Cash Flow Analysis

The basic idea in cash flow analysis is that we want summarize the cash flowing into and out of the company over a fixed time-horizon, e.g. 5 years. This information is a necessary first step in creating a financial strategy and is used by companies to assess long-term profitability, set budgets, and summarize the company's activity to investors.

The process for performing a cash flow analysis is as follows:

Step 1: Determine the time-horizon for the cash flow analysis. Generally the time-horizon should include several years during which the company is generating revenue. For start-up companies this will typically be 3-5 years depending on when the company starts selling the product.

The time-horizon is then broken down into a set of periods. Typically a period is one quarter, however, if the time-horizon is particularly long (e.g. 10 years) a longer period length (e.g. 1 year) might be used.

Let

$$n = \text{total number of periods in the time horizon}$$

Step 2: Make a list of all revenues and expenses for the company over the time-horizon of interest.

- *Expenses*: all sources of money flowing out of the company (e.g. salary, facilities).
- *Revenues*: all sources of money flowing into the company (e.g. sales, patent licensing).

Step 3: For each period in the time-horizon estimate the value ($) of each revenue and each expense identified in Step 2.

Let

$$\begin{aligned} m &= \text{the total number of sources of expenses} \\ l &= \text{the total number of sources of revenues} \end{aligned}$$

We need to estimate

$$\begin{aligned} e_{i,j} &= \text{the value of j-th expense } (j=1,2,\ldots m) \text{ in period } i \\ r_{i,k} &= \text{the value of k-th revenue } (k=1,2,\ldots l) \text{ in period } i \end{aligned}$$

for i=0,1,2,...,n-1 where the period i=0 is the first period in the cash flow analysis (e.g. Quarter 1 of Year 1).

If a particular revenue or expense does not occur in a period then the value is $0 (e.g. no sales in Quarter 1 of Year 1). Also, remember that revenues have a positive value in the cash flow analysis and expenses have a negative value.

Step 4: Determine the net cash flow for each period. The net cash flow at period i is the sum of all expenses and revenues that occurred in that period.

$$\text{Net Cash Flow}_i = \sum_{j=1}^{m} e_{i,k} + \sum_{k=1}^{l} r_{i,k}$$

Step 5: Compute the present value of the net cash flow for each period. The present value at period i is computed by discounting the net cash flow from that period.

$$\begin{aligned} NCF_i &= \text{Net Cash Flow at period } i \\ d &= \text{discount rate} \\ PV_i &= \frac{NCF_i}{(1+d)^i} \end{aligned}$$

Remember that i=0,1,2,...,n-1, so when i=0 then PV = NCF. See the handout on present value and discounting for the details of how to compute the present value.

Step 6: Organize the results from Steps 2, 3, 4 (revenues, expenses, net cash flows, and present values) into a table as follows:

	Period 0 (Present)	Period 1	Period 2	...	Period n-1
Expense 1	$e_{0,1}$	$e_{1,1}$	$e_{2,1}$		$e_{n-1,1}$
Expense 2	$e_{0,2}$	$e_{1,2}$	$e_{2,2}$		$e_{n-1,2}$
...					
Expense m	$e_{0,m}$	$e_{1,m}$	$e_{2,m}$		$e_{n-1,m}$
Revenue 1	$r_{0,1}$	$r_{1,1}$	$r_{2,1}$		$r_{n-1,1}$
Revenue 2	$r_{0,2}$	$r_{1,2}$	$r_{2,2}$		$r_{n-1,2}$
...					
Revenue l	$r_{0,l}$	$r_{1,l}$	$r_{2,l}$		$r_{n-1,l}$
Net Cash Flow (NCF)	NCF_0	NCF_1	NCF_2		NCF_{n-1}
Present Value (PV)	PV_0	PV_1	PV_2		PV_{n-1}

For start-up companies the cash flow analysis serves two additional purposes:

1. Determining how much funding is necessary to get to the point where the company is profitable (revenues > expenses).
2. Determining the return that investors will receive on their invested capital.

