Capitalizing Research And Development Expenditures Technology Companies - Part II

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We will define research and development (R&D) expenditures to be the costs incurred during the development and introduction of new products to market. GAAP accounting requires that R&D be expensed as incurred and not capitalized. Materials, equipment, and facilities used in R&D activities are expensed as consumed, including depreciation. Additional R&D costs may include salaries, wages, and other personnel costs; contract services; and a reasonable allocation of indirect corporate costs unless they are not clearly related to R&D activities. R&D expenditures are tax deductible in the period that the expenditures are made.

To properly calculate a return on investment, R&D costs must be capitalized and not expensed. In this white paper we will develop a methodology for capitalizing and amortizing research and development expenditures. Given that we only have publicly-available information to work with, we will make the following assumptions...

Table 1: Capitalized R&D Model Assumptions

1 A contant percentage of all R&D expenditures result in a commercially viable product.
2 The dollar amount of R&D expenditures capitalized is the after-tax expenditure.
3 Product revenue declines at a constant rate due to technological obsolesence.
4 R&D expenditures are a positive linear function of product lifetime revenue.
5 Capitalized R&D expenditures are amortized over the product's remaining revenue life.

Our primary focus will be on the technology company that consistently brings new products to market and therefore has an on-going investment in research and development. Revenue growth for this company will be the net result of an increase in revenue due to new products brought to market and a decrease in revenue due to the technological obsolesence of its existing product line. To assist us in our endeavor we will work through the following hypothetical problem...

Our Hypothetical Problem

ABC Company is a technology company that has a substantial investment in research and development. The table below presents financial data applicable to ABC Company's new product launch...

Table 2: ABC Company New Product Parameters

Description	Value
New product annualized revenue at product launch ($)	15,000,000
Company GAAP financials - Operating revenue ($)	100,000,000
Company GAAP financials - R&D expense ($)	17,780,000
Income tax rate (%)	20.00
Weighted-average product revenue life in years (#)	3.00
New product launch month (#)	6

We are tasked with answering the following questions...

Question 1: What is product lifetime revenue at product launch?

Question 2: What is the balance of Capitalized R&D at product launch?
Question 3: What is the balance of Capitalized R&D at the end of year five?
Question 4: What is the amortization of capitalized R&D in year four?
Question 5: Graph the balance of Capitalized R&D over time.

Product Lifetime Revenue

We defined the variable R_t^s to be annualized revenue at time t on a product brought to market at time s, and the variable λ to be the rate of technological obsolescense. The equation for annualized revenue at time t is... [1]

$$R_t^s = R_s^s \operatorname{Exp}\left\{ -\lambda (t-s) \right\} \text{ ...where... } s \leq t \tag{1}$$

We defined the variable $R_{m,n}^s$ to be cumulative revenue realized over the time interval $[m,n]$ on a product brought to market at time s. Using Equation (1) above, the equation for cumulative revenue is... [1]

$$R_{m,n}^s = R_s^s \left(\operatorname{Exp}\left\{ -\lambda (m-s) \right\} - \operatorname{Exp}\left\{ -\lambda (n-s) \right\} \right) \lambda^{-1} \tag{2}$$

Using Equation (3) above, if we change the time interval from $[m,n]$ to $[s,\infty]$ then the equation for product lifetime revenue at product launch is...

$$R_{s,\infty}^s = R_s^s \left(\operatorname{Exp}\left\{ -\lambda (s-s) \right\} - \operatorname{Exp}\left\{ -\lambda (\infty-s) \right\} \right) \lambda^{-1} \tag{3}$$

Using Equation (3) above, we will note the following...

$$\operatorname{Exp}\left\{ -\lambda (s-s) \right\} = 1 \text{ ...and... } \operatorname{Exp}\left\{ -\lambda (\infty-s) \right\} = 0 \tag{4}$$

Using Equations (3) and (4) above, the equation for product lifetime revenue at product launch is...

$$R_{s,\infty}^s = R_s^s \lambda^{-1} \tag{5}$$

Note the using Equation (5) above, if we are given lifetime product revenue at the beginning of any time period then annualized product revenue at the beginning of that time periood is...

$$\text{if... } R_{0,\infty}^0 = R_0^0 \lambda^{-1} \text{ ...then... } R_0^0 = \lambda R_{0,\infty}^0 \tag{6}$$

