# ECON 180 FALL 2021: PROJECT 4

DUE December 3 by 11:59 PM VICTORIA, B.C. TIME

**DUE TO THE END OF THE COURSE,**

**NO EXTENSIONS ARE POSSIBLE TO BEYOND DECEMBER 6, AT 11:59 PM**

**Honor Code**: I guarantee that this submission is **entirely my own work**. I have **cited any outside sources** in APA or IEEE style. **(You must accept this code to receive a mark.)**

**Name or Signature for Honor Code**: __Myfanwy Warren_____

**Last 3 digits of student number**: ___454___

**Please enter your answers in the spaces and tables provided. Your submission must be in either PDF or Microsoft 365 (Word, etc.) format, so Brightspace can read it properly.**

| Question | | Marks |
|---|---|---|
| 1 | a-e | 78 each |
| | Q1 (Average) | 78 |
| 2 | i. | 2 |
| | ii. | 4 |
| | iii. | 4 |
| | Q2 (Total) | 10 |
| 3 (non-bonus) | a,c,d | 78 each |
| | Q3 (non-bonus) (Average) | 78 |
| Q1 to Q3 | (Q1+Q3 (non-bonus))/2+Q2 | 88 |
| 3 (bonus) | b | 2 |
| | e | 2 |
| | Bonus (Total) | 4 |
| Subtotal | (Q1 to Q3) + Bonus | 92 |
| Communication | | 6 (doubles if subtotal ≥ 83) |
| Total | | Max 100 |

I've provided an Excel spreadsheet with this project, but **you don't have to use it**. None of the questions require that you submit it, but you may find it useful as a starting point. If you think the table is confusing, or difficult to use, feel free to ignore it.

Version 1.1 (Nov 21): Fixed a typo on pages 4 and 5. (There was a (P/A,i,N) factor where there should bave been a (P/F,i,N) factor. Thanks to student S.F. for pointing this out.

## Table of Contents



# Question 1: Sensitivity Analysis

## 1.a Scenario Analysis (Lecture 23)

Your value of interest is the present value of buying a house in Edmonton. This is given by the formula

$$H \times (A/P, B_{monthly}, 300) \times (P/A, MARR_{monthly}, 300) \times (P/F, MARR_{monthly}, 35)$$

- H = Price of a house in Edmonton
- $B_{monthly} = (1 + (APR/2))^{1/6} - 1$
- APR = APR on the mortgage (which is compounded every 6 months)
- $MARR_{monthly} = (1+2.45\%)^{1/12} - 1$

You will notice that since the MARR is given, this is a function of only two parameters, H and B.

Assume Sam prefers a LOWER present value of housing costs to a HIGHER present value of housing costs (cheaper is better).

**Fill out the following table using the values you obtained in Project 1 (or values from the Project 1 key if you didn't complete Project 1). For each of the parameters listed, explain whether you are using the minimum, the baseline or the maximum value. (This is already filled out for the baseline case.) Sam prefers a lower present value of housing costs to a higher one.**

**The companion spreadsheet will do many of the calculations for you.** All you have to do is pick the correct values. To make it simple for the TAs to mark, in the yellow cells, please write whether the parameter values you are using in each case are the minimum, maximum or baseline (the trivial baseline case is filled out for you).

| | Scenario | Worst Case | Baseline | Best Case |
|---|---|---|---|---|
| | PV Housing | **$ 132,890.35** | **$ 68,240.92** | **$ 50,559.80** |
| Values | H | $111,000 | $66,000 | $52,000 |
| | APR | 4.82% | 3.39% | 2.82% |
| MAX, MIN or BASELINE? | H | max | BASELINE | min |
| | APR | max | BASELINE | min |

## 1.b. Tornado Graph (Lecture 23)

**Create a Tornado Diagram for the net present value of living and working (earning salary & paying rent) in Vancouver, assuming that rent goes up each month at a rate equivalent to 1.4% per year, and salary goes up at a rate of 10% every 14 months (about 8.51% per year). Note that there are a total of 480 rent payments, and the first rent payment is in Month 36. Assume that the minimum/maximum/baseline values from Project 1 are for the *first month's rent*, R. Similarly, assume Salary is paid once per year. There are 40 salary payments, and the first one is in Year 3. Assume that the minimum/maximum/baseline values from Project 1 are for the *first year's salary, S.***

This present value is represented by the following equation:

$S \times (P/A,g_{sal},2.45\%,40) \times (P/F,2.45\%,2) - R \times (P/A,g_{rent},MARR_{monthly}, 480) \times (P/F,MARR_{monthly},35)$

- S = initial yearly salary
- R = first month's rent
- $g_{sal} = (1+10\%)^{12/14} - 1 = 8.51\%$ (approx.)
- $MARR_{monthly} = (1+2.45\%)^{1/12} - 1$
- $g_{rent} = (1 + 1.4\%)^{1/12} - 1$

