Lending Club

Study Lending Club Loans and Choose the Optimal Investment Plan

By

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1, Introduction

Lending Club is a peer to peer lending online marketplace platform that connects borrowers and investors together. Lending Club allows investors and borrowers directly lend or borrow from each other in a safe and secure platform. The advantage of using Lending Club over the traditional way of putting money for example in a saving account is that you receive a much higher interest rate. As a borrower, borrowing directly from the investors via Lending Club is faster and easier than from the bank and especially you would get lower interest rate than from the bank. As an investor, you would also get higher interest rate.

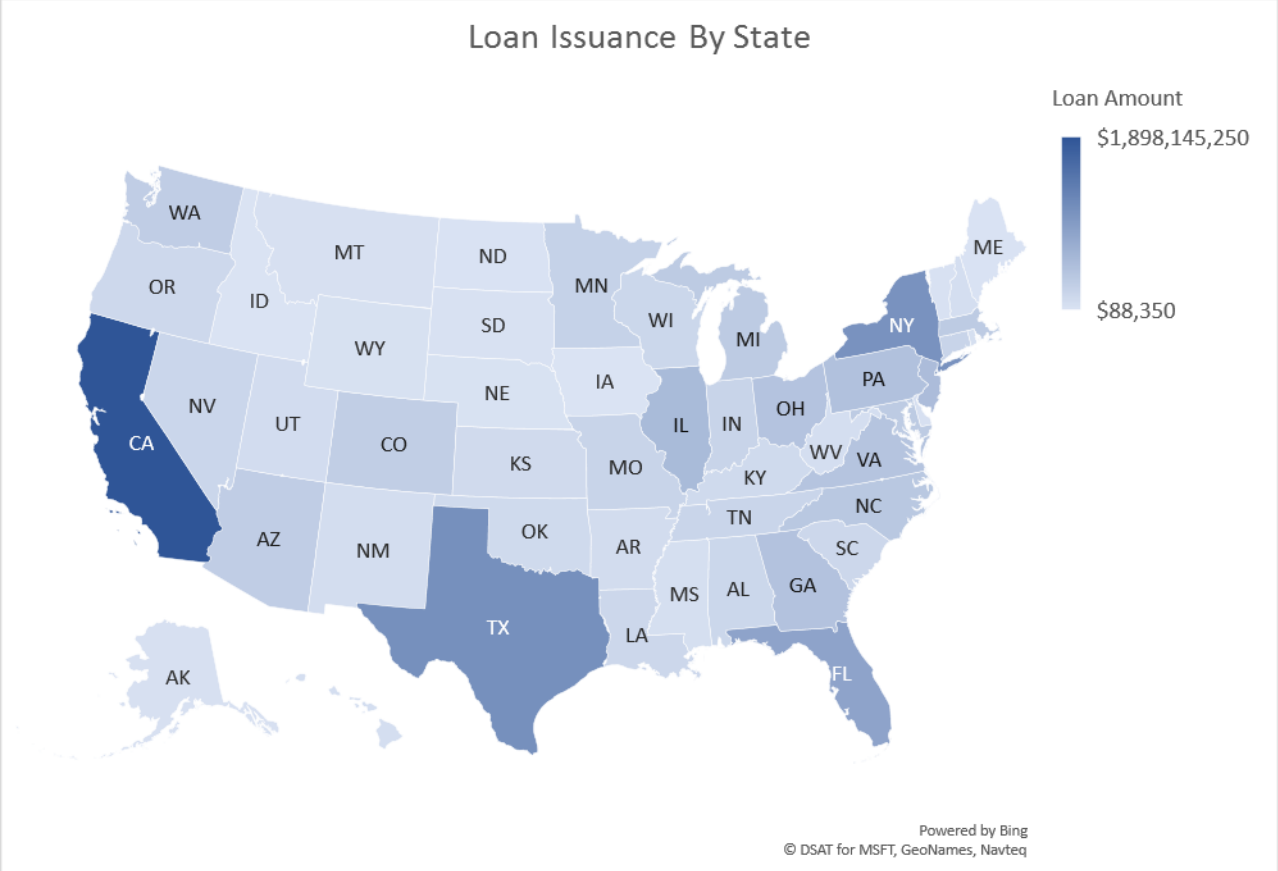
Lending Club categorizes their loans into seven different loan grades: A through G. The lending process is quite simple. If people want to borrow, they need to apply and meet certain criteria such as minimum fico score of 600, and debt to income ratio below 50%, and must be employed, etc. Any investor can browse the loans on their website and choose which loans they want to fund.

