

Math 331 Project: Dream House Mortgage

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Introduction

The goal of this project is to find a dream home and select a mortgage for that home. Considerations such as location, price, and safety are essential to choosing the home. Through this project, we are simulating the financial dealings of buying a house by selecting a suitable mortgage. Based on the income of the family attempting to buy their dream home, the total payment will be divided into a down payment amount and the amount to be borrowed. The amount to be borrowed will be obtained through a suitable mortgage company or bank. This project will examine the financial details for 15 and 30 year mortgages and investigate the significance of fixed and adjustable mortgage rates.

Analysis

We selected a 3 bedroom house in Wheaton, Illinois. This home is close to the train allowing for an easy commute to work for the actuary and accountant working in Chicago. The home is in a very safe neighborhood and within walking distance of the metra, downtown Wheaton, and excellent restaurants. At a price of \$329,000, the home is affordable with the combined annual salary of \$200,000 for the couple. Both individuals have perfect credit scores, which allows them to access lower rate mortgages and save money on interest.

Part (a)

To determine an appropriate down payment, we assumed the couple had saved \$2,000 a month at a 3% nominal rate (.25% monthly) for the past 5 years. $2000s_{60|.25\%} = \$129,293.43$. This means the couple is able to purchase the home with a down payment of \$129,000 and a \$200,000 mortgage.

Next, mortgages at Bank of America, Wells Fargo, and Chase Bank were compared. The Annual Percentage Rates (APR) and corresponding payments were found for 15 year, 30 year, and adjustable mortgages.

Mortgage Data

	15 Yr APR	15 Yr PMT	30 Yr APR	30 Yr PMT	7/1 Adjustable APR	7/1 Adjustable PMT
Wells Fargo	4.346%	\$1,492.00	4.836%	\$1,043.00	4.763%	\$984.00
Bank of America	4.260%	\$1,467.00	4.473%	\$984.00	4.541%	\$912.00
Chase	4.504%	\$1,517.24	4.928%	\$1,058.42	4.907%	\$1,013.37

Part (b)

Additionally, closing costs were found for both Wells Fargo and Bank of America:

Closing Costs

	15 Yr Closing Cost	30 Yr Closing Cost	7/1 Adjustable Closing Cost
Wells Fargo	\$6,225	\$5,276	\$6,235
Bank of America	\$10,107	\$8,845	\$9,671

Part (c)

The next step was to determine if we needed mortgage insurance, and how much. However, after consulting with many sources including our mortgage providers (Bank of America and Wells Fargo have information online, we spoke with an insurer at Chase), we concluded that mortgage insurance is unnecessary for our loan. Most of the time mortgage insurance is required with less than a 20% down payment; our down payment of almost 40% well exceeds this requirement.

Choosing a Mortgage Company

After considering all this information, we chose Bank of America as the mortgage company. With low rates and ample information about closing costs and other fees, Bank of America appears to be the best option. Chase bank did not have closing cost information and had much higher rates. While Wells Fargo had lower closing costs, in the long run the lower APR and payments of Bank of America are more economical.

Part (d)

First we calculated the monthly payment of the 15 year loan, utilising 4 different initial mortgage values. This is because Bank of America does not specify the specific closing costs, rather it provides an estimate. One is the initial \$200,000 mortgage, a second is the mortgage with estimated closing costs, or \$210,107, and the third initial value is \$208,359. This value takes into account the suggested “points” on Bank of America’s website, which suggests an extra additional payment at $t=0$ to lower the interest rate. The recommended initial payment was \$1,748 in this instance. The final value was the initial mortgage minus \$1,748, or 198,252

Initial Value= $Ra_{180|,355\%}$

	Initial Value	APR/12	Number of PMTs	Calculated Payment
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Initial Loan	\$200,000	.355	180	\$1,505.57
Loan+Closing	\$210,107	.355	180	\$1581.65
Loan+Closing -PMT(0)	\$208,359	.355	180	\$1568.49
Loan-PMT(0)	\$198,252	.355	180	\$1492.41

Online, Bank of America referenced a payment value of \$1,467.00, or a cheaper monthly payment than calculated in any of the three instances above. This could be a direct result of not listing the exact closing cost information it uses to calculate APR.