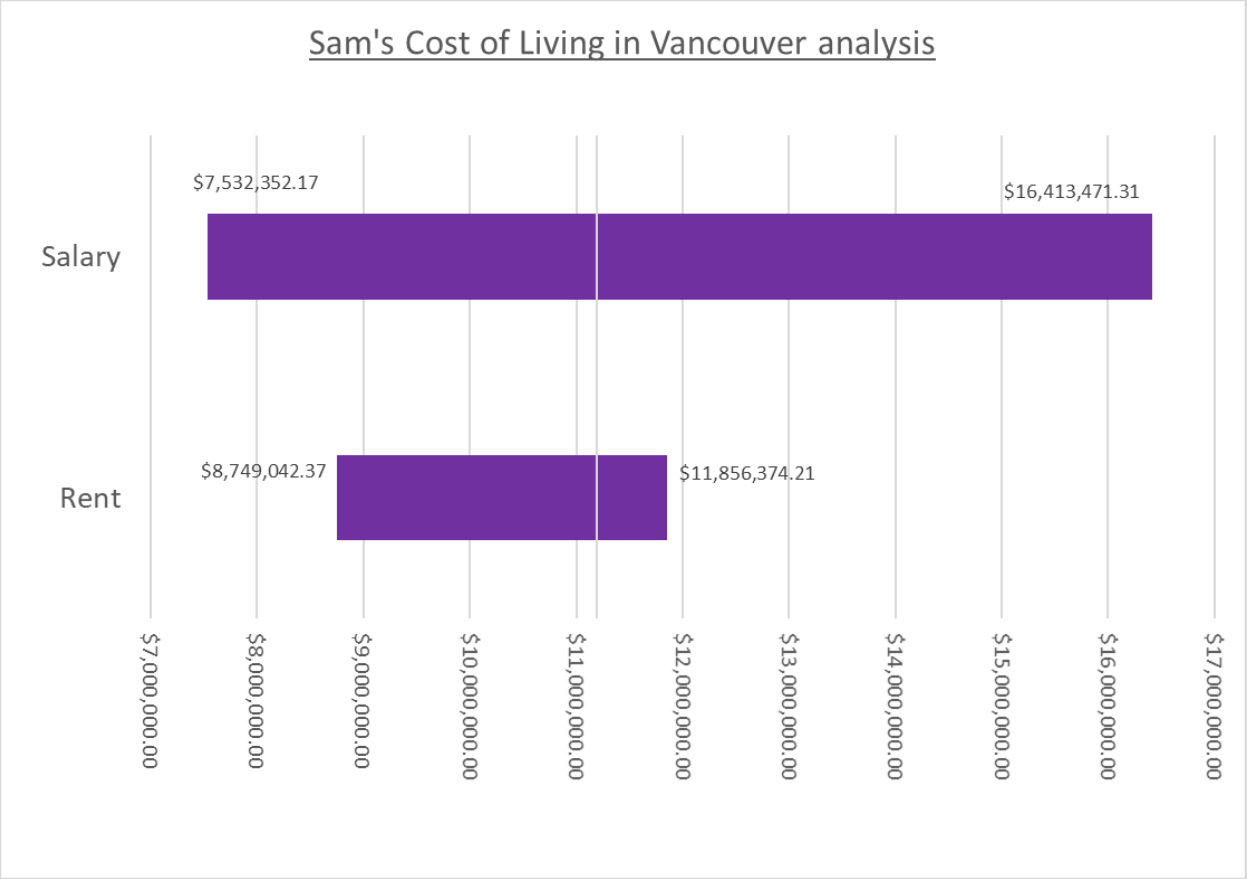
**You're not supposed to spend much, if any, time mucking around with this formula**. I want you to concentrate on creating the tornado graph. To that end, **I have included an implementation of the present value of (salary – housing) in Vancouver in the companion spreadsheet**.

TAs will be checking for the following:

- Widest bars at the top, narrowest bars at the bottom.
- Vertical line through the baseline value.
- Properly labeled axes.
- One bar for each of R,S
- (Optional) Data labels on either side of each bar.
- (Optional) Uniform colour for the bars.

**IF YOU'RE NOT COMFORTABLE WITH EXCEL, IT'S FINE TO DO THIS BY HAND AND SUBMIT, e.g. A SCAN OR CELL PHONE PHOTO OF YOUR GRAPH.**

**[INSERT YOUR TORNADO GRAPH ABOUT HERE – PLEASE DO NOT JUST COPY AND PASTE FROM EXCEL, AS THAT MAY BREAK THE IMAGE! COPY FROM EXCEL AND 'PASTE SPECIAL', PREFERABLY AS PDF, PNG, GIF, JPG OR TIFF]**


Sam's Cost of Living in Vancouver analysis
Salary
Rent
$7,532,352.17
$16,413,471.31
$8,749,042.37
$11,856,374.21
$7,000,000.00
$8,000,000.00
$9,000,000.00
$10,000,000.00
$11,000,000.00
$12,000,000.00
$13,000,000.00
$14,000,000.00
$15,000,000.00
$16,000,000.00
$17,000,000.00

## 1.c Spider Diagram (Lecture 23)

**Create a Spider Diagram for the present value of living and working (earning salary, paying rent) in Vancouver.**

**The relevant equation is the same as before.** This present value is represented by the following equation:

$S \times (P/A,g_{sal},2.45\%,40) \times (P/F,2.45\%,2) - R \times (P/A,g_{rent},MARR_{monthly}, 480) \times (P/F,MARR_{monthly},35)$

- S = initial yearly salary
- R = first month's rent
- $g_{sal} = (1+10\%)^{12/14} - 1 = 8.51\%$ (approx.)
- $MARR_{monthly} = (1+2.45\%)^{1/12} - 1$
- $g_{rent} = (1 + 14\%)^{1/12} - 1$

**Write down your MIN and MAX values of your parameters in terms of % deviation from baseline** (the spreadsheet will perform this calculation for you).