Given that Lending Club grew from $1.5 billion in 2003 in term of loan originations to over $24 billion worth of total loan issuance in 2016, Lending Club's business model is doing very well. As an investor who wants to invest money using Lending Club marketplace, we would want to find the optimal investment plan given the various scenarios. The goal is to have a portfolio that consistently generates profit.

2, Analyzing Lending Club Loans

1, Loan Amount by State

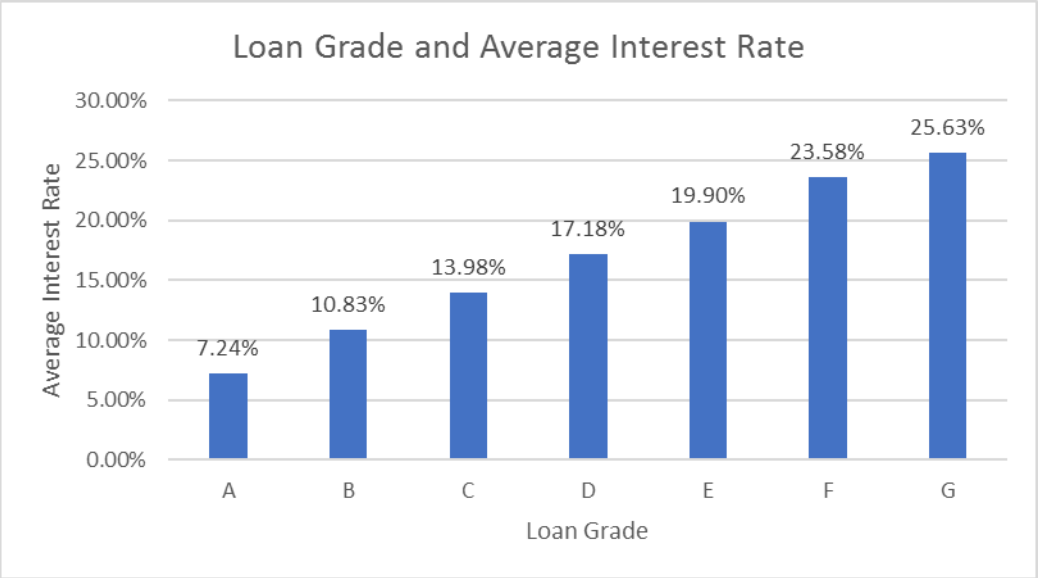
First let's look at which states that use Lending Club the most. As seen in the below map, California, Texas, Florida, and New York, these four states responsible for about 38% of the total amount of loan.



