	
4	01/05/2000	-0.323	-0.012	0.064	-0.012	0.096		0.150		0.097	
5	01/06/2000	0.247	-0.230	-0.052	0.052	0.227		0.089		0.038	
6	01/07/2000	-0.030	0.104	0.038	-0.003	0.018		0.005		0.001	
7	01/08/2000	0.199	0.010	0.017	0.103	0.036		0.033		0.009	
8	01/09/2000	-0.577	0.143	0.072	-0.053	0.518		0.422		0.275	
9	01/10/2000	-0.240	-0.361	-0.123	0.011	0.015		0.014		0.063	
10	01/11/2000	-0.157	-0.277	-0.158	-0.092	0.014		0.000		0.004	
11	01/12/2000	-0.098	-0.193	-0.158	0.022	0.009		0.003		0.015	
12	01/01/2001	0.454	-0.127	-0.140	0.068	0.337		0.352		0.149	
13	01/02/2001	-0.156	0.280	0.038	-0.108	0.190		0.038		0.002	
14	01/03/2001	0.209	-0.025	-0.020	-0.073	0.055		0.053		0.080	
15	01/04/2001	0.155	0.139	0.049	0.124	0.000		0.011		0.001	
16	01/05/2001	-0.217	0.150	0.081	0.029	0.135		0.089		0.061	
17	01/06/2001	0.165	-0.107	-0.009	-0.015	0.074		0.030		0.033	
18	01/07/2001	-0.192	0.084	0.043	0.003	0.076		0.055		0.038	
19	01/08/2001	-0.013	-0.109	-0.027	-0.070	0.009		0.000		0.003	
20	01/09/2001	-0.164	-0.042	-0.023	-0.097	0.015		0.020		0.005	
21	01/10/2001	0.132	-0.127	-0.065	0.042	0.067		0.039		0.008	
22	01/11/2001	0.213	0.054	-0.006	0.124	0.025		0.048		0.008	

	MSE	
ES(0.7)	0.020	<--- =AVERAGE(F2:F240)
ES(0.3)	0.016	<--- =AVERAGE(H2:H240)
R	0.010	<--- =AVERAGE(J2:J240)

The regression model has the lowest MSE and is therefore the best model at prediciting the returns of Apple.

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