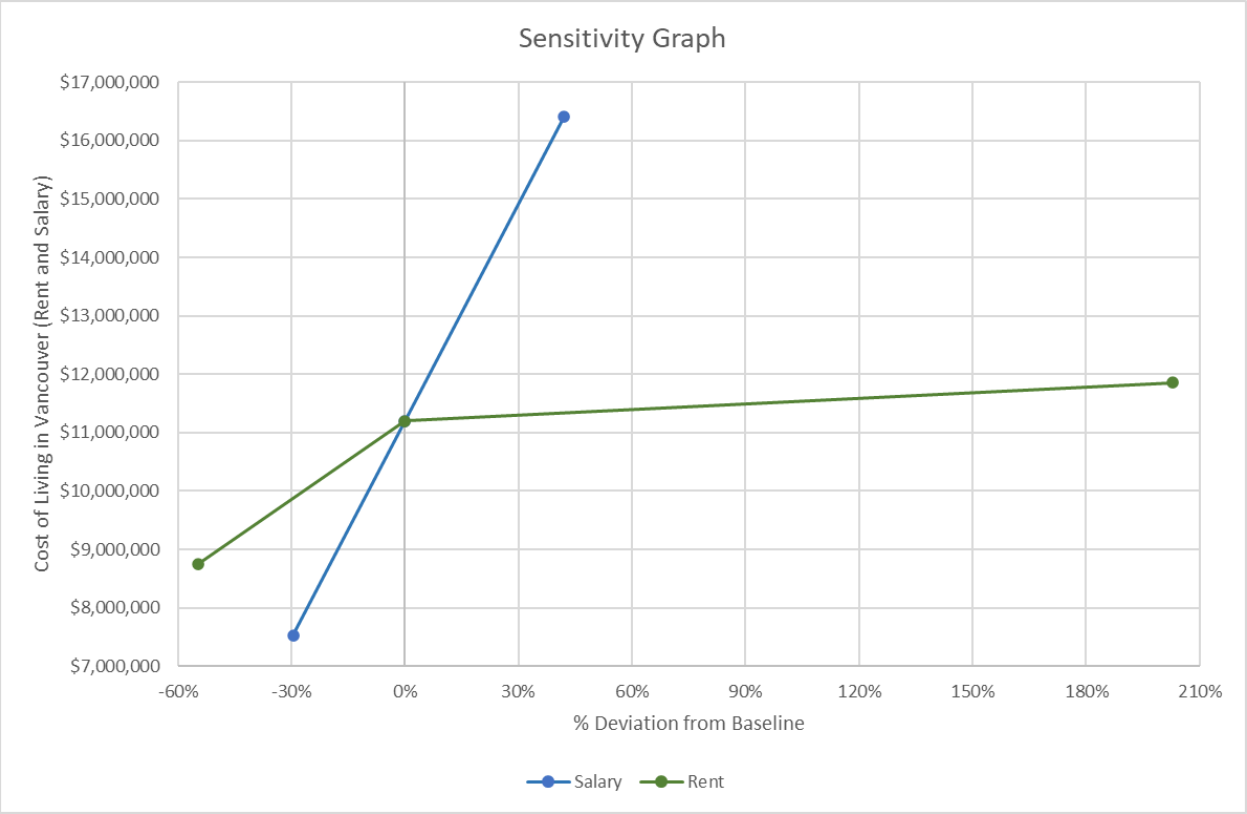
MIN AND MAX PARAMETER VALUES IN % DEVIATION FROM BASELINE

| | MIN | MAX |
|---|---|---|
| S | -29.55% | 42.05% |
| R | -54.55% | 202.73% |

TAs will be checking for the following:

- Axes are properly labeled
- Plots only extend over the allowed range.
- The entirety of each plot is visible (not zoomed in).
- X-axis units are % deviation from baseline.
- All plots cross at 0% deviation from baseline.
- The vertical endpoints of your plots correspond to the bar endpoints of your tornado diagram (since they should be showing the same thing: the value when all parameters except one are at their baseline levels, and that remaining parameter taxes on its MAX or MIN values).

**INSERT YOUR SPIDER DIAGRAM ABOUT HERE – PLEASE DO NOT JUST COPY AND PASTE FROM EXCEL, AS THAT MAY BREAK THE IMAGE! COPY FROM EXCEL AND 'PASTE SPECIAL', PREFERABLY AS PDF OR TIFF. IF YOU'RE NOT COMFORTABLE WITH EXCEL, IT'S FINE TO DO THIS BY HAND AND SUBMIT, e.g. A SCAN OR CELL PHONE PHOTO OF YOUR GRAPH.**




## 1.d Switching Values (Lecture 24)

i. Calculate the Switching Value for S in 1.c, assuming that R stays at its baseline level. (You're calculating how low the starting salary can be, and still have it be enough to cover rent, in present value terms.) Show your work.

Hint: This is probably easier than you think, as the present value equation in 1.c boils down to "PV = S x (A number) – R x (Another number)".

Switching value for S, assuming R is at its baseline level: _0.097361___

[Work]
(Present Value of Salary)*(Switching Value) - (Present Value of Rent)*1 = 0
(Switching Value) = (Present Value of Rent)/(Present Value of Salary)
(Switching Value) = 0.0973607849406415

ii. Calculate the Switching Value for R in 1.c, assuming that S stays at its baseline level. (You're calculating how high the rent can be, and still have it be affordable in present value terms, given Sam's salary.) Show your work.

Switching value for R, assuming S is at its baseline level: __10.27107578___-

[Work]

(Present Value of Rent)*(Switching Value) - (Present Value of Salary)*1 = 0

(Switching Value) = (Present Value of Salary)/(Present Value of Rent)

(Switching Value) = 10.27107578

## 1.e Decision Trees (Lecture 25)

In this question, you're asked to put together a decision tree based on information from

Wall, K., Zhao, J., Ferguson, S. & Rodriguez, C. (2018). Results from the 2016 Census: Is field of study a factor in the payoff of a graduate degree? [Web Page]. https://www150.statcan.gc.ca/n1/pub/75-006-x/2018001/article/54978-eng.htm

For this question, you don't have to worry about the time value of money, inflation or taxes. This is intended to be a simple question that tests your ability to create and interpret simple decision trees (and nothing else).

Alex is a non-binary student about to finish high school. They are considering an engineering degree (or two, or three). The *only* thing they are concerned about right now is their potential yearly income (they're ignoring tuition fees, etc.), and they've come up with the following:

- Right now, they need to **choose** whether to go for a bachelor's degree or get a job immediately after high school. If they get a job immediately, they will earn $70,336 a year (the median Canadian household income in the 2016 census).
- If Alex gets a bachelor's degree, they can **choose** to stop at a bachelor's degree or go on for a master's degree.
- If Alex stops at a bachelor's degree, there is a 47% **chance** they will work as an engineer and earn income of $105,200 per year. The other 53% of the time, they will *not* be able to work as an engineer, despite their degree, and will earn $70,336 a year.
- If Alex get's a master's degree, they can **choose** to stop at a master's degree or go on for a PhD.
- If Alex stops at a master's degree, there is a 51% **chance** they will work as an engineer and earn income of $105,100 per year[1]. The other 49% of the time, they will *not* be able to work as an engineer, despite their degree, and will earn $70,336 a year.
- If Alex gets a PhD, there is a 37% **chance** they work as an engineer, earning $108,500 per year, a 25% chance they work as a professor, earning $127,700 per year, and a 38% chance they will not work as either an engineer or a professor, and will earn $70,336 a year.

[1] Yes, this is slightly lower than the $150,200 earned by someone with a bachelor's degree. That's true to the original source (Statistics Canada).

i. Draw a decision tree representing the situation facing Alex. There should be three square 'choice' nodes, three round 'chance' nodes, and eight terminal nodes representing all possible outcomes. (Hint: the choice node at the very left of the tree should be 'Stop at High School or get a Bachelor's Degree?')