In order to determine the return on investment (ROI) we first need to compute the net present value (NPV) of the company. The NPV is simply the sum of the present values from the cash flow analysis:

$$Net\ Present\ Value = \sum_{i=1}^{n} PV_i$$

The net profit ($) on the investment is

$$\begin{aligned} NPV &= Net\ Present\ Value \\ Equity &= \%\ of\ the\ company\ received\ for\ the\ investment \\ Net\ Profit &= NPV \times Equity \end{aligned}$$

and the Return on Investment (ROI) is

$$ROI = \frac{Net\ Profit - Investment}{Investment}$$

Example:
Your company has come up with an innovative new bicycle that integrates high-powered head-lights, GPS navigation, and electric pedal assist. As part of the financial strategy team you have been put in charge of performing the cash flow analysis for the company that will be used to obtain funding from investors.

Step 1: Determine the time-horizon and period length

The company expects to start selling the electric bicycle after one year of product development. Based on this you have decided to create quarterly cash flow analysis for the next four years.

$$n = 4 \times 4 = 16$$

Step 2: Make a list of all relevant cash flows.

After talking to the product development team and marketing team you have identified the following set of expenses and revenues.

Expenses (Cash Out)
Product Development (Salary, Equipment, Materials)
Manufacturing (Salary, COGS, Transportation)
Marketing and Support (Salary, Advertising campaigns)
Facilities (Office space)

Revenues (Cash In)
Sales

Steps 3,4,5: Estimate the value of each revenue and expense , net cash flow, and for each period

From Step 2:

$$\begin{aligned} m &= 4 \\ l &= 1 \end{aligned}$$

and

$$\begin{aligned} e_{i,1} &= \textit{product development expenses} \text{ in } \textit{period } i \\ e_{i,2} &= \textit{manufacturering expenses} \text{ in } \textit{period } i \\ e_{i,3} &= \textit{marketing} \text{ and } \textit{support expenses} \text{ in } \textit{period } i \\ e_{i,4} &= \textit{facilities expenses} \text{ in } \textit{period } i \\ r_{i,1} &= \textit{sales revenue} \text{ in } \textit{period } i \end{aligned}$$

You have assumed a 10% annual discount rate. The quarterly discount rate is then 2.5% (10% / 4).

Working with the product development and marketing team you have estimated the expenses and revenues (all numbers in $1,000) over the next four years as follows:

Quarter 1 Year 1 (i=0)

Step 3	*Step 4*	*Step 5*
$e_{0,1} = -50$ $e_{0,2} = 0$ $e_{0,3} = 0$ $e_{0,4} = -50$ $r_{0,1} = 0$	$NCF_0 = [0] + [-50 + 0 + 0 + -50]$ $= -100$	$PV_0 = \frac{-100}{(1+0.025)^0}$ $= -100$

Quarter 2 Year 1 (i=1)

Step 3	*Step 4*	*Step 5*
$e_{1,1} = -75$ $e_{1,2} = 0$ $e_{1,3} = 0$ $e_{1,4} = -50$ $r_{1,1} = 0$	$NCF_1 = [0] + [-75 + 0 + 0 + -50]$ $= -125$	$PV_1 = \frac{-125}{(1+0.025)^1}$ $= -122$

Quarter 3 Year 1 (i=2)

Step 3	*Step 4*	*Step 5*
$e_{2,1} = -100$ $e_{2,2} = 0$ $e_{2,3} = 0$ $e_{2,4} = -50$ $r_{2,1} = 0$	$NCF_2 = [0] + [-100 + 0 + 0 + -50]$ $= -150$	$PV_2 = \frac{-150}{(1+0.025)^2}$ $= -143$

Quarter 4 Year 1 (i=3)

Step 3	*Step 4*	*Step 5*
$e_{3,1} = -75$ $e_{3,2} = -50$ $e_{3,3} = 0$ $e_{3,4} = -50$ $r_{3,1} = 0$	$NCF_3 = [0] - [-75 + -50 + 0 + -50]$ $= -175$	$PV_3 = \frac{-175}{(1+0.025)^3}$ $= -163$

Quarter 1 Year 2 (i=4)

Step 3	*Step 4*	*Step 5*
$e_{4,1} = 0$ $e_{4,2} = -50$ $e_{4,3} = -100$ $e_{4,4} = -50$ $r_{4,1} = 100$	$NCF_4 = [100] + [0 + -50 + -100 + -50]$ $= -100$	$PV_4 = \frac{-100}{(1+0.025)^4}$ $= -91$