This same process was repeated for the 30 year mortgage (note the closing cost changes as does the “points” payment to \$578), with the following results:

$$\text{Initial Value} = Ra_{360|.37275\%}$$

	Initial Value	APR/12	Number of PMTs	Calculated Payment
Initial Loan	\$200,000	.37275	360	\$1,010.16
Loan+Closing	\$208,845	.37275	360	\$1,054.84
Loan+Closing -PMT(0)	\$208,267	.37275	360	\$1,051.92
Loan-PMT(0)	\$199,422	.37275	360	\$1,007.25

Once again, all of the calculated payments are higher than the one listed on the website: \$984. Of course, as the initial value increases so does the calculated monthly payment.

Part (e)

To determine the total cost of the mortgage, the number of payments is multiplied by the value of payments. The payments given on Bank of America’s website will be used for these calculations. For the 15 year mortgage there are 180 payments (15×12), and each payment is \$1,467. This results in a total cost of $180 \times 1467 = \$264,060$. The total interest of this mortgage is total cost - mortgage, or $(\$264,060 - \$200,000) = \$64,060$.

The same process occurs to find the total cost for the 30 year mortgage, which has 360 payments of \$984. The product of 360×984 is \$354,240. This results in a total cost of \$354,240 and total interest of \$154,240.

If we use the same process but for our calculated payments based off the loan, closing costs, and point deductions you get slightly different values. The chart below highlights the variation in total cost and interest cost for the 15 and 30 year mortgages using payment values from Bank of America and from our own calculations. It is important to note that the calculated payment loan types do not have a starting loan balance of \$200,00.

Loan Type	Total Cost	Interest
15 Yr B. of A. PMT	\$264,060	\$64,060
15 Yr. Calculated PMT (\$208,359 loan)	\$282,328.20	\$282,328.20-208,359 =\$73,969.20.
30 Yr B. of A. PMT	\$354,240	\$154,240
30 Yr. Calculated PMT (\$208,267 loan)	\$378,691.20	\$378,691.20-208,267 =\$170,424.20

The chart reveals how longer mortgages charge much more interest and have a much higher total cost. This makes sense intuitively, as the longer the time period the more accumulation of interest. It is also important to note that higher initial values will also cause higher interest, as seen in the comparison between 15 year and 30 year loan types.

Part (f)

Finally, we consider if the couple would choose to pay an additional \$1,000 a month toward their 15 year or 30 year mortgage (see appendix for how \$1,000 was chosen). Since the couple have relatively high paying jobs, and chose a cheaper house due to its location and their personal preferences, they are able to drastically increase their monthly payments. The calculated payments were utilized for this section, not the Bank of America payments. Through trial and error, it was determined that the couple could pay off their 15 year mortgage in 96 months or 8 years and their 30 year mortgage in 128 months or 10 years and 8 months. This drastic decrease highlights how affordable this home is for the couple and their ability to pay off the mortgage quickly.

These calculations can be confirmed with the financial calculator solving for n and using the values below as inputs:

	I/Y	PV	PMT	FV	Compute "N"
15 Yr	.355	\$208,359	\$1568.49+1,000	0	95.85
30 Yr	.37275	\$208,267	\$1,051.92+1,000	0	127.76

What if the \$1,000 was invested into a mutual fund instead? PARNX, or Parnassus Fund, is a large cap blend mutual fund with an average annualized return of 10.10%. If the \$1,000 payments were made into a fund assuming a rate of .84% a month for the two time periods calculated above then the accumulated values would be \$146,832.91 and \$228,549.70 for the 15 and 30 year options ($1000s_{96|.84\%}$ and $1000s_{128|.84\%}$). To determine if this is a better option than paying off the mortgage early, the difference in total cost of the mortgage must be considered. If the same equations are used as in part e, however with the new payment values, the total cost and interest are:

Loan Type	Total Cost	Interest
\$2568.49 payment, 96 periods	\$246,575.04	\$38,216.04
\$2,051.92 payment, 128 periods	\$262,645.76	\$54,378.76

Investing in the stock market was the better option in both cases. For the 15 year mortgage the market made \$146,832.91 vs. a savings of \$35,753.16. The 30 year mortgage instance would result in a market gain of \$228,549.70 vs. savings of \$116,045.44. Of course, this assumes that the fund returns a steady annual rate, when in reality the market fluctuates. The safer bet is to pay off the mortgage, however an investor willing to stomach a bit more risk for added return can easily see the benefit of investing in a fund with such high annualized returns, and understand that the market will go up over the long run.

Adjustable Rate Mortgage

Bank of America 7/1 Adjustable Mortgage has an APR of 4.541% and initial monthly payment of \$912.00. However, once the adjustable kicks in after 7 years the APR can jump as high as 8.5% with maximum payments around \$1,408 (Bank of America). This is the danger of Adjustable Rate Mortgages: people assume their payments will remain low and don't read the fine print.

Conclusion

This project highlights the importance of fully understanding mortgages before attempting to purchase a house. There are many complicated things to consider that impact the house and mortgage that you should choose. To determine if a 15 or 30 year mortgage is right, you must consider how much money you are able to pay each month. Shorter mortgages cost less and have lower interest rates, however they require significantly higher monthly payments. Adjustable mortgages are especially important to understand, as once their fixed period is over, rates and payments can skyrocket. Many individuals did not understand this in the beginning of the 21st century, which was a contributing factor to the housing market crash and great recession.

It is also difficult to get concrete information on closing costs. Each estimator and bank gives slightly different values, and until you are signing final papers it may be necessary to estimate these costs. That further complicates your eventual payment, as the closing costs may increase and cause a higher APR.

Since closing costs are only provided as an estimate, it is also difficult to understand how banks calculate their APR. Most highlight that it depends on closing costs, yet do not provide a set amount. This proves difficult when attempting to recalculate payments on mortgages, as you may incorrectly assume closing costs that cause your payments to be slightly skewed. We suspect that this was the case for our calculated payments.

Finally, a common question people have is if they should pay off their mortgage faster, or invest that money elsewhere. If there is a higher rate of return compared to the APR of the mortgage, then the money should be invested elsewhere. This was the case for our couple, who were able to invest in a large cap blend strategy rather than pay off the mortgage sooner. However, if you suspect that you will not earn a higher rate of return than the APR on the mortgage, paying the loan off faster is in your best interest.

Appendix

The \$1,000 additional payment was decided after analyzing cash flows of the couple. Annual salary grew at 2% due to inflation, with raises of 10% taking place at year 10 and 20. Tax was assumed to be 40% of income, and expenses were assumed to grow at various levels. Food expenses at 5%, transportation at 1%, miscellaneous at 4%, and bills at 3%. Monthly train passes were found online since that is the main form of transportation for the couple to get to work.

The table on the next page highlights that before any mortgage payments, the couple typically has between \$4,000 and \$6,000 free each month to use on travel, children, etc. It is feasible to assume, therefore, that mortgage payments could significantly increase from the recommended 15-year and 30-year amounts by an additional \$1,000 and quickly decrease the principle of the mortgage.