Using Equation (3) above, if we change the time interval from $[m,n]$ to $[t,\infty]$ then the equation for product lifetime revenue at time t on a product brought to market at time s is...

$$R_{t,\infty}^s = R_s^s \left(\operatorname{Exp}\left\{ -\lambda (t-s) \right\} - \operatorname{Exp}\left\{ -\lambda (\infty-s) \right\} \right) \lambda^{-1} \tag{7}$$

Using Equations (3) and (7) above, the equation for remaining product lifetime revenue at time t on a product brought to market at time s is...

$$R_{t,\infty}^s = R_s^s \operatorname{Exp}\left\{ -\lambda (t-s) \right\} \lambda^{-1} \tag{8}$$

Capitalized Research and Development

We will define the variable ω to be the pre-tax dollar investment in research and development needed today to generate one dollar of revenue tomorrow. If we ignore the time-value of money then this statement in equation form is...

$$\text{Product R\&D Expenditures (Now)} = \omega \times \text{Product Lifetime Revenue (Future)} \tag{9}$$

We will define the variable α to be the income tax rate. The equation for the balance of capitalized research and development at product launch (i.e. time zero) is...

$$\text{Capitalized R\&D (Now)} = \text{Product R\&D Expenditures (Now)} \times (1-\alpha) \tag{10}$$

Using Equation (9) above, we can rewrite Equation (10) above as...

$$\text{Capitalized R\&D (Now)} = \omega \times (1-\alpha) \times \text{Product Lifetime Revenue (Future)} \tag{11}$$

We will define the variable X_t^s to be the balance of capitalized research and development at time t on a product brought to market at time s. Using Equations (8) and (11) above, the equation for capitalized research and development at time t on a product brought to market at time s is...

$$X_t^s = (1-\alpha)\,\omega\,R_{t,\infty}^s = (1-\alpha)\,\omega\,R_s^s\,\text{Exp}\left\{-\lambda\,(t-s)\right\}\lambda^{-1} \tag{12}$$

Using Appendix Equation (22) below, the derivative of Equation (12) above with respect to time is...

$$\frac{\delta}{\delta t}\,X_t^s = -(1-\alpha)\,\omega\,R_s^s\,\text{Exp}\left\{-\lambda\,(t-s)\right\} \tag{13}$$

We will define the variable $E_{m,n}^s$ to be the amortization of capitalized research and development over the time interval $[m,n]$ on a product brought to market at time s. Note that the amoritzation of capitalized research and development is an after-tax expense. Using Equation (13) above, the equation for amortization expense is...

$$E_{m,n}^s = -\int_m^n \frac{\delta X_t^s}{\delta t}\,\delta t = (1-\alpha)\,\omega\,R_s^s \int_m^n \text{Exp}\left\{-\lambda\,(t-s)\right\}\delta t \tag{14}$$

Using Appendix Equation (23) below, the solution to Equation (14) above is...

$$E_{m,n}^s = (1-\alpha)\,\omega\,R_s^s\left(\text{Exp}\left\{-\lambda\,(m-s)\right\} - \text{Exp}\left\{-\lambda\,(n-s)\right\}\right)\lambda^{-1} \tag{15}$$

Model Parameter Estimates

We defined the variable β to be weighted-average revenue life in years. Using the data in Table 2 above, the estimated value of the rate of technological obsolesence variable lambda is... [1]

$$\lambda = \frac{1}{\beta} = \frac{1}{3.00} = 0.3333 \tag{16}$$

We defined the variable ω to be the pre-tax dollar investment in research and development needed today to generate one dollar of revenue tomorrow. Using the data in Table 2 above, the estimated value of the variable gamma is...

$$\omega = \frac{\text{GAAP R\&D expense}}{\text{GAAP operating revenue}} = \frac{17,780,000}{100,000,000} = 0.1778 \tag{17}$$

The Solution To Our Hypothetical Problem

Question 1: What is product lifetime revenue at product launch?

Using Equations (5) and (16) above and the parameters in Table 2 above, the answer to the question is...

$$R_{0.50,\infty}^{0.50} = 15,000,000 \times 0.3333^{-1} = 45,000,000 \tag{18}$$

Question 2: What is the balance of Capitalized R&D at product launch?

Using Equations (12), (16), (17), and (18) above and the parameters in Table 2 above, the answer to the question is...

$$X_{0.50}^{0.50} = (1-0.20) \times 0.1778 \times 45,000,000 = 6,400,800 \tag{19}$$

Question 3: What is the balance of Capitalized R&D at the end of year five?