Quarter 2 Year 2 (i=5)

Step 3	*Step 4*	*Step 5*
$e_{5,1} = 0$ $e_{5,2} = -50$ $e_{5,3} = -20$ $e_{5,4} = -50$ $r_{5,1} = 150$	$NCF_5 = [150] + [0 + -50 + -20 + -50]$ $= 30$	$PV_5 = \frac{30}{(1+0.025)^5}$ $= 27$

Quarter 3 Year 2 (i=6)

Step 3	*Step 4*	*Step 5*
$e_{6,1} = 0$	$NCF_6 = [220]+[0 + -75 + -25 + -50]$	$PV_6 = \frac{70}{(1+0.025)^6}$
$e_{6,1} = -75$	$= 70$	$= 60$
$e_{6,2} = -25$		
$e_{6,3} = -50$		
$r_{6,4} = 220$		

Quarter 4 Year 2 (i=7)

Step 3	*Step 4*	*Step 5*
$e_{7,1} = 0$	$NCF_7 = [300]+[0 + -100 + -30 + -50]$	$PV_7 = \frac{120}{(1+0.025)^7}$
$e_{7,2} = -100$	$= 120$	$= 101$
$e_{7,3} = -30$		
$e_{7,4} = -50$		
$r_{7,1} = 300$		

Quarter 1 Year 3 (i=8)

Step 3	*Step 4*	*Step 5*
$e_{8,1} = 0$	$NCF_8 = [450]+[0 + -150 + -50 + -50]$	$PV_8 = \frac{200}{(1+0.025)^8}$
$e_{8,2} = -150$	$= 200$	$= 164$
$e_{8,3} = -50$		
$e_{8,4} = -50$		
$r_{8,1} = 450$		

Quarter 2 Year 3 (i=9)

Step 3	*Step 4*	*Step 5*
$e_{9,1} = 0$	$NCF_9 = [450]+[0 + -150 + -50 + -50]$	$PV_8 = \frac{200}{(1+0.025)^9}$
$e_{9,2} = -150$	$= 200$	$= 160$
$e_{9,3} = -50$		
$e_{9,4} = -50$		
$r_{9,1} = 450$		

Quarter 3 Year 3 (i=10)

Step 3	*Step 4*	*Step 5*
$e_{10,1} = 0$	$NCF_{10} = [600]+[0 + -200 + -75 + -50]$	$PV_{10} = \frac{275}{(1+0.025)^{10}}$
$e_{10,2} = -200$	$= 275$	$= 215$
$e_{10,3} = -75$		
$e_{10,4} = -50$		
$r_{10,1} = 600$		

Quarter 4 Year 3 (i=11)

Step 3	Step 4	Step 5
$e_{11,1} = 0$ $e_{11,2} = -200$ $e_{11,3} = -75$ $e_{11,4} = -50$ $r_{11,1} = 600$	$NCF_{11} = [600]+[0 + -200 + -75 + -50]$ $= 275$	$PV_{11} = \frac{275}{(1+0.025)^{11}}$ $= 210$

Quarter 1 Year 4 (i=12)

Step 3	Step 4	Step 5
$e_{12,1} = 0$ $e_{12,2} = -200$ $e_{12,3} = -75$ $e_{12,4} = -50$ $r_{12,1} = 600$	$NCF_{12} = [600]+[0 + -200 + -75 + -50]$ $= 275$	$PV_{12} = \frac{275}{(1+0.025)^{12}}$ $= 204$

Quarter 2 Year 4 (i=13)

Step 3	Step 4	Step 5
$e_{13,1} = 0$ $e_{13,2} = -200$ $e_{13,3} = -75$ $e_{13,4} = -50$ $r_{13,1} = 600$	$NCF_{13} = [600]+[0 + -200 + -75 + -50]$ $= 275$	$PV_{13} = \frac{275}{(1+0.025)^{13}}$ $= 199$

Quarter 3 Year 4 (i=14)

Step 3	Step 4	Step 5
$e_{14,1} = 0$ $e_{14,2} = -200$ $e_{14,3} = -75$ $e_{14,4} = -50$ $r_{14,1} = 600$	$NCF_{14} = [600]+[0 + -200 + -75 + -50]$ $= 275$	$PV_{14} = \frac{275}{(1+0.025)^{14}}$ $= 195$

