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GLOBAL FINANCIAL LITERACY
EXCELLENCE CENTER

Case Study

Lecture 13.1

Case introduction

Alice and Jacob are newlyweds and will be faced with many financial decisions throughout their lifetime. The following list of facts will be used throughout this lecture to help evaluate the decisions they will make.

- Both Alice and Jacob are 25 years old.

- They currently rent a one-bedroom apartment for $900 per month (including renter's insurance).

- Jacob works in construction and Alice works as a bank teller, but hopes to someday move up to a management position.

- They make $70,000 combined, and file their taxes jointly.

- Their salaries increase with inflation, which is initially assumed to be nonexistent.

- They plan to set aside about 5% of their after-tax income each year for retirement, but do not do so in a tax-advantaged account.

- They have $4,000 in credit card debt, but no other debt.

Case introduction

We evaluate the couple's financial situation by considering the following questions:

- How much must the couple pay each year in taxes?
- What is the effect switching to a tax-advantaged retirement account?
- How can they pay off their credit card debt and what is the effect of doing so?
- How much should they be saving for retirement?
- Should Alice get an MBA?
- Which house can the couple afford?
- If interest rates fall after they purchase their home, should the couple refinance their mortgage?

Income Taxes

Income taxes

Although it's easy to see that their combined salaries amount to $70,000, Alice and Jacob must know their after-tax income to budget properly.

Ex. Alice and Jacob, who are married and filing jointly, make $70,000 and are subject to the following federal tax-rate schedule:

Income	Marginal Tax Rate
from $0 to $18,150	10%
over $18,150 to $73,800	15%
over $73,801 to $148,850	25%
over $148,851	28%

They can take two personal exemptions, each worth $3,950. The standard deduction is $12,400 and they have itemizable deductions of $2,000. Calculate their federal taxes and effective federal tax rate.

Income taxes

Income	Marginal Tax Rate
from $0 to $18,150	10%
over $18,150 to $73,800	15%
over $73,801 to $148,850	25%
over $148,851	28%

Ans. Because the standard deduction is greater than their itemizable deductions, Alice and Jacob should take the standard deduction. Considering this and their two personal exemptions, their taxable income is:

$$Taxable\ Income = \$70,000 - \$12,400 - 2 * \$3,950 = \$49,700$$

Their federal income taxes are therefore:

$$Federal\ Income\ Taxes = 0.10 * \$18,150 + 0.15 * (\$49,700 - \$18,150)$$
$$= \$6,547.50$$

Income taxes

Ans. (continued)

$6,547.50 in federal taxes on $70,000 in gross income implies a 9.35% effective federal income tax rate:

$$Effective\ Federal\ Income\ Tax\ Rate = \frac{\$6,547.50}{\$70,000} = 9.35\%$$

Though we won't walk through the details here, we can similarly calculate that Alice and Jacob must pay $2,308.25 in state income taxes. They must also pay $5,355 in payroll taxes (Social Security and Medicare). Therefore, their after-tax income is:

$$\$70,000 - \$6,547.50 - \$2,308.25 - \$5,355 = \$55,789$$

Tax-advantaged Investing

Tax-advantaged investing

By not putting their retirement savings in a tax-advantaged account, Alice and Jacob are leaving money on the table. This next example shows how much.

Ex. Alice and Jacob plan to retire in another 40 years (at age 65). They are setting aside $2,500 per year, which is a little less than 5% of their after-tax income. Compare how much retirement wealth the couple will have if they invest in a Roth IRA compared to a regular investment account. Compare the withdrawals such wealth can sustain for 25 years of retirement.

Assume that the couple earns a 7% return on their investments while saving for retirement and, after moving into less risky investments, a 3% return during retirement. Assume no inflation. Assume the couple must pay a 15% accrual short-term capital gains tax on their non-tax-advantaged account.

Income taxes

Ans. First, we start with the tax-advantaged Roth IRA account because the calculations are simpler. With the Roth IRA, the contributions are made using after-tax dollars, but are not subject to any taxes thereafter.

During the savings phase, the returns are not taxed, so the couple realizes the full 7% return. After 40 years, the $2,500 contributions will grow to $499,088.