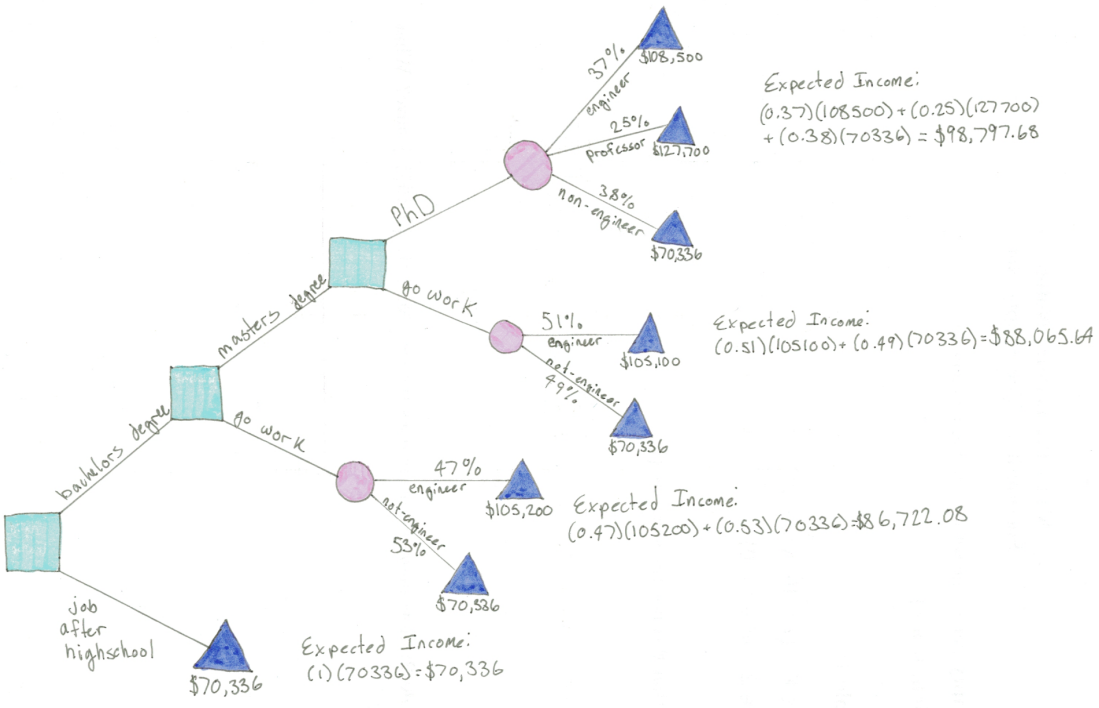
**[Insert Decision Tree Here – a phone photo of a freehand drawing is fine, or you could use a drawing program, Powerpoint, etc. and paste the resulting image as a GIF, JPG, PNG, etc.]**

ii. Assume Alex is risk neutral (makes decisions based on mathematical expected value), and when having to make a choice, will choose a higher expected income over a lower expected income. Use your decision to calculate Alex's expected income. Show your work.

Expected Income: ___$98,797.68_____ a year

[Show your work]

As shown in the decision tree, the expected value of income increases with each level of education, starting at $70,336 per year for getting a job right out of highschool, to $98,797.68 per year if getting a PhD.



# Question 2: Monte Carlo Challenge Question (Lecture 27)

For this question, **run 10 (ten) trials of a Monte Carlo simulation of the present value of living and working in Vancouver, using min/baseline/maximum information from Project 1. If you are doing this by hand, instead of with Excel, you may run 5 (five) trials, instead.** The TAs will be making sure your curve looks like it should, and is properly labeled. You are also asked to post your 'headers' and first five trials (there's a sample answer in what follows).

**The relevant equation is the same as before.** This present value is represented by the following equation:

$S \times (P/A,g_{sal},2.45\%,40) \times (P/A,2.45\%,2) - R \times (P/A,g_{rent},MARR_{monthly}, 480) \times (P/F,MARR_{monthly},35)$

- S = initial yearly salary
- R = first month's rent
- $g_{sal} = (1+10\%)^{12/14} - 1 = 8.51\%$ (approx.)
- $MARR_{monthly} = (1+2.45\%)^{1/12} - 1$
- $g_{rent} = (1 + 14\%)^{1/12} - 1$

**The Companion Spreadsheet includes an implementation of the present value calculation.**

i. (2 marks) To generate your random numbers, you may wish to use the Excel sheet provided for that purpose (random.xls) in the manner discussed in the 'Probabilistic Sensitivity Analysis in Excel' optional lecture. For each of your variables, choose either a triangle, uniform or normal distribution, and briefly explain why you chose it. If you find the triangle distribution confusing, it's fine to restrict yourself to choosing between a normal or uniform distribution.

| Variable | Distribution | Reason |
|---|---|---|
| S | Triangle | Salaries are not distributed uniformly, as there are considerably more Salaries distributed around $88,000. However, the distribution is not even around the mean with the higher salaries being more extreme and spread out, and is therefore a Triangle Distribution. |
| R | Triangle | Rents are not distributed uniformly, as there are considerably more rents distributed around $3300. However, the distribution is not even around the mean with the higher rents being more spread out, and is therefore a Triangle Distribution. |

Any distribution choice is fine, as long as the reason is logical. Triangle: values near baseline most likely, but distribution is lopsided. Normal: Values near baseline are more likely, distribution is symmetric and baseline is near the middle of the [MIN,MAX] range. Uniform: Any number between MIN and MAX equally likely.

ii. (4 marks) Also, provide the median, mean, minimum, maximum and 80% confidence interval (or 60% confidence interval if doing this by hand).

| PV Vancouver Salary (10 trials, or 5 trials if by hand) | |
|---|---|
| MEAN | $85677.95 |
| MEDIAN | $86267.25 |
| MIN | $64954.63 |
| MAX | $106929.69 |
| 80% CONF (60% if by hand) | $74674.47 |
| | $100071.86 |

iii. (4 marks) Create a Cost Acceptability Curve for your data.

