**Using Excel to build a Financial Model for an Individual.**

**(Simple Financial Model Project)**

**TIA TSC**

**Background**

Introduction Sarah Chan, at age 22, was hired into an entry-level actuarial position in 2012 with a starting salary of $50,000. She has been successful at passing actuarial exams and she expects to earn $100,000 by 2017 when she’ll get her fellowship. Her salary is expected to increase by 3% per year starting in 2018, all the way until she retires at age 65.

Outside of work, she has a 30-year fixed mortgage that she pays $18,000 per year. She started paying her mortgage in 2012. She also has student loan debt that she will pay off in 2021. Both the mortgage and the student loan debt payments are steady through the life of the loan. She does save $100 per month into her retirement fund; Sarah does not expect to increase her contribution (i.e., steady $100 per month until she retires). Sarah has other expenses like various insurance, living expenses, and other expenses. Whatever money she has left over annually, she puts into her Personal Savings Account that earns 1% interest and that rate is not expected to change until she retires.

Your overall task is to create a financial model in Excel that projects Sarah Chan’s Net Income and Personal Savings Account until she retires at age 65. Historical data is through 12/31/2016. Your first projected year is as of 12/31/2017.

**Objectives:**

Project the model until Sarah’s retirement at age 65. Summarize her historical income statement and calculate her historical ratios.

We can then use those historical ratios to make future assumptions to project the model to 65.

Determine how much money Sarah will have in her personal savings account when she retires.

**Execution: (FinancialModelBuild)**

1. **The historical data**

**Note:** values formatted in blue are historical values, while values in black are calculated or projected. Bolded values are financial metrics (Net Income, total revenue, total expenses etc)

**a)** Extend the Age row to 65, and the year row to match (2055).

**b)** Her salary increases to $100,000 in 2017 and increases by 3% each year after that.

In cell N6*: =M6 \* (1 + $N$31)*

*Extend to AY6*

**c)** Savings for retirement:

It is given that Sarah will keep this expense cost at a fixed $1200.

**d)** Total Revenue: starting in cell H8: *=SUM(H6)*

Extend to AY8 since Sarah’s only source of income is her salary, her total revenue should be equivalent to her salary.

**e)** Mortgage and Student loans:

30-year mortgage that started in 2012 would have an end date at 2042, student loans expected to be paid by 2021. These are both fixed amount payments. Mortgage should end in cell AL11 and student loans should end in cell Q12

**f)** Total Expenses: Now we can calculate the historical expenses

Starting in cell H18 *=SUM(H11:H16)*

Extend to cell AY18

**g)** Pretax operating income: Total revenue – total expenses.

In cell H20: *= H8 – H18*

Extend to year cell AY20

**h)** Determining the income tax percent

Looking at year 2012 we see an income tax paid of $14,000. With a salary of $50,000 the income tax % is then 14,000/50,000 = 0.28 or 28%. This can be assumed to be a constant value and we enter that value under Income Tax Rate as a % of Annual Salary under Ratios & Assumptions.

The projected income taxes row starting at cell M22 will have values = M6\*$M$38. (We will return here later when we extend our ratios to future assumptions.

**i)** Determining net income: Pretax Operating income – income taxes

In cell H24: *=H20 - H22*

Extended to AY24

**j)** Value of Personal Savings account

Notice that the first entry in 2012 for personal savings account is equivalent to the net income $2,450. The 2nd entry in 2013, $9,974.50 which is equivalent to $2,450\*(1.01) + $7,500

Where (1.01) is the given savings interest rate and $7,500 is the Net income for the year 2013.

This will be used in calculating the value of the value of the personal savings account in future projections.

1. **Historical Ratios**
2. Salary growth:

For the years leading up to 2017 (Where she expects her salary growth to shift from an advancement to $100,000 to a 3% growth model) we can calculate the historic salary growth by (Salary New – Salary Old) / Salary Old which will give the Salary growth as a percentage. In cell N31 we assume that salary growth will remain fixed at 3.0% annually. For cell O31 we assign it value *= N31* and extend that to AY31.

1. Mortgage as a % of annual salary

In cell H32: *=H11/H6*

Extend to L32, **note** that the payments are a fixed value ($18,000).