2, Interest Rate Across Loan Grades

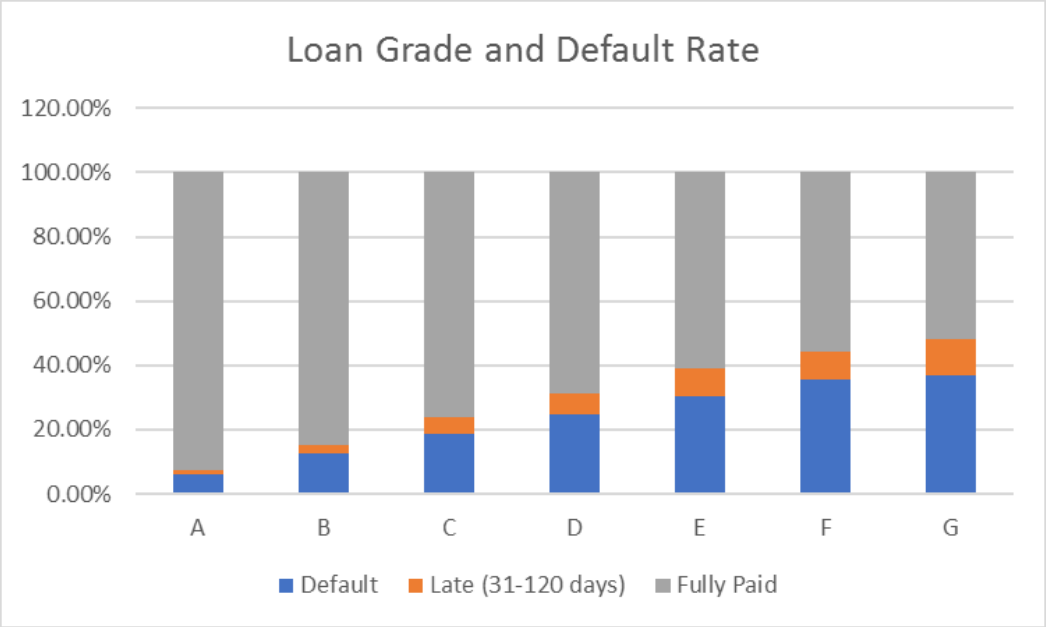
The graph below shows the relationship between loan grades and its respective interest rates. Loan grade A is the safest with interest rate of 7.24% on average and loan grade G is the riskiest with interest rate of 25.65% on average. If we were to put our money in the saving account we would generate less than 1% annual rate of return, as a matter of fact the Chase

saving account only gives 0.01% annual rate of return, so 7.24% rate on their safest loan grade A is not a bad rate of return and that's the reason why the company has been doing quite well.



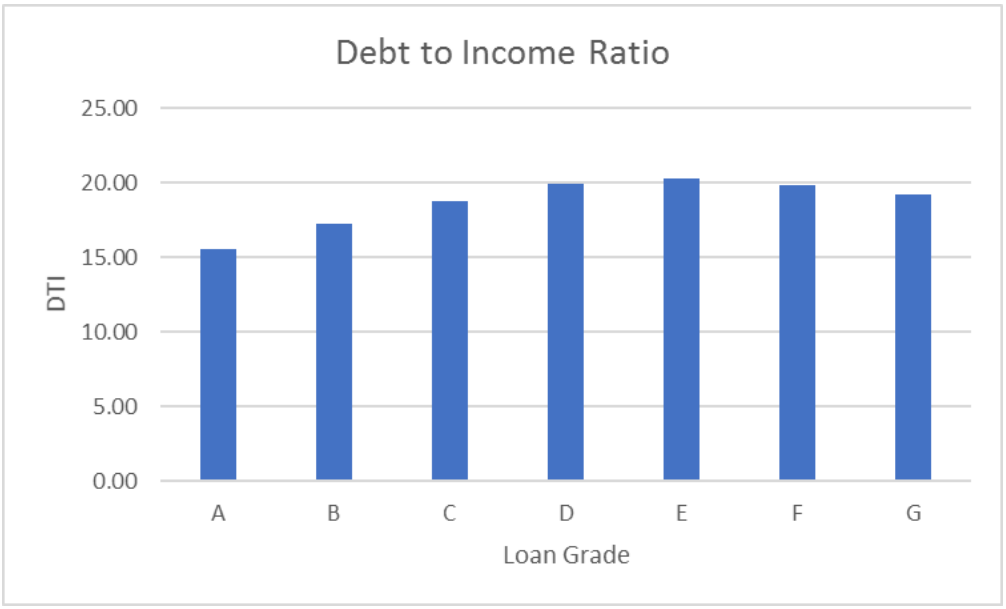
3, Default Loans

In the previous graph we see that the loan grade G's average interest rate is 25.63%, but if we look closely at the default rate for loan grade G, to be precise the default rate for loan grade G is 36.9% while the default rate for loan grade A is only 6.22%. The Graph below shows the default rate across all loan grades. If you like risk, loan grade G is for you; however, if you are a risk-averse investor then loan grade A is for you.