**[INSERT YOUR COST ACCEPTABILITY CURVE ABOUT HERE – PLEASE DO NOT JUST COPY AND PASTE FROM EXCEL, AS THAT MAY BREAK THE IMAGE! COPY FROM EXCEL AND 'PASTE SPECIAL', PREFERABLY AS PDF, GIF, PNG, JPG OR TIFF. IT'S ALSO FINE TO DRAW IT BY HAND AND INCLUDE (FOR EXAMPLE) A CELL PHONE PHOTO.]**

# Question 3: Taxes

## 3. a Marginal vs. Average Tax Rates (Lecture 30)

The following are the income tax rates and brackets[2] for B.C. in 2021:

| Taxable Income – 2021 Brackets | Tax Rate |
|---|---|
| $0 to $42,184 | 5.06% |
| $42,184.01 to $84,369 | 7.70% |
| $84,369.01 to $96,866 | 10.50% |
| $96,866.01 to $117,623 | 12.29% |
| $117,623.01 to $159,483 | 14.70% |
| $159,483.01 to $222,420 | 16.80% |
| Over $222,420 | 20.5% |

Suppose Sam's taxable income is equal to the baseline income for Vancouver from Project 1, and that Sam only pays B.C. taxes as shown above.

What is Sam's marginal tax rate? Briefly explain your reasoning.

Marginal tax rate: ____10.50_____ %

[Reasoning]

If Sam earns the baseline income for Vancouver, they are earning $88,000 per year. This lands them into the 10.50% range for their marginal income.

What is Sam's average tax rate? Briefly explain your reasoning.

Average tax rate: __6.55_____ %

[Reasoning]

$42,184 x 5.06% = $2134.51
$42,184.99 x 7.70% = $3248.24
$3,630.99 x 10.50% = $381.25
Total = $2134.51 + $3248.24 + $381.25 = $5,764.00
$5,764.00/$88,000.00 = 6.55%

How much is a $1,000 tax deduction worth to Sam? Briefly explain your reasoning.

Worth of a $1,000 tax deduction: ____$105.00_____

[Reasoning]

[2] Source: https://www2.gov.bc.ca/gov/content/taxes/income-taxes/personal/tax-rates

($3,630.99-$1,000) x 10.50% = $276.25

$381.25 - $276.25 = $105.00

The actual worth of a $1000 tax deduction if Sam is earning $88,000 per year is the difference between being taxed for the full $88,000 amount and being taxed $87,000. Bth amounts are still in the 10.50% range and therefore only those values need to be calculated to compare, as the 5.06% and 7.70% ranges will be the same amount for both taxable incomes.

How much is a $1,000 refundable tax credit worth to Sam? Briefly explain your reasoning.

Worth of a $1,000 refundable tax credit: __$1000_____

[Reasoning]

A refundable tax credit will reduce the amount Sam has to pay in taxes by $1000 and if their taxes are lower than $1000 (say they have to pay $500 only) they will get the remainder paid back to them by the CRA. This means that a refundable tax credit is always worth exactly its dollar amount.

An example might be if Sam owed $700 in taxes and got a $1000 refundable tax credit, they would have to pay $0 in taxes, and would be paid $300 by the CRA.

## 3.b Bonus Question (Lecture 30)

**This bonus question is worth only 2 marks**.

Suppose that in the absence of taxes, Sam's salary works like in Question 1: the present value of Sam's salary is

$S \times (P/A, g_{sal}, 2.45\%, 40) \times (P/A, 2.45\%, 2)$

- S = initial yearly salary
- $g_{sal} = (1+10\%)^{12/14} - 1 = 8.51\%$ (approx.)
- $MARR_{monthly} = (1+2.45\%)^{1/12} - 1$

Calculate the present value of Sam's salary *after paying B.C. taxes*. Assume the tax brackets and tax rates from 3.a are the same each and every year, and show your work.

(You may find it helpful to draw a diagram. This question shouldn't be *hard*, mechanically, but it can be a bit finicky to keep track of all the tax brackets, which is why this is a bonus question – given the time pressure on this project, I didn't think it was right to expect every student in the class to spend so much time on a question. Still, I think that at least some of you will find this interesting and/or fun.)

Present Value of Salary after B.C. taxes: _____

[Show your work]

## 3.c Complete Tax Calculation (Lectures 30 and 31)

FYI: This question is based on the 'drilling machine' question from Project 2.

Suppose your firm buys a drilling machine in Month 0, and sells it in Month 102. Perform a complete tax calculation and find the after-tax present value of buying, using and selling the asset, given the following information:

- There is no inflation.
- Your firm's before-tax MARR is 10% per year.
- The relevant tax rate is t = 27% (15% federal + 12% B.C.)
- It is appropriate to use the usual rule of thumb to calculate the after-tax MARR.
- The machine costs $6,000 in Month 0
- The machine provides income of $500 per month from Month 1 to Month 102, inclusive (102 months, first income payment is Month 1).
- Your firm gets $100.92 scrap value from the machine in Month 102.
- This drilling machine counts as a Class 8 good, so the CRA-mandated depreciation rate for tax purposes is d=20% per year.

What is the after-tax net present value of this machine? Show your work. (Hint: You'll need to use CTF and CSF).

After-Tax Net Present Value: _____$165,530.72_____

[Work]

Done in a spreadsheet, small font due to 103 lines of data. Final value is the summation of the final column