Year	Annual Salaries	After Tax Salary	Monthly Salary	food (700 /week)	train (\$400/ month)	miscellaneous	bills	total expenses	remaining money
1	200000	120000	10000	2800	400	1000	1000	5200	4800
2	204000	122400	10200	2940	404	1040	1030	5414	4786
3	208080	124848	10404	3087	408	1082	1061	5638	4766
4	212242	127345	10612	3241	412	1125	1093	5871	4741
5	216486	129892	10824	3403	416	1170	1126	6115	4709
6	220816	132490	11041	3574	420	1217	1159	6370	4671
7	225232	135139	11262	3752	425	1265	1194	6636	4625
8	229737	137842	11487	3940	429	1316	1230	6915	4572
9	234332	140599	11717	4137	433	1369	1267	7205	4511
10	262920	157752	13146	4344	437	1423	1305	7509	5637
11	268179	160907	13409	4561	442	1480	1344	7827	5582
12	273542	164125	13677	4789	446	1539	1384	8159	5518
13	279013	167408	13951	5028	451	1601	1426	8506	5445
14	284593	170756	14230	5280	455	1665	1469	8869	5361
15	290285	174171	14514	5544	460	1732	1513	9248	5266
16	296091	177655	14805	5821	464	1801	1558	9644	5160
17	302013	181208	15101	6112	469	1873	1605	10059	5042
18	308053	184832	15403	6418	474	1948	1653	10492	4911
19	314214	188529	15711	6739	478	2026	1702	10945	4765
20	352548	211529	17627	7075	483	2107	1754	11419	6208
21	359599	215760	17980	7429	488	2191	1806	11915	6065
22	366791	220075	18340	7801	493	2279	1860	12433	5907
23	374127	224476	18706	8191	498	2370	1916	12975	5732
24	381610	228966	19080	8600	503	2465	1974	13541	5539
25	389242	233545	19462	9030	508	2563	2033	14134	5328
26	397027	238216	19851	9482	513	2666	2094	14754	5097
27	404967	242980	20248	9956	518	2772	2157	15403	4845
28	413067	247840	20653	10454	523	2883	2221	16082	4572

29	421328	252797	21066	10976	529	2999	2288	16792	4275
30	429754	257853	21488	11525	534	3119	2357	17534	3954

Works Cited

“Accountant Salary.” U.S. News & World Report L.P., 2018, <https://money.usnews.com/careers/best-jobs/accountant/salary>. Accessed 6 May 2018.

“Actuary V Salaries.” Salary.com, 2018, <https://www1.salary.com/Actuary-V-Salaries.html>. Accessed 6 May 2018.

Catherine. Personal Interview. 26 April 2018.

Cirone, Micheal. “119 W Seminary Ave, Wheaton, IL 60187.” Zillow, https://www.zillow.com/homes/for_sale/Wheaton-IL/124720982_zpid/15894_rid/2-beds/globalrelevanceex_sort/41.885889,-88.081813,41.845556,-88.143611_rect/13_zm/ Accessed 6 May 2018.

“Mortgage Rates.” Bank of America Corporation, 2018, <https://www.bankofamerica.com/mortgage/mortgage-rates/>. Accessed 25 Mar 2018.

“My Metra.” Metra Commuter Rail Division of the Regional Transportation Authority, 2018, <https://store.metrarail.com/ShoppingCart/AddTicket>. Accessed 6 May 2018.

“Removing Mortgage Insurance.” Wells Fargo, 2018, <https://www.wellsfargo.com/mortgage/manage-account/insurance/mortgage-insurance/how-to-remove-mortgage-insurance/>. Accessed 6 May 2018.

Reynolds, Susan. “How Do I Calculate PMI Mortgage Insurance?.” SFGATE, <http://homeguides.sfgate.com/calculate-pmi-mortgage-insurance-7763.html>. Accessed 6 May 2018.

“Today’s Mortgage Rates and Refinance Rates.” Wells Fargo, 2018, <https://www.wellsfargo.com/mortgage/rates/>. Accessed 25 Mar 2018.

“What is mortgage insurance and how does it work?.” Consumer Financial Protection Bureau, 25 Sep 2017, <https://www.consumerfinance.gov/ask-cfpb/what-is-mortgage-insurance-and-how-does-it-work-en-1953/>. Accessed 6 May 2018.

“Your Estimated Rate Quotes.” JPMorgan Chase & Co, 2018, <https://apply.chase.com/mortgage/CRQ/CRQResults.aspx>. Accessed 25 Mar 2018.