Time Value of Money	
P/Y	1
PMT	-$2,500
N	40
PV	$0
I/Y	7%
FV=	$499,088

Time Value of Money	
P/Y	1
PV	-$499,088
N	25
FV	$0
I/Y	3%
PMT=	$28,662

And in retirement, the couple may withdraw $28,662 per year for 25 years.

Income taxes

Ans. (continued)

Outside of the Roth IRA, the returns are subject to taxation. In the worst-case scenario where Alice and Jacob trade frequently, they will be subject to an accrual tax on their short-term capital gains each year. Short-term capital gains are taxed as income, so are taxed at the couple's highest marginal tax rate of 15%. This means the returns fall from 7% (during the savings phase) and 3% (during retirement) to:

$$7\% * (1 - 15\%) = 5.95\%$$

$$3\% * (1 - 15\%) = 2.55\%$$

Income taxes

Ans. (continued)

These after-tax returns can be used to calculate the couple's retirement wealth and withdrawals in this worst-case scenario. Under such conditions, the couple will save $382,077 by retirement and be able to sustain withdrawals of $20,856 per year for 25 years:

Time Value of Money	
P/Y	1
PMT	-$2,500
N	40
PV	$0
I/Y	5.95%
FV=	$382,077

Time Value of Money	
P/Y	1
PV	-$382,077
N	25
FV	$0
I/Y	2.55%
PMT=	$20,856

Thus, the simple decision to invest in a tax-advantaged account may be worth more than $100,000 in retirement wealth and about $8,000 in retirement income!

Tax-advantaged investing

Armed with this information about the advantages of the Roth IRA account, Alice and Jacob open one.

Combined with about $30,000 in expected annual Social Security benefits, they can expect to achieve a total retirement income of about $58,000 per year, which will allow them to maintain their current standard of living.

Credit Card Debt

Credit card debt

Though credit cards can help a family smooth out cash flows, continually maintaining a balance can be expensive.

Ex 1. Alice and Jacob currently have a $4,000 balance on their credit card with a 15% APR. This may fluctuate over time, but the expense of a dependency on credit card debt can be estimated by assuming that their average balance remains the same over their lifetime.

If Alice and Jacob maintain an average $4,000 balance until retiring in 40 years, how much will they ultimately pay in finance charges?

Ans 1. The monthly finance charge will be $\frac{0.15}{12} * \$4,000 = \$50$. Over 40 years these fees will amount to:

$$40 * 12 * \$50 = \$24,000$$

Credit card debt

Ex 2. After realizing that credit card debt will cost them so much in the long run, Alice and Jacob resolve to pay off their debt. They don't have the funds to do so immediately, so plan to pay off their debt in small monthly payments over three years. Calculate the monthly payments Alice and Jacob must make to pay off their credit card in three years.

Ans 2. These payments may be found using a financial calculator:

Time Value of Money	
P/Y	12
PV	$4,000
N	36
FV	$0
I/Y	15%
PMT=	$138.66

Credit card debt

Ex 3. Though Alice and Jacob must reduce their consumption by about $12 *$ $\$139 = \$1,664$ per year to pay off their credit card debt, they will save themselves $\$12 * 50 = \$600$ per year in finance charges, allowing them to increase their consumption for many years thereafter. And if they decide to invest the saved $600 in their retirement account, they can dramatically increase their retirement income. Calculate the increase in the couple's expected retirement income from investing the $600 in saved finance charges. Use the same assumptions that were used previously.

Ans 3. After paying off their credit card in three years, Alice and Jacob will be 28 years old. They will then retire in 37 years. Paying off their credit card and investing the $600 per year could increase their income by $5,525 during retirement!

Time Value of Money	
P/Y	1
PMT	-$600
N	37
PV	$0
I/Y	7%
FV=	$96,202

Time Value of Money	
P/Y	1
PV	-$96,202
N	25
FV	$0
I/Y	3%
PMT=	$5,525

Retirement Planning

Retirement planning

Alice and Jacob only set aside $2,500 per year because it is a nice, round number. To better ensure that they are able to enjoy a financially sound retirement, they should calculate the contribution needed to maintain a certain standard of living.