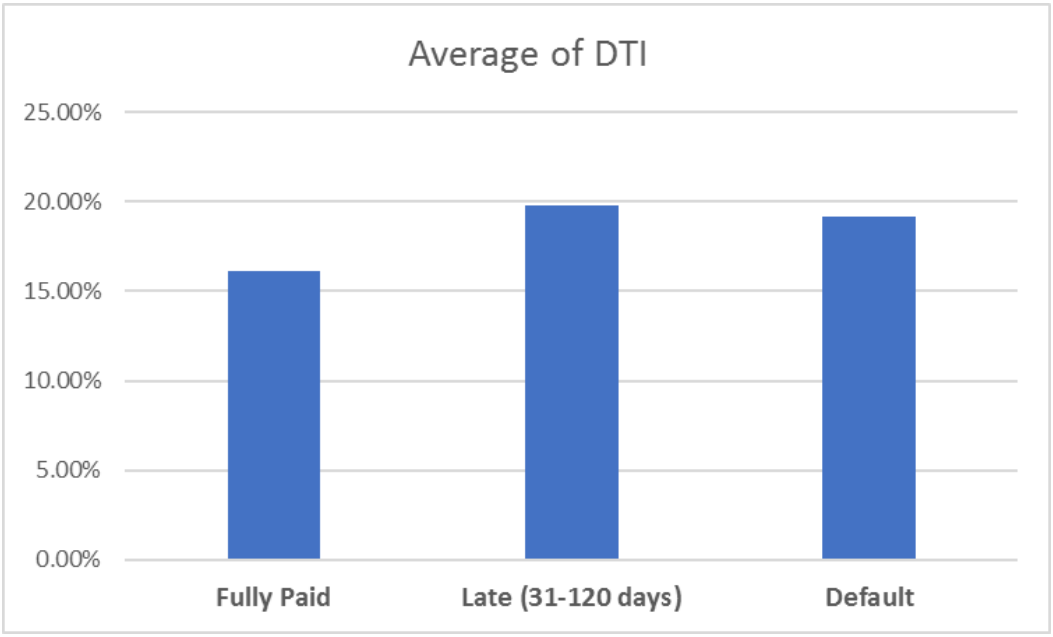


4, Debt to Income Ratio

What is debt to income ratio? This is just the ratio of your monthly debt payments divided by your gross monthly income. The DTI ratio is important to determine whether the borrower will pay back the loan in the future. Now let's look at the debt to income ratio across loan grades. As expected, the grade A loan has the lowest DTI ratio which is 15.58%. The loan with the highest DTI ratio is not loan grade G, but instead it's the grade E loan which is 20.34%. This is surprising as I expect the loan grade G to have the highest DTI ratio, but according to the data, this is not the case. For loan grade D to G, the DTI ratio is not much different.



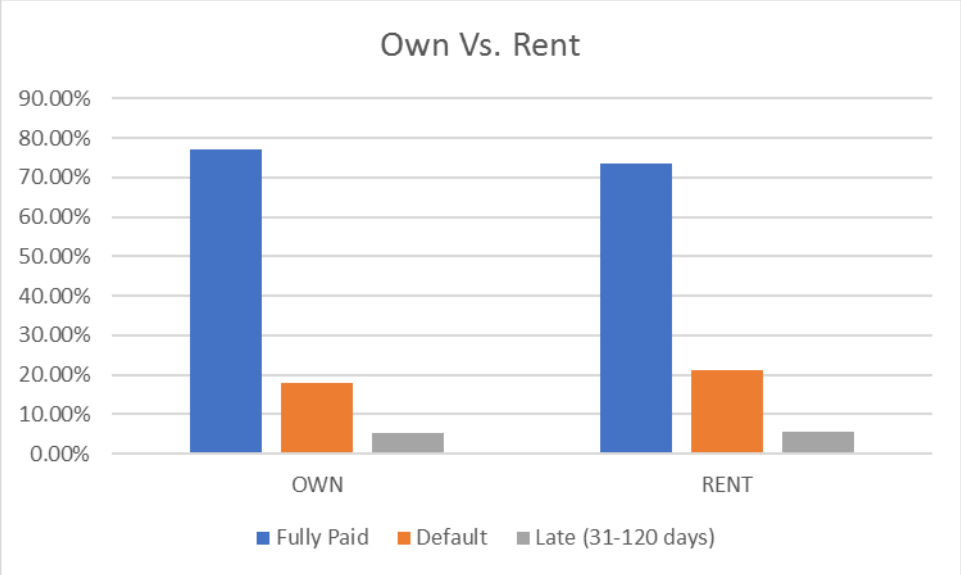
Loan grades with high debt to income ratio tend to have higher default rate as shown in below graph.