Quarter 4 Year 4 (i=15)

Step 3	Step 4	Step 5
$e_{15,1} = 0$ $e_{15,2} = -200$ $e_{15,3} = -75$ $e_{15,4} = -50$ $r_{15,1} = 600$	$NCF_{15} = [600]+[0 + -200 + -75 + -50]$ $= 275$	$PV_{15} = \frac{275}{(1+0.025)^{15}}$ $= 190$

Step 6: Organize the results from Steps 2, 3, 4 (revenues, expenses, net cash flows, and present values) into a table

Period i=	*0*	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*
	Q1Y1	*Q2Y1*	*Q3Y1*	*Q4Y1*	*Q1Y2*	*Q2Y2*	*Q3Y2*	*Q4Y2*	*Q1Y3*	*Q2Y3*	*Q3Y3*	*Q4Y3*	*Q1Y3*	*Q2Y3*	*Q3Y3*	*Q4Y3*
Product Development	*-50*	*-75*	*-100*	*-75*												
Manufacturing				*-50*	*-50*	*-50*	*-75*	*-100*	*-150*	*-150*	*-200*	*-200*	*-200*	*-200*	*-200*	*-200*
Marketing and Support					*-100*	*-20*	*-25*	*-30*	*-50*	*-50*	*-75*	*-75*	*75*	*-75*	*-75*	*-75*
Facilities	*-50*	*-50*	*-50*	*-50*	*-50*	*-50*	-50	-50	*-50*	*-50*	*-50*	*-50*	*-50*	*-50*	*-50*	*-50*
Sales					*100*	*150*	*220*	*300*	*450*	*450*	*600*	*600*	*600*	*600*	*600*	*600*
Net Cash Flow	*-100*	*-125*	*-150*	*-175*	*-100*	*30*	70	120	*200*	*200*	*275*	*275*	*275*	*275*	*275*	*275*
Present Value	*-150*	*-122*	*-143*	*-163*	*-91*	*27*	60	101	*164*	*160*	*215*	*210*	*204*	*199*	*195*	*190*

You have been given the task of using the cash flow analysis to create the funding plan for the start-up. This requires that we first determine how much money is needed to get to the point where the start-up is cash-flow positive. We see that the start-up will have positive net cash flows starting Quarter 3 Year 2 (period 5). The necessary funding is then

$$\begin{aligned} Funding &= \sum_{i=0}^{4} PV_i \\ &= -618 \end{aligned}$$

The start-up will need $618,000 to get to the point where is is cash flow positive. We next need to calculate the NPV of the company in order to determine how much equity (ownership) to offer for the $618,000 investment (funding).

The NPV of the company is the sum of the discounted net cash flows (present values) over the entire time-horizon of the cash flow analysis.

$$\begin{aligned} NPV &= \sum_{i=0}^{15} PV_i \\ &= 918 \end{aligned}$$

The company will have $918,000 in equity after four years of operation.

One approach to determine how much (%) equity should be offered is to start by finding the break-even point for the investment (ROI=0).

Remember that

$$\begin{aligned} Net\,Profit &= NPV \times Equity \\ ROI &= \frac{Net\,Profit - Investment}{Investment} \end{aligned}$$

then

$$\begin{aligned} 0 &= \frac{(918 \times Equity) - 618}{618} \\ 0 &= 918 \times Equity - 618 \\ 618 &= 918 \times Equity \\ \frac{618}{918} &= Equity \\ Equity &= 0.67 \end{aligned}$$

In order for the investor to break-even (ROI=0) on their investment of $618,000 after four years we would need to offer 67% equity. However, most investors are looking for a 5 – 10X (500% - 1000%) ROI. Therefore, it is unlikely that the start-up will able to obtain funding based on the current cash flow estimates.

Based on this cash flow analysis, the start-up has several options:

1. *Revise the estimates of expenses and revenues in order to produce a significantly larger NPV over the first four years of operation. For example, how could we cut down the manufacturing costs of the product.*
2. *Perform a cash flow analysis over a longer period (e.g. six years) to see if there is a significant increase in the NPV. Keep in mind that investors will expect a larger ROI if the time-horizon of the investment is longer.*
3. *Close down the company.*