| Month | Purchases | Dispositions | Income | Total | Base UCC for CCA | CCA | Remaining UCC | Taxable Amount | After Tax |
|---|---|---|---|---|---|---|---|---|---|
| 0 | $6,000 | $0 | $0 | -$6,000 | $3,000 | $600 | -$6,600 | -$6,600.00 | -$6,471.66 |
| 1 | $0 | $0 | $500 | $500 | -$7,100 | -$1,420 | -$4,680 | -$4,642.98 | -$4,642.98 |
| 2 | $0 | $0 | $500 | $500 | -$5,180 | -$1,036 | -$3,144 | -$3,094.45 | -$3,094.45 |
| 3 | $0 | $0 | $500 | $500 | -$3,644 | -$729 | -$1,915 | -$1,870.10 | -$1,870.10 |
| 4 | $0 | $0 | $500 | $500 | -$2,415 | -$483 | -$932 | -$903.01 | -$903.01 |
| 5 | $0 | $0 | $500 | $500 | -$1,432 | -$286 | -$146 | -$140.05 | -$140.05 |
| 6 | $0 | $0 | $500 | $500 | -$646 | -$129 | $483 | $460.92 | $460.92 |
| 7 | $0 | $0 | $500 | $500 | -$17 | -$3 | $987 | $933.37 | $933.37 |
| 8 | $0 | $0 | $500 | $500 | $487 | $97 | $1,389 | $1,303.85 | $1,303.85 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 9 | $0 | $0 | $500 | $500 | $889 | $178 | $1,712 | $1,593.44 | $1,593.44 |
| 10 | $0 | $0 | $500 | $500 | $1,212 | $242 | $1,969 | $1,818.85 | $1,818.85 |
| 11 | $0 | $0 | $500 | $500 | $1,469 | $294 | $2,175 | $1,993.38 | $1,993.38 |
| 12 | $0 | $0 | $500 | $500 | $1,675 | $335 | $2,340 | $2,127.54 | $2,127.54 |
| 13 | $0 | $0 | $500 | $500 | $1,840 | $368 | $2,472 | $2,229.71 | $2,229.71 |
| 14 | $0 | $0 | $500 | $500 | $1,972 | $394 | $2,578 | $2,306.51 | $2,306.51 |
| 15 | $0 | $0 | $500 | $500 | $2,078 | $416 | $2,662 | $2,363.22 | $2,363.22 |
| 16 | $0 | $0 | $500 | $500 | $2,162 | $432 | $2,730 | $2,404.02 | $2,404.02 |
| 17 | $0 | $0 | $500 | $500 | $2,230 | $446 | $2,784 | $2,432.22 | $2,432.22 |
| 18 | $0 | $0 | $500 | $500 | $2,284 | $457 | $2,827 | $2,450.45 | $2,450.45 |
| 19 | $0 | $0 | $500 | $500 | $2,327 | $465 | $2,862 | $2,460.81 | $2,460.81 |
| 20 | $0 | $0 | $500 | $500 | $2,362 | $472 | $2,889 | $2,464.95 | $2,464.95 |
| 21 | $0 | $0 | $500 | $500 | $2,389 | $478 | $2,911 | $2,464.18 | $2,464.18 |
| 22 | $0 | $0 | $500 | $500 | $2,411 | $482 | $2,929 | $2,459.56 | $2,459.56 |
| 23 | $0 | $0 | $500 | $500 | $2,429 | $486 | $2,943 | $2,451.90 | $2,451.90 |
| 24 | $0 | $0 | $500 | $500 | $2,443 | $489 | $2,955 | $2,441.87 | $2,441.87 |
| 25 | $0 | $0 | $500 | $500 | $2,455 | $491 | $2,964 | $2,429.99 | $2,429.99 |
| 26 | $0 | $0 | $500 | $500 | $2,464 | $493 | $2,971 | $2,416.66 | $2,416.66 |
| 27 | $0 | $0 | $500 | $500 | $2,471 | $494 | $2,977 | $2,402.23 | $2,402.23 |
| 28 | $0 | $0 | $500 | $500 | $2,477 | $495 | $2,981 | $2,386.94 | $2,386.94 |
| 29 | $0 | $0 | $500 | $500 | $2,481 | $496 | $2,985 | $2,371.01 | $2,371.01 |
| 30 | $0 | $0 | $500 | $500 | $2,485 | $497 | $2,988 | $2,354.59 | $2,354.59 |
| 31 | $0 | $0 | $500 | $500 | $2,488 | $498 | $2,990 | $2,337.82 | $2,337.82 |
| 32 | $0 | $0 | $500 | $500 | $2,490 | $498 | $2,992 | $2,320.80 | $2,320.80 |
| 33 | $0 | $0 | $500 | $500 | $2,492 | $498 | $2,994 | $2,303.61 | $2,303.61 |
| 34 | $0 | $0 | $500 | $500 | $2,494 | $499 | $2,995 | $2,286.32 | $2,286.32 |
| 35 | $0 | $0 | $500 | $500 | $2,495 | $499 | $2,996 | $2,268.97 | $2,268.97 |
| 36 | $0 | $0 | $500 | $500 | $2,496 | $499 | $2,997 | $2,251.60 | $2,251.60 |
| 37 | $0 | $0 | $500 | $500 | $2,497 | $499 | $2,998 | $2,234.26 | $2,234.26 |
| 38 | $0 | $0 | $500 | $500 | $2,498 | $500 | $2,998 | $2,216.95 | $2,216.95 |
| 39 | $0 | $0 | $500 | $500 | $2,498 | $500 | $2,998 | $2,199.70 | $2,199.70 |
| 40 | $0 | $0 | $500 | $500 | $2,498 | $500 | $2,999 | $2,182.53 | $2,182.53 |
| 41 | $0 | $0 | $500 | $500 | $2,499 | $500 | $2,999 | $2,165.45 | $2,165.45 |
| 42 | $0 | $0 | $500 | $500 | $2,499 | $500 | $2,999 | $2,148.47 | $2,148.47 |
| 43 | $0 | $0 | $500 | $500 | $2,499 | $500 | $2,999 | $2,131.59 | $2,131.59 |
| 44 | $0 | $0 | $500 | $500 | $2,499 | $500 | $2,999 | $2,114.82 | $2,114.82 |
| 45 | $0 | $0 | $500 | $500 | $2,499 | $500 | $3,000 | $2,098.16 | $2,098.16 |
| 46 | $0 | $0 | $500 | $500 | $2,500 | $500 | $3,000 | $2,081.62 | $2,081.62 |
| 47 | $0 | $0 | $500 | $500 | $2,500 | $500 | $3,000 | $2,065.20 | $2,065.20 |
| 48 | $0 | $0 | $500 | $500 | $2,500 | $500 | $3,000 | $2,048.89 | $2,048.89 |
| 49 | $0 | $0 | $500 | $500 | $2,500 | $500 | $3,000 | $2,032.71 | $2,032.71 |
| 50 | $0 | $0 | $500 | $500 | $2,500 | $500 | $3,000 | $2,016.66 | $2,016.66 |