5, Home Ownership

Those who own a home will likely to pay back the loan than those who don't own a home. Now let's look at homeowners versus renters. According to the graph below the borrowers

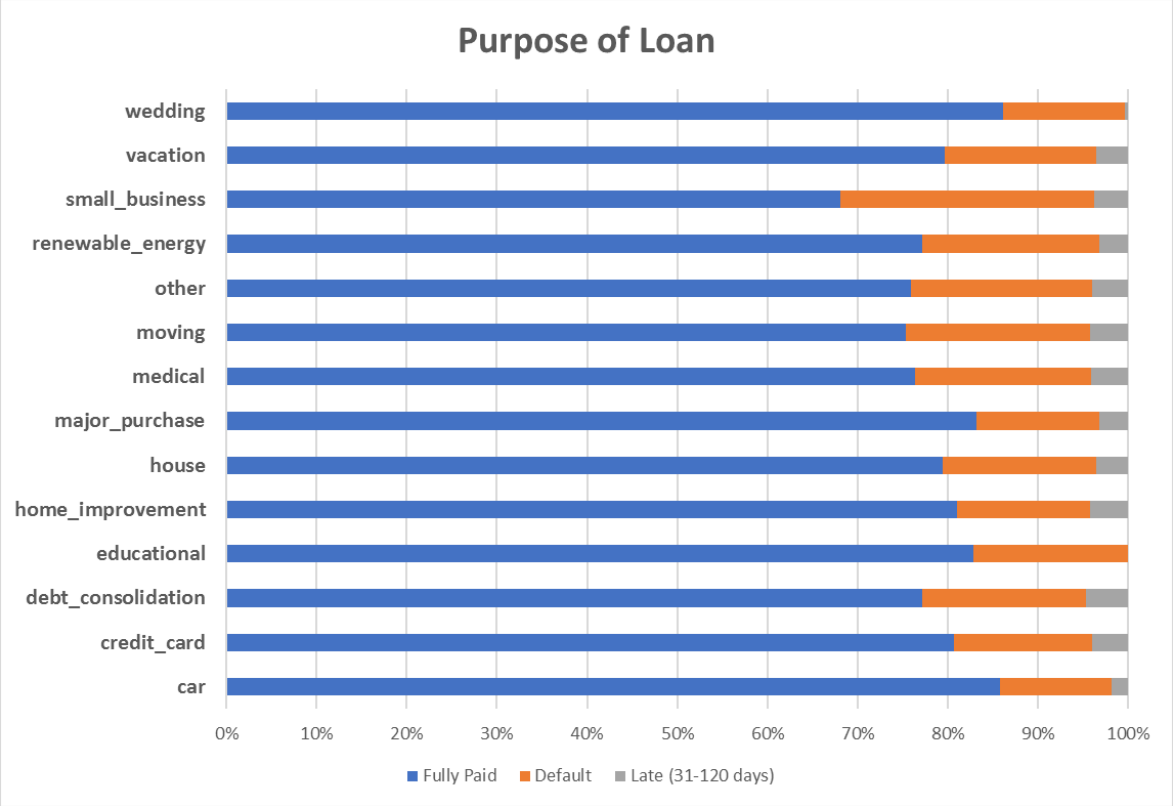
who own a home tend to have lower default rate. Borrowers who own a home have average default rate of 17.81% while renters have average default rate of 21.08% to be precise.