1. Student loan debt as a % of annual salary

In cell H33: *=H12/H6*

Extend to L33, **note** that the payments are a fixed value ($3,600)

1. Insurance Costs as % of annual salary

In cell H34: *= H13/H6*

Extend to L34, **note** the constant rate of 0.5%

1. Living Expenses as a % of annual salary

In cell H35: *=H14/H6*

Extend to L35, **note** the constant rate of 9.0%

1. Savings for Retirement as a % of annual salary

In cell H36: *=H15/H6*

Extend to L36, **note** that the payments are a fixed value ($1,200)

1. Other Expenses as a % of Annual Salary

In cell H37: *=H16/6*

Extend to L37, **note** the constant rate of 12.0%

1. Income Tax Rate as a % of annual salary

In cell H38: *= H22/ H6*

Extended to L38, **note** we already determined this value to be a fixed 28.0%

1. Interest of Savings account

This value is given as 1.0%

1. **Assumptions and future projections**
2. Salary growth

We are given an assumed annual salary growth of 3.0%. In order to build the model for future user interaction, we assign value of 3.0% in cell N31 and in cell O31 we assign value *=N31* and extend that to AY31. This sets consecutive cells equal to each other in relative reference to the value in N31 (3.0%).

1. Mortgage/Student/ Savings for retirement as % of annual salary

These are fixed payments, and we assume that they will continue to remain fixed throughout the life of this model.

1. Insurance cost as a % of annual salary

As noted in the calculation of historical ratios, the cost of Sarah’s insurance is a constant 5.0% of her annual salary and so we use 5.0% to make future projections. Like in salary growth we want to allow room for future user input assumptions, so we use cell M34 as a relative reference cell for the range *N34:AY34.*

1. Living Expenses as a % of annual salary

Use the constant 9.0% for future projections.

1. Other Expenses as a % of annual salary

12.0%

f) Income Tax Rate as a % of annual salary

28.0%

g) Interest of Savings Account

1.0%

**Using the assumptions of ratios to fill out the financial model:**

These are all extended to column AY in their respective rows.

1. Salary growth (Cell N6): *=M6\*(1+N31)*

Where N31 is the assumed salary growth rate and M6 is the previous year’s salary.

1. Insurance Expense (Cell M13): *=M6\*M34*

Where M6 is that year’s salary and M34 is the assumed Insurance cost as % of annual salary.

1. Living Expenses (Cell M14): *=M6\*M35*

Where M6 is that year’s salary and M35 is the assumed Living Expenses as % of annual salary.

1. Other Expenses (Cell M16): *=M6\*M37*

Where M6 is that year’s salary and M37 is the assumed Other Expenses as % of annual salary.

1. Income Taxes (Cell M24): *=M38\*M6*

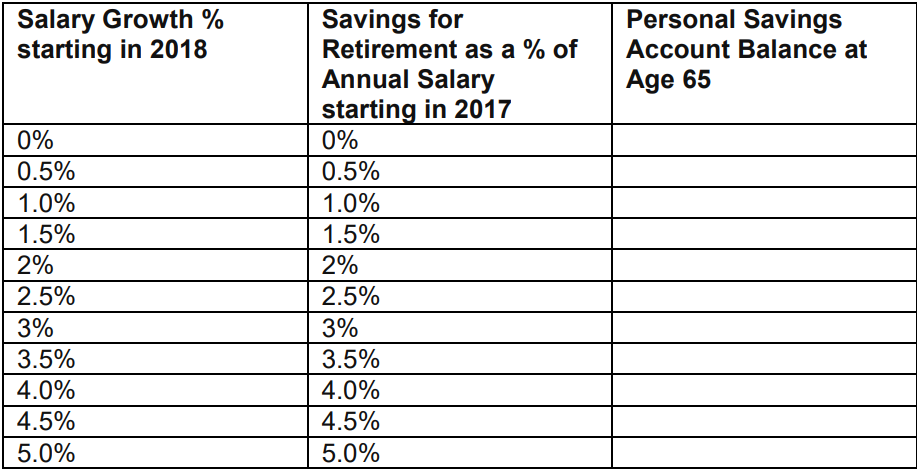
Where M6 is that year’s salary and M38 is the assumed income tax rate.