| 51 | $0 | $0 | $500 | $500 | $2,500 | $500 | $3,000 | $2,000.72 | $2,000.72 |
| 52 | $0 | $0 | $500 | $500 | $2,500 | $500 | $3,000 | $1,984.91 | $1,984.91 |
| 53 | $0 | $0 | $500 | $500 | $2,500 | $500 | $3,000 | $1,969.22 | $1,969.22 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 54 | $0 | $0 | $500 | $500 | $2,500 | $500 | $3,000 | $1,953.65 | $1,953.65 |
| 55 | $0 | $0 | $500 | $500 | $2,500 | $500 | $3,000 | $1,938.20 | $1,938.20 |
| 56 | $0 | $0 | $500 | $500 | $2,500 | $500 | $3,000 | $1,922.87 | $1,922.87 |
| 57 | $0 | $0 | $500 | $500 | $2,500 | $500 | $3,000 | $1,907.66 | $1,907.66 |
| 58 | $0 | $0 | $500 | $500 | $2,500 | $500 | $3,000 | $1,892.58 | $1,892.58 |
| 59 | $0 | $0 | $500 | $500 | $2,500 | $500 | $3,000 | $1,877.61 | $1,877.61 |
| 60 | $0 | $0 | $500 | $500 | $2,500 | $500 | $3,000 | $1,862.75 | $1,862.75 |
| 61 | $0 | $0 | $500 | $500 | $2,500 | $500 | $3,000 | $1,848.02 | $1,848.02 |
| 62 | $0 | $0 | $500 | $500 | $2,500 | $500 | $3,000 | $1,833.40 | $1,833.40 |
| 63 | $0 | $0 | $500 | $500 | $2,500 | $500 | $3,000 | $1,818.90 | $1,818.90 |
| 64 | $0 | $0 | $500 | $500 | $2,500 | $500 | $3,000 | $1,804.51 | $1,804.51 |
| 65 | $0 | $0 | $500 | $500 | $2,500 | $500 | $3,000 | $1,790.24 | $1,790.24 |
| 66 | $0 | $0 | $500 | $500 | $2,500 | $500 | $3,000 | $1,776.07 | $1,776.07 |
| 67 | $0 | $0 | $500 | $500 | $2,500 | $500 | $3,000 | $1,762.02 | $1,762.02 |
| 68 | $0 | $0 | $500 | $500 | $2,500 | $500 | $3,000 | $1,748.08 | $1,748.08 |
| 69 | $0 | $0 | $500 | $500 | $2,500 | $500 | $3,000 | $1,734.26 | $1,734.26 |
| 70 | $0 | $0 | $500 | $500 | $2,500 | $500 | $3,000 | $1,720.54 | $1,720.54 |
| 71 | $0 | $0 | $500 | $500 | $2,500 | $500 | $3,000 | $1,706.92 | $1,706.92 |
| 72 | $0 | $0 | $500 | $500 | $2,500 | $500 | $3,000 | $1,693.42 | $1,693.42 |
| 73 | $0 | $0 | $500 | $500 | $2,500 | $500 | $3,000 | $1,680.02 | $1,680.02 |
| 74 | $0 | $0 | $500 | $500 | $2,500 | $500 | $3,000 | $1,666.73 | $1,666.73 |
| 75 | $0 | $0 | $500 | $500 | $2,500 | $500 | $3,000 | $1,653.55 | $1,653.55 |
| 76 | $0 | $0 | $500 | $500 | $2,500 | $500 | $3,000 | $1,640.47 | $1,640.47 |
| 77 | $0 | $0 | $500 | $500 | $2,500 | $500 | $3,000 | $1,627.49 | $1,627.49 |
| 78 | $0 | $0 | $500 | $500 | $2,500 | $500 | $3,000 | $1,614.61 | $1,614.61 |
| 79 | $0 | $0 | $500 | $500 | $2,500 | $500 | $3,000 | $1,601.84 | $1,601.84 |
| 80 | $0 | $0 | $500 | $500 | $2,500 | $500 | $3,000 | $1,589.17 | $1,589.17 |
| 81 | $0 | $0 | $500 | $500 | $2,500 | $500 | $3,000 | $1,576.60 | $1,576.60 |
| 82 | $0 | $0 | $500 | $500 | $2,500 | $500 | $3,000 | $1,564.12 | $1,564.12 |
| 83 | $0 | $0 | $500 | $500 | $2,500 | $500 | $3,000 | $1,551.75 | $1,551.75 |
| 84 | $0 | $0 | $500 | $500 | $2,500 | $500 | $3,000 | $1,539.47 | $1,539.47 |
| 85 | $0 | $0 | $500 | $500 | $2,500 | $500 | $3,000 | $1,527.30 | $1,527.30 |
| 86 | $0 | $0 | $500 | $500 | $2,500 | $500 | $3,000 | $1,515.21 | $1,515.21 |
| 87 | $0 | $0 | $500 | $500 | $2,500 | $500 | $3,000 | $1,503.23 | $1,503.23 |
| 88 | $0 | $0 | $500 | $500 | $2,500 | $500 | $3,000 | $1,491.33 | $1,491.33 |
| 89 | $0 | $0 | $500 | $500 | $2,500 | $500 | $3,000 | $1,479.54 | $1,479.54 |
| 90 | $0 | $0 | $500 | $500 | $2,500 | $500 | $3,000 | $1,467.83 | $1,467.83 |
| 91 | $0 | $0 | $500 | $500 | $2,500 | $500 | $3,000 | $1,456.22 | $1,456.22 |
| 92 | $0 | $0 | $500 | $500 | $2,500 | $500 | $3,000 | $1,444.70 | $1,444.70 |
| 93 | $0 | $0 | $500 | $500 | $2,500 | $500 | $3,000 | $1,433.27 | $1,433.27 |
| 94 | $0 | $0 | $500 | $500 | $2,500 | $500 | $3,000 | $1,421.93 | $1,421.93 |
| 95 | $0 | $0 | $500 | $500 | $2,500 | $500 | $3,000 | $1,410.68 | $1,410.68 |
| 96 | $0 | $0 | $500 | $500 | $2,500 | $500 | $3,000 | $1,399.52 | $1,399.52 |
| 97 | $0 | $0 | $500 | $500 | $2,500 | $500 | $3,000 | $1,388.45 | $1,388.45 |
| 98 | $0 | $0 | $500 | $500 | $2,500 | $500 | $3,000 | $1,377.47 | $1,377.47 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 99 | $0 | $0 | $500 | $500 | $2,500 | $500 | $3,000 | $1,366.57 | $1,366.57 |
| 100 | $0 | $0 | $500 | $500 | $2,500 | $500 | $3,000 | $1,355.76 | $1,355.76 |
| 101 | $0 | $0 | $500 | $500 | $2,500 | $500 | $3,000 | $1,345.03 | $1,345.03 |
| 102 | $0 | $100.92 | $500 | $600.92 | $2,399 | $480 | $3,121 | $1,388.26 | $1,388.26 |