6, Purpose of Loan

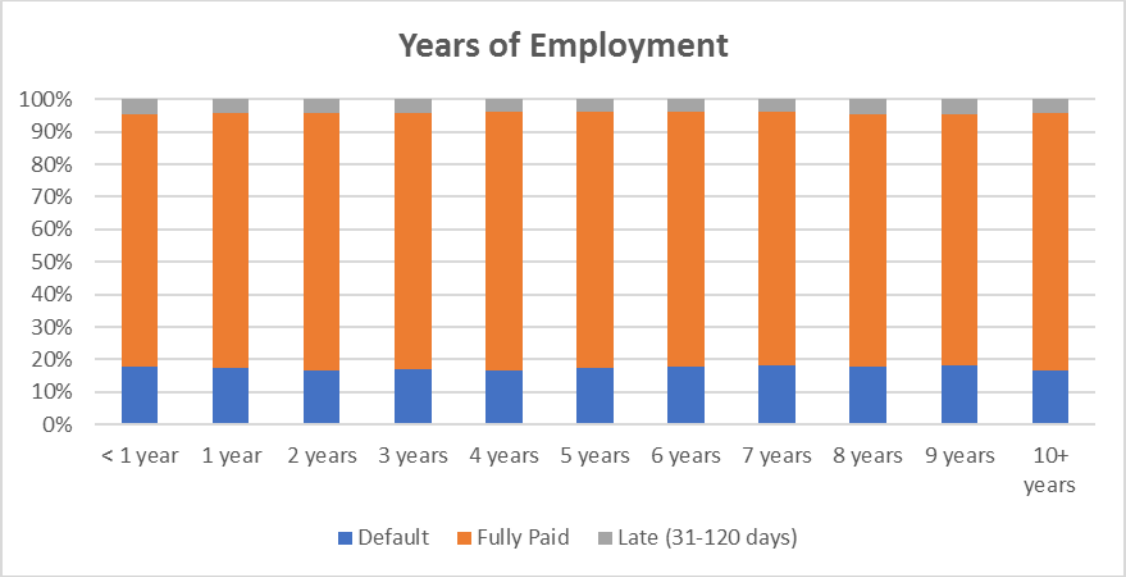
As for an investor before we decide to give out a loan to someone we need to know the purpose of the loan because this would help us predict whether the borrower will pay back the loan in the future. There are mainly 13 categories of purpose for loan from asking for loan to have a wedding to asking a loan to buy a car. Now which loan purposes have higher default rate? According to the graph below small business loans have the highest default rate which is 28.05% meaning among all the default loans, 28.05% of them are business loans. The second highest loan purpose is asking a loan for moving meaning the borrowers ask for money because they need to relocate. The moving loan purpose has the default rate of 20.48%. The third highest default rate loan purpose is for medical purpose with the default rate of 19.51%.

Now the safest loans are car loans with default rate of 12.29% and the second safest loans are wedding loan with the default rate of 13.5%.