1. Personal Savings Account (Cell M26): *=L26\*(1+M39)+M24*

Where L26 refers to the previous year’s personal savings account balance, M39 is the assumed interest rate on the savings account and M24 is the current year’s net income.

Given current assumptions Sarah Chan will have $3,701,179.18 in her personal savings account at the age of 65.

1. **Calculating the personal savings account balance across a range of assumed salary growth rates and savings interest rates. (FinancialModelWork)**

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Using Excel’s data table function in What-if? Analysis we can quickly calculate the results using our previous model’s setup.

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| $3,701,179.9 | 0.0% | 0.5% | 1.0% | 1.5% | 2.0% | 2.5% | 3.0% | 3.5% | 4.0% | 4.5% | 5.0% |
| 0.0% |  |  |  |  |  |  |  |  |  |  |  |
| 0.5% |  |  |  |  |  |  |  |  |  |  |  |
| 1.0% |  |  |  |  |  |  |  |  |  |  |  |
| 1.5% |  |  |  |  |  |  |  |  |  |  |  |
| 2.0% |  |  |  |  |  |  |  |  |  |  |  |
| 2.5% |  |  |  |  |  |  |  |  |  |  |  |
| 3.0% |  |  |  |  |  |  |  |  |  |  |  |
| 3.5% |  |  |  |  |  |  |  |  |  |  |  |
| 4.0% |  |  |  |  |  |  |  |  |  |  |  |
| 4.5% |  |  |  |  |  |  |  |  |  |  |  |
| 5.0% |  |  |  |  |  |  |  |  |  |  |  |

The first step is to create the above setup in Excel with the top left cell having value *=AY26* which is the value of the personal savings account at age 65. Highlighting the entire region, we select data table under What-If? Analysis and apply the value of the row input cell to $N$31 which was our relative reference cell for salary growth rate. The column input cell is similarly $M$39 being the relative reference cell for our savings interest rate. The resulting table gives the values we seek. We use the OFFSET() function to pull the values in a separate sheet to fill this table.

|  |  |  |
| --- | --- | --- |
| Salary Growth % Starting in 2018 | Savings for Retirement as a % of Annual Salary Starting in 2017 | Personal Savings account Balance at Age 65 |
| 0.0% | 0.0% | $ 1,819,987.91 |
| 0.5% | 0.5% | $ 2,045,628.18 |
| 1.0% | 1.0% | $ 2,300,208.14 |
| 1.5% | 1.5% | $ 2,587,855.48 |
| 2.0% | 2.0% | $ 2,913,311.66 |
| 2.5% | 2.5% | $ 3,282,024.20 |
| 3.0% | 3.0% | $ 3,700,253.04 |
| 3.5% | 3.5% | $ 4,175,192.63 |
| 4.0% | 4.0% | $ 4,715,112.44 |
| 4.5% | 4.5% | $ 5,329,518.30 |
| 5.0% | 5.0% | $ 6,029,337.91 |

**Figure 4.a)** The implementation of the OFFSET() function to obtain the appropriate values can be found in worksheet DataTable Results

1. **Creating a life insurance model for Sarah Chan (LifeInsuranceModel)**

Sarah Chan, FSA (age 27) is going to earn a salary of $100,000 in 2017. Her salary is expected to increase by 3% per year starting in 2018, all the way until she retires at age 65.

Sarah is looking to buy life insurance that will pay out a benefit to her beneficiary if she passes away at or before age 65. She can choose to purchase a life insurance policy where the benefit is a flat amount (e.g. $50,000) or a percent of her salary (e.g. 200% of her salary).

We want to create a financial model that calculates the life insurance premium that Sarah Chan would have to pay.

1. **Setting up the financial model**

We have the following given assumptions:

1. Salary growth is 3.0%
2. Flat benefit amount = $50,000
3. % benefit amount = 200% of Salary
4. Probability of dying within one year: see mortality table for given year.
5. Probability of surviving within on year = 1- Probability of dying within one year
6. Present Value Interest Rate = 5.0%
7. Present Value factor = (1 + Present value interest rate)^ - Projection year
8. Life insurance premium required = sum of Expected benefit discounted back to present value
9. Salary projection is done the same way as before (Cell I7): *=H7\*(1+$I$25)*

Where H7 refers to the previous year’s salary and $I$25 is an absolute reference to the assumed annual salary growth. Extended values to AT7.