Ex. Alice and Jacob, who are now 28 years old, hope to retire at age 65 and would like to maintain an annual income of $60,000 (in real terms) for 30 years (enough to last them until age 95). They currently have an $8,000 retirement account balance. They expect to earn a 9% nominal return on their investments while saving for retirement and a 5% nominal return thereafter. They expect the inflation will average 2% during their lifetime and that they will collect $30,000 (in today's dollars) in annual Social Security payments during retirement.

Calculate how much Alice and Jacob must contribute to their retirement account each year.

Retirement planning

Ans.

With 2% inflation, Alice and Jacob can expect to earn a 7% real return on their investments while saving for retirement and a 3% real return thereafter:

$$Nominal\ Return\ -\ Inflation\ Rate \approx Real\ Return$$

$$Saving\ for\ retirement:\ 9\% - 2\% = 7\%$$
$$During\ retirement:\ 5\% - 2\% = 3\%$$

And because they expect to receive $30,000 worth of Social Security benefits (in real terms), they need only to save enough to withdraw another real $30,000 per year from their retirement account to achieve their target real income of $60,000.

Retirement planning

Ans. (continued)

The real balance of their retirement account necessary to sustain 30 years of $30,000 real withdrawals is about $588K.

Time Value of Money	
P/Y	1
PMT	$30,000
N	30
FV	$0
I/Y	3%
PV=	-$588,013

Time Value of Money	
P/Y	1
FV	$588,013
PV	-$8,000
N	37
I/Y	7%
PMT=	-$3,057

To reach such a balance, they should make real contributions of $3,057 per year for the next 37 years (until they are 65).

Retirement planning

Ans. (continued)

Alice and Jacob must convert all values to nominal terms to understand the amounts they should actually contribute and withdraw.

The first contribution should be $\$3{,}057 * 1.02^1 = \$3118$ and the final contribution should be $\$3{,}057 * 1.02^{37} = \$6{,}361$.

At retirement, the balance should reach $\$588K * 1.02^{37} = \$1{,}223K$.

The couple should withdraw $\$30{,}000 * 1.02^{38} = \$63{,}669$ during their first year in retirement and should receive the same amount in Social Security benefits. This will allow them to withdraw $\$30{,}000 * 1.02^{67} = \$113{,}066$ at age 95 before running out of retirement funds.

Investing in an MBA

Investing in an MBA

Ex 1. At age 29, Alice enrolls in a business school to pursue an MBA so that she becomes eligible for a promotion to a manager in the bank she works at. She currently makes $30,000 per year as a teller. As a manager, her salary will increase to $60,000 per year. Tuition for the program is $40,000 per year for two years, and her income will fall to $10,000 per year from summer and part-time work while she is pursuing her degree. The following table summarizes the Alice and Jacob's pre-tax and after-tax income under the relevant scenarios:

| Status	Pre tax income	After –tax income
No MBA	$70,000	$55,000
Student	$50,000	$42,000
w/MBA	$100,000	$77,000

Calculate the IRR and NPV of Alice's investment in an MBA. Ignore inflation and use the discount rate on Alice's 7% real investment rate. Assume her increased earnings last until she retires at age 65 and ignore any changes to her Social Security benefits.

Investing in an MBA

Ans 1.

When Alice is a student, the couple's after-tax income drops by about $13,000. Her tuition costs $40,000. Therefore, her incremental cash flows from pursuing an MBA are about negative $53,000 per year for the first two years. Thereafter, the couple's combined after-tax income will be about $22,000 higher each year until they retire at age 65.

The following cash flow diagram summarizes the incremental cash flows associated with Alice getting an MBA:

$22,000   ··· $22,000 $22,000

Age 29   Age 30   Age 31   ...   Age 63   Age 64

($53,000)   ($53,000)
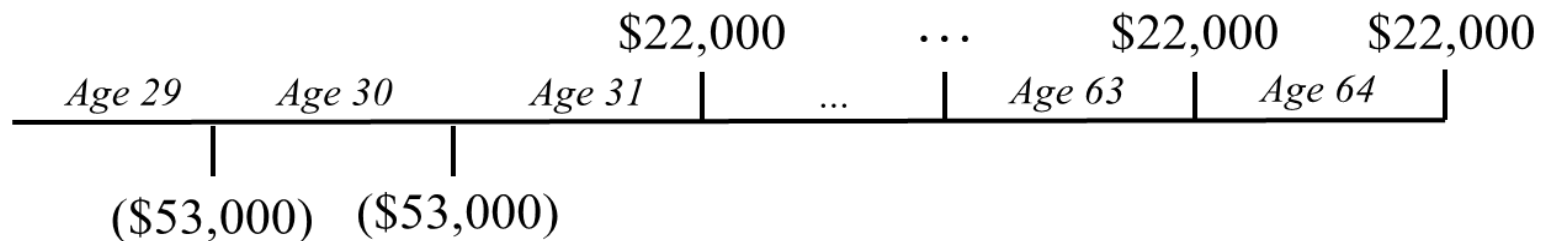
Investing in an MBA

Ans 1. (continued)

These cash flows can be used to calculate the IRR and NPV of Alice's decision to get an MBA:

Cash Flow Worksheet	
CF_0	$0
C01	-$53,000
F01	2
C02	$22,000
F02	34
IRR=	18.9%
I	7.0%
NPV=	$151,173

Because the IRR is higher than the discount rate of 7%, the NPV of the MBA is positive and Alice's increased earnings outweigh the cost of the MBA.

Student loans

Ans 2. Alice's monthly pre-tax student loan payments can be easily calculated as $1,117 per month using a financial calculator. Her monthly student loan payments can be calculated net of taxes by recalculating the payments using an after-tax interest rate of $6\% * (1 - 0.30) = 4.2\%$ for after-tax monthly payments of $1,083.

Time Value of Money	
P/Y	12
PV	$106,000
FV	$0
N	120
I/Y	6.0%
PMT=	-$1,177
I/Y	4.2%
PMT=	-$1,083

This implies annual student loan payments of $14,124 gross of tax and annual student loan payments of about $13,000 gross of tax. The difference is the average annual tax savings of $1,124 from the student loan interest deduction.

(Note that these tax savings are only an average, but will differ each year because as the loan amortizes, the amount of the loan payment going to interest decreases. We also assume no deduction limits.)

Effect of MBA on retirement income

Ex 3. Using the NPV of the MBA and Alice and Jacob's 7% savings rate, estimate the increase in the couple's wealth at retirement if they put all of their increases in income in their retirement account.

Ans 3. Earlier, we calculated the NPV of the MBA to be $151,173. This can be compounded forward to find the future value of the investment in an MBA:

$$\$151,173 * 1.07^{37} = \$1,847,881$$

In other words, if Alice and Jacob maintain their same spending habits after she gets her MBA and use the increased income to invest more in their retirement account, they'll have about $1.8M more in their account at retirement. This increase can sustain $94K more in withdrawals during retirement!

Time Value of Money	
P/Y	1
PV	-$1,847,881
FV	$0
N	30
I/Y	3%
PMT=	$94,278

Buying a House

Affordable house price

In the last example, we saw that after Alice gets her MBA, she and Jacob could greatly increase their retirement wealth by investing all of their increased income. But instead of increasing their savings, the couple might instead prefer to increase their consumption today. Buying a larger house is one way they might do so.

Ex 1. After Alice completes her MBA, she and Jacob make about $100,000 per year before taxes. They have $1,177 in monthly student loan payments and no other debt. They are now 30 years old and would like to move out of their one bedroom apartment and into a new home. They would like to know how large of a house they can afford.

Assume they limit their debt payments to 30% of their monthly income. If they borrow with a 30-year mortgage at a 4.5% APR with a 20% down payment, how large of a house can Alice and Jacob afford. Assume they won't take the mortgage interest deduction.