Using Equations (12), (16), (17), and (18) above and the parameters in Table 2 above, the answer to the question is...

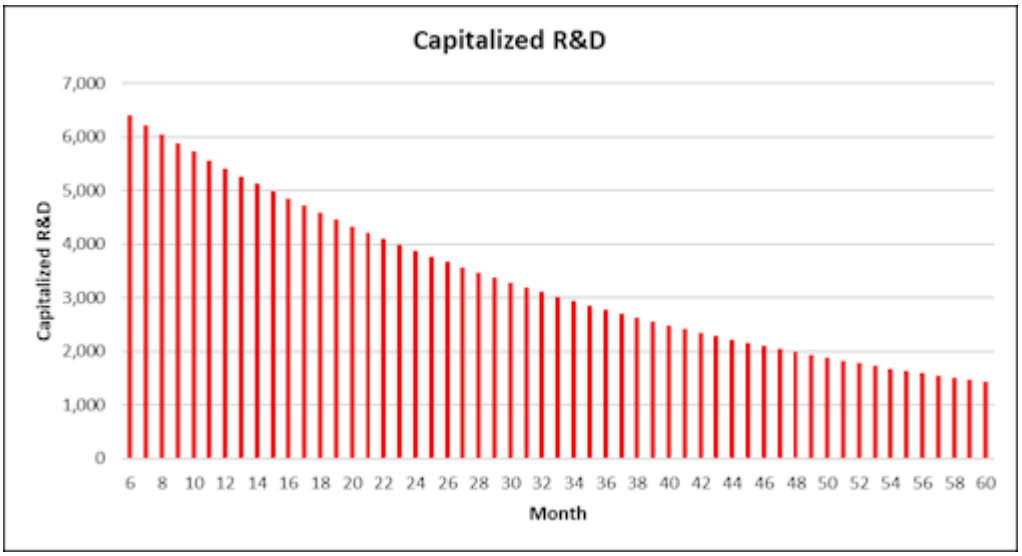
$$X_{5.00}^{0.50} = (1-0.20) \times 0.1778 \times 15,000,000 \times \text{Exp}\left\{-0.3333 \times (5.00-0.50)\right\} \times 0.3333^{-1} = 1,428,200 \tag{20}$$

Question 4: What is the amortization of capitalized R&D in year four?

Using Equations (15), (16), (17), and (18) above and the parameters in Table 2 above, the answer to the question is...

$$E_{3.00,4.00}^{0.50} = (1 - 0.20) \times 0.1778 \times 15,000,000 \times \left(\text{Exp}\left\{ -0.3333 \times (3.00 - 0.50) \right\} - \text{Exp}\left\{ -0.3333 \times (4.00 - 0.50) \right\} \right) \times 0.3333^{-1} = 788,600 \tag{21}$$

Question 5: Graph the balance of Capitalized R&D over time.



References

[1] Gary Schurman, *Modeling Technology Product Revenue,* December, 2019

Appendix

A. The solution to the following derivative is...

$$\begin{aligned} \frac{\delta}{\delta t} X_t^s &= \frac{\delta}{\delta t} \left((1 - \alpha) \, \omega \, R_s^s \, \text{Exp}\left\{ -\lambda \, (t - s) \right\} \lambda^{-1} \right) \\ &= -\lambda \left((1 - \alpha) \, \omega \, R_s^s \, \text{Exp}\left\{ -\lambda \, (t - s) \right\} \lambda^{-1} \right) \\ &= -(1 - \alpha) \, \omega \, R_s^s \, \text{Exp}\left\{ -\lambda \, (t - s) \right\} \end{aligned} \tag{22}$$

B. The solution to the following integral is...

$$\begin{aligned} \int_m^n \text{Exp}\left\{ -\lambda \, (t - s) \right\} \delta t &= -\frac{1}{\lambda} \, \text{Exp}\left\{ -\lambda \, (t - s) \right\} \Big|_m^n \\ &= -\frac{1}{\lambda} \left(\text{Exp}\left\{ -\lambda \, (m - s) \right\} - \text{Exp}\left\{ -\lambda \, (n - s) \right\} \right) \\ &= \left(\text{Exp}\left\{ -\lambda \, (n - s) \right\} - \text{Exp}\left\{ -\lambda \, (m - s) \right\} \right) \lambda^{-1} \end{aligned} \tag{23}$$