1. The flat benefit amount is given to be $50,000 but the value should only be assigned if Sarah decides she wants to purchase the coverage offering the flat benefit payout.

In cell H10: *=IF($B$26="Y", $H$26,0)*

Where cell $B$26 is associated with a y/n value on whether Sarah is choosing the flat benefit coverage. The IF() statement checks if that value is “Y”, if true $H$26 is a cell referencing the value of the flat benefit amount, otherwise it returns $0.

1. Like the flat benefit row, we want to only assign a value if Sarah decides she wants to choose this particular coverage.

In cell H11: *=IF($B$27="Y", H7\*H27,0)*

$B$27 serves the same purpose as $B$26 for the flat benefit. The cell H27 is a reference to the % of salary as benefit payout (200%), although we set the % benefit

values consecutive to H27 as being equivalent to their previous cell (ie., cell I27: = H27) for future user interaction. IF() Sarah chooses Y then the payout is H7\*H27 where H7 is the current year’s salary and H27 is the % of Salary as a benefit).

In row 12 we use =SUM() to sum the benefits. Since it is unlikely that Sarah would choose to purchase both benefits, this row can be assumed to be the value of whichever benefit she chooses.

1. The probability of dying within a year can be found in the accompanying mortality table. We use a VLOOKUP() to find those values.

In cell H13: *=VLOOKUP(H2, 'Mortality Table'!$A$5:$C$124, 3, FALSE)*

Where H2 is a reference to Sarah’s Age, the second argument is the Mortality table. 3 is the column number in which female probabilities are located within the table, and FALSE forces an exact match).

1. Probability of survival is easily calculated as (In Cell H14): 1 – H13

Where H13 is the probability of dying within on year previously found using VLOOKUP().

Probability of surviving up to beginning of projected year then dying within one year.

This requires that the individual survives every year up to the projected year then die within one year. Assuming independence between each year, this can be calculated by the product of the probability of survival in previous years multiplied by the probability of dying within on year for the current year.

At **Age 27** (Year 1, Cell H15): *=H13*, the probability is just the probability of dying within one year.

**Age 28** (year 2, cell I15): *=PRODUCT($H$14:H14)\*I13*, We call on the PRODUCT() function and call a range to find the product of the probability of survival in previous years. The $H$14 absolute reference defines the earliest value of the range as the probability of surviving the first year, for the 2nd year, since the only year we are interested in this context is also H14). Multiplied by the probability of dying within one year for that particular year (year 2)

**Age 29** (year 3, cell J15): *=PRODUCT($H$14:I14)\*J13*

The product range now calls *($H$14:I14)*  so years 1 and 2.

1. Present-Value Interest Rate is assumed to be 5.0%. We assign it’s value under actuarial assumptions in cell H29 in a similar way to the assumption for salary growth.
2. Present Value factor: We add a new row above Sarah’s Age called Projection Year, with year 1 starting at age 27 going to 39 when she retires at 65. In cell H18: *=(1+H29)^-(H1)* where (1+H29) is 1+the present value interest rate and –(H1) is a reference to the projection year.
3. Expected Benefit for a given year is calculated as the Total Benefit for that year \* Probability of surviving up to beginning of projecting year then dying within on year.

For year 1 (Cell H16): *=H12\*H15*

Expected Benefit Discounted back to Present value is calculated as the Expected Benefit \* Present value factor

For year 1 (Cell H18): =H16\*H17

1. We can now calculate the insurance premium which is the sum of the present values of the expected benefits.

In cell G20: *=SUM(H18:AT18)*

1. **Using our LifeInsuranceModel**
2. Comparing the life insurance premiums of the two assumed plans.

Flat benefit coverage premium: $1,656.04

%Salary coverage premium: $13,469.96

1. If Sarah only wanted to pay $1,000 a month what would the benefits for both coverages be?

We use GoalSeek under What-If? Analysis on the life insurance premium cell to determine the benefits.

Flat benefit coverage benefit: $30,192

%Salary coverage benefit (as % of salary): 15%