Affordable house price

Ans 1. Their monthly income is $\frac{\$100,000}{12} = \$8,333$. If they limit their monthly debt payments to 30% of their monthly income, they can only spend up to x dollars on their mortgage, where x solves the formula:

$$\frac{x + \$1{,}177}{\$8{,}333} = 0.30$$

This implies that their maximum monthly mortgage payment is:

$$x = 0.30 * \$8{,}333 - \$1{,}177 = \$1{,}323$$

Affordable house price

Ans 1. (continued)

The $1,069 maximum monthly mortgage payment can be used to find their maximum mortgage size:

Time Value of Money	
P/Y	12
PMT	-$1,323
FV	$0
N	360
I/Y	4.5%
PMT=	$261,109

Because this is the amount they borrow after making a 20% down payment, this implies a maximum affordable house price of:

$$\frac{\$261,109}{1 - 0.20} \approx \$326,386$$

Saving for a down payment

Ex 2. Alice and Jacob decide to target a purchase price of $280,000. They don't want to dip into their retirement account for the down payment, so plan to set aside a bit each month for the next three years until they have enough for a down payment. Alice's parents agree to given them cash for half of the down payment. If they earn a 5% return on their savings, how much should they set aside each month?

Ans 2. They must save up enough to pay for half of the 20% down payment on a $280,000 home. This amounts to:

$$\frac{1}{2} * 0.20 * \$280K = \$28K.$$

To reach this goal, they should set aside $723 per month, or $8,676 per year.

Time Value of Money	
P/Y	12
FV	$28,000
PV	$0
N	36
I/Y	5%
PMT=	-$723

Affordability ratios

Ex 3. After saving up for a down payment at age 33, Alice and Jacob decide to purchase a $280K house with a 30-year, 4.5% APR mortgage with a 20% down payment, calculate their housing expense and total debt ratios. Assume property taxes and insurance amount to 1.5% of the house price and their student loan payments are $1,117 per month. Use their gross income of $100,000 to calculate the ratios.

Ans 3. After the down payment, Alice and Jacob will need to borrow $0.80 * \$280K = \$224K$. The mortgage payment on the house will be $1,135 per month.

The property tax and insurance payments on the home will be $0.0125 * \$280K = \$4,200$ per year, or $350 per month.

Time Value of Money	
P/Y	12
PV	$224,000
FV	$0
N	360
I/Y	4.5%
PMT=	-$1,135

Affordability ratios

Ans 3. (continued)

The housing expense ratio is calculated as:

$$\frac{Mortgage\ Payment + Property\ Taxes\ \&\ Insurance}{Gross\ Income}$$

With a monthly income of $\frac{\$100,000}{12} = \$8,333$ this equals:

$$\frac{\$1,135 + \$350}{\$8,333} = 18\%$$

Affordability ratios

Ans 3. (continued)

The total debt ratio is calculated as:

$$\frac{Mortgage\ Payment + Property\ Taxes\ \&\ Insurance + Other\ Debt}{Gross\ Income}$$

This equals:

$$\frac{\$1{,}135 + \$350 + \$1{,}177}{\$8{,}333} = 32\%$$

Both of these ratios are within the ranges typically accepted by banks, so Alice and Jacob should have little trouble securing the mortgage under ordinary credit conditions.

Income and expenses

Between Alice getting her MBA and the couple purchasing their first home, their income and expenses have changed dramatically since we began the case study. The following table summarizes the effect of their decisions on their income and expenses.

Age 28 Pre-MBA		Age 30 MBA & Saving for House		Age 33 MBA and House	
Gross income	$70,000	Gross income	$100,000	Gross income	$100,000
Taxes	$14,211	Taxes	$23,021	Taxes	$23,021
After-tax income	$55,789	After-tax income	$76,979	After-tax income	$76,979
Annual rent	$10,800	Annual rent	$10,800	Mortgage	$13,620
Retirement savings	$3,060	Student loans, net	$13,000	Property taxes/insurance	$4,200
Remainder	$41,929	Saving for home	$8,676	Student loans, net	$13,000
		Retirement savings	$3,060	Retirement savings	$3,060
		Remainder	$41,443	Remainder	$43,099

Even after purchasing a larger home, Alice's MBA allows the couple to maintain a slightly higher standard of living. In reality the effect would be larger because they would be able to reduce their taxes somewhat through the mortgage interest deduction, and inflation would decrease the real value of their mortgage and student debt.

Today we learned…

- ✓ Using a case study, we applied financial concepts to real-life situations:
    - ✓ Income taxes
    - ✓ Tax-advantaged investing
    - ✓ Credit card debt
    - ✓ Retirement planning
    - ✓ Investing in an MBA
    - ✓ Buying a house