## 3.d Capital Cost Allowance (Lecture 31)

Consider the following sequence of events:

- The relevant tax rate for your firm is t = 27%.
- Your firm buys a drilling machine for $6,000 in 2021. At the time of purchase, this is your firm's first and only Class 8 asset. The CRA-determined depreciation rate for Class 8 assets is 20% per year.
- In 2029, your firm sells the drilling machine for $100.92, and buys a new one for $6,000.
- In 2038, your firm sells the drilling machine for $100.92. In doing so, it has sold its last Class 8 asset.
- Your firm always claims the maximum CCA each year (as in the lecture examples).

i. Calculate the firm's Class 8 remaining UCC after the sale in 2038.

Remaining UCC: ____$856_____

[Work]

| Year | Purchases | Dispositions | Base UCC for CCA | CCA | Remaining UCC |
|---|---|---|---|---|---|
| 2021 | $6,000 | $0 | $3,000 | $300 | $5,700 |
| 2022 | $0 | $0 | $5,700 | 1140 | $4,560 |
| 2023 | $0 | $0 | $4,560 | 912 | $3,648 |
| 2024 | $0 | $0 | $3,648 | 729.6 | $2,918 |
| 2025 | $0 | $0 | $2,918 | 583.68 | $2,335 |
| 2026 | $0 | $0 | $2,335 | 466.944 | $1,868 |
| 2027 | $0 | $0 | $1,868 | 373.5552 | $1,494 |
| 2028 | $0 | $0 | $1,494 | 298.84416 | $1,195 |
| 2029 | $6,000 | $100.92 | $4,094.46 | 218.891328 | $6,976 |
| 2030 | $0 | $0 | $6,976 | 1395.297062 | $5,581 |
| 2031 | $0 | $0 | $5,581 | 1116.23765 | $4,465 |
| 2032 | $0 | $0 | $4,465 | 892.9901199 | $3,572 |
| 2033 | $0 | $0 | $3,572 | 714.3920959 | $2,858 |
| 2034 | $0 | $0 | $2,858 | 571.5136768 | $2,286 |
| 2035 | $0 | $0 | $2,286 | 457.2109414 | $1,829 |
| 2036 | $0 | $0 | $1,829 | 365.7687531 | $1,463 |
| 2037 | $0 | $0 | $1,463 | 292.6150025 | $1,170 |
| 2038 | $0 | $100.92 | $1,070 | 213.908002 | $856 |

ii. Since your firm is 'closing out' its Class 8 account in 2038, any remaining non-zero UCC is either a terminal loss or a recapture.

In 2038, will your firm face a terminal loss, recapture, or neither from Class 8?

(Terminal Loss/Recapture/Neither) __Terminal Loss_____

[Briefly explain your reasoning]

Since the final UCC is higher than the final disposition, there is money left over to be owed to the government through taxes.

iii. Assume the relevant tax rate is t=27%, and your firm's taxable income is over $900,000[3]. By how much will this terminal loss or recapture increase or decrease the taxes your firm has to pay in 2038? Briefly explain your reasoning.

(Hint: This is not a trick question. Given your answers to parts i. and ii. and the information given, it should be very straightforward.)

Change in tax bill for the 2038 tax year: ___$231.12_____

[Briefly explain your reasoning]

$856*27% = $231.12

Since there is a terminal loss of $856, the firm will have to add $856 to their taxable amount, which increases taxes by $231.12, assuming a 27% tax rate.

[3] This assumption is just so that you don't have to worry about whether a large enough tax deduction (if there is one) would send the firm's taxable income below zero.

## 3.e Bonus Question (Lecture 31)

Based *only* on your answers to part d., is the CRA's depreciation for Class 8 assets greater than or less than the rate at which the drilling machine's value depreciated?

(Hint: Suppose that the resale value of the machine fell by 20% per year – exactly the same rate as the CRA's depreciation rate for Class 8 assets. How would that change your answer to part 3.d.i? You don't necessarily need to re-calculate everything to work this out – you may be able to reason your way through it – but there's a reason this is a low-stakes bonus question. For further insight, consider reading Dr. Tedds' 2015 blog post on the CCA[4], or skimming the 1989 paper[5] on tractor depreciation in Saskatchewan.)

Based only on CCA and terminal loss/recapture information, is the CRA depreciation rate greater or lower than the depreciation rate of the drilling machine's resale value?

___Greater_____

[Briefly explain your reasoning]

The firm sells the last Class 8 asset for only $100.92, which is less than the final amount in the class, $856. This is a terminal loss, and means that the resale value fell faster than the CCA. Assuming the machine fell at the same rate as the CCA (20%), The final value, in 2038, would be over $700. This is more than the final resale value, confirming that the machine fell at a faster rate than the CCA.

[4] Tedds, L. (2015, February 13). Tax Policy that no one will listen to: CCA systems is overly complex and not a political tool [Blog Post]. https://deadfortaxreasons.wordpress.com/2015/02/13/tax-policy-that-no-one-will-listen-to-cca-systems-is-overly-complex-and-not-a-political-tool/

[5] Schoney, R. A. & Rinholm, R. A. (1989). Capital Cost Allowance and Tax Neutrality: A Case Study of Saskatchewan Farmers' Claims Versus Actual Depreciation. Canadian Journal of Agricultural Economics, 37, 47-62. https://doi-org.ezproxy.library.uvic.ca/10.1111/j.1744-7976.1989.tb03335.x