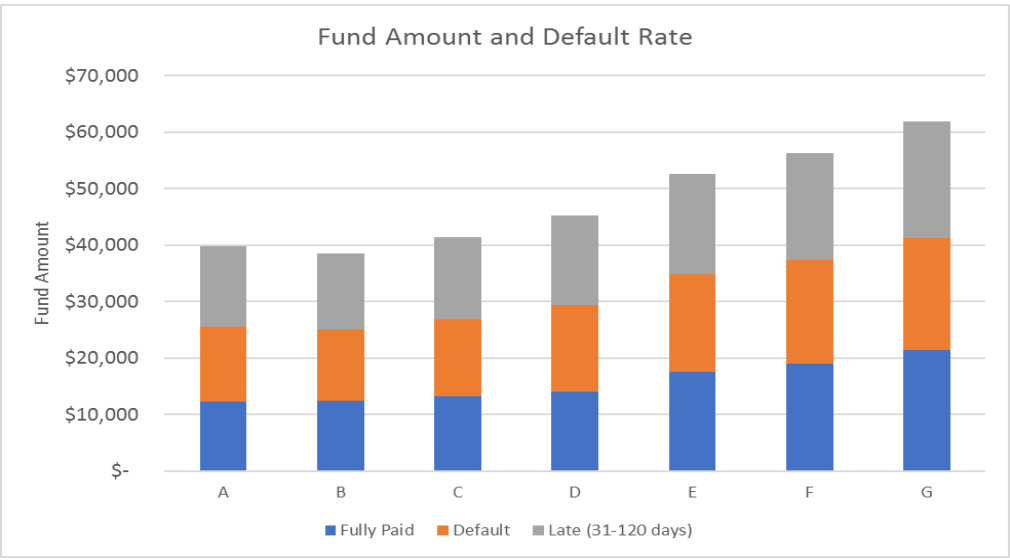
7, Years of Employment

Normally we would expect the burrowers with longer years of employment to pay back the loan in the future. So, I was expecting that number of years of employment would have a higher impact on quality of the loan, but turned out it doesn't make much of an impact according the data. As seen in the graph below we don't see a big difference in term of default rate across different years of employment from borrowers. This is a surprise.



8, Fund Amount and Default Rate

Now let's look at the relationship between fund amount and the default rate. First of all loan grade A on average has the loan amount of $14,023 per loan while the loan grade G on average has the loan amount of $20,498 per loan. So now if we look at the default rate, the small loans have low default rate while the big loans have high default rate. The loan grade G consists of big loans and it has high default rate. The loan grade A only consist of small loans and it has low default rate.



3, Finding Optimal Investment Plan

After we have analyzed the loans, the variables that have sufficient impact to the default rate would be debt to income ratio, and the purpose of the loan, and of course the grade of the loan. These will be the constraints that we will be including in the model.

The rule of safe investment is to diversify the portfolio, so in this model I want to invest 30% or more on loan grade A and 20% or more on loan grade B, and 10% or less for each loan grade C to G. From analyzing the historical loan data, the car, wedding, and home improvement loans have the lowest default rate, so I would want 20% or more of my portfolio to consist of car loans and 20% or more for wedding loans, and 20% or more for home improvement loans. According to the historical data, the average DTI of all the loans is 18.71% so I would want the average DTI of my loan portfolio to be 18.71% or less. Also the average homeownership of all the loans is 64.23%, so I would also want my loan portfolio to consist of 64.23% or more of homeowners. The last constraint would be the default rate. I would want the default rate to be less than or equal to 10% in my portfolio.

We will be using linear optimization approach to figure the optimal investment plan based on these constraints.

Formulation:

Decision Variables

A = Percentage of Investment for Vehicle A

B = Percentage of Investment for Vehicle B

C = Percentage of Investment for Vehicle C

D = Percentage of Investment for Vehicle D

E = Percentage of Investment for Vehicle E

F = Percentage of Investment for Vehicle F

G = Percentage of Investment for Vehicle G

Objective – Maximize Rate of Return

Max (*A*7.24%) + (B*10.83%) + (C*13.98%) + (D*17.18%) + (E*19.9%) + (F*25.58%) + (G*25.63%)*

Constraints

Total of investment: A + B + C + D + E + F +G = 100%

Percentage of Investment for Vehicle A >= 30%

Percentage of Investment for Vehicle B >= *20%*

Percentage of Investment for Vehicle C <= 10%

Percentage of Investment for Vehicle D <= 10%

Percentage of Investment for Vehicle E <= 10%

Percentage of Investment for Vehicle F <= 10%

Percentage of Investment for Vehicle G <= 10%

Default Rate <= 10%

(A*6.22%) + (B*12.42%) + (C*18.84%) + (D*24.7%) + (E*30.41%) + (F*35.42%) + (G*36.9%) <= 10%

DTI <= average DTI which is 18.71%.

(A*15.58%) + (B*17.31%) + (C*18.79%) + (D*19.91%) + (E*20.34%) + (F*19.83%) + (G*19.18%) <= 18.71%

Homeownership >= average homeownership which is 14.29%

(A*71%) + (B*65%) + (C*64%) + (D*62%) + (E*63%) + (F*62%) + (G*62%) >= 14.29%

Loan Purpose Constraints:

Car >= 20%

(A*26.64%) + (B*30.44%) + (C*23.93%) + (D*11.66%) + (E*5.18%) + (F*1.79%) + (G*0.36%) >= 20%

Wedding >= 20%

(A*19.13%) + (B*23.52%) + (C*20.92%) + (D*21.56%) + (E*9.37%) + (F*4.39%) + (G*1.11%) >= 20%

Home Improvement >= 20%

(A*19.33%) + (B*27.94%) + (C*26.55%) + (D*14.63%) + (E*8.12%) + (F*2.75) + (G*0.69%) >= 20%

Nonnegativity $A, B, C, D, E, F, G \geq 0$

Results:

	Decisions	AVG Rate	Average of DTI	OWN	RENT	Fully Paid	Default	Late (31-120 days)	Car	Wedding	Home Improvement
Investment Vehicle A	56.96%	7.24%	15.58%	71%	29%	92.63%	6.22%	1.15%	26.64%	19.13%	19.33%
Investment Vehicle B	38.49%	10.83%	17.31%	65%	35%	85.02%	12.42%	2.56%	30.44%	23.52%	27.94%
Investment Vehicle C	0.00%	13.98%	18.79%	64%	36%	76.32%	18.84%	4.84%	23.93%	20.92%	26.55%
Investment Vehicle D	0.00%	17.18%	19.91%	62%	38%	68.68%	24.70%	6.61%	11.66%	21.56%	14.63%
Investment Vehicle E	0.00%	19.90%	20.34%	63%	37%	60.87%	30.41%	8.72%	5.18%	9.37%	8.12%
Investment Vehicle F	0.00%	23.58%	19.83%	62%	38%	55.55%	35.42%	9.03%	1.79%	4.39%	2.75%
Investment Vehicle G	4.55%	25.63%	19.18%	62%	38%	51.95%	36.90%	11.15%	0.36%	1.11%	0.69%
			Average	Average							
			18.71%	**64.23%**							

Objective	
Maximize Annual Rate of Return	9.46%

Constraints	LHS		RHS
Total investor distribution = 1	100.00%	=	100%
Investment A	56.96%	>=	30%
Investment B	38.49%	>=	20%
Investment C	0.00%	<=	10%
Investment D	0.00%	<=	10%
Investment E	0.00%	<=	10%
Investment F	0.00%	<=	10%
Investment G	4.55%	<=	10%
Default Rate	10.00%	<=	10.00%
Homeownership	68.45%	>=	64%
DTI	16.41%	<=	18.71%
car	26.91%	>=	20.00%
wedding	20.00%	>=	20.00%
Home Improvement	21.79%	>=	20.00%

We use Excel Solver to identify the optimal solution. The optimal solution for this model given all the constraints is 9.46% average annual rate of return. We get this return by putting 56.96% of the investment in loan grade A and 38.49% in loan grade B and 4.55% in loan grade G, together a total of 100% of the investment.

Of course the optimal rate of return would be different based on the constraints that we have. But let's look the constraints. With the annual rate of return 9.46%, our average DTI would be 16.41% and we would have 26.91% of car loans and 20% of wedding loans and 21.79% of Home Improvement loans in our portfolio which is what we want to have. However, we would like to have as low default rate as possible, but our default rate is 10%. This is not surprising because investing with Lending Club we get high return but the risk is also high. The interest rate on the saving account is 0.01% which is nothing. So I think it's still worth the risk.

Sensitivity Analysis:

riable Cells

Cell	Name	Final Value	Reduced Cost	Objective Coefficient	Allowable Increase	Allowable Decrease
B5	Investment Vehicle A Decisions	0.56959176	0	0.072433116	0.010125396	0.001582545
B6	Investment Vehicle B Decisions	0.384910049	0	0.108296182	0.001262943	0.005648953
B7	Investment Vehicle C Decisions	0	-0.006797366	0.139800983	0.006797366	1E+30
B8	Investment Vehicle D Decisions	0	-0.009349717	0.171758145	0.009349717	1E+30
B9	Investment Vehicle E Decisions	0	-0.017715394	0.198973217	0.017715394	1E+30
B10	Investment Vehicle F Decisions	0	-0.011183082	0.235827866	0.011183082	1E+30
B11	Investment Vehicle G Decisions	0.045498192	0	0.256267061	1E+30	0.006253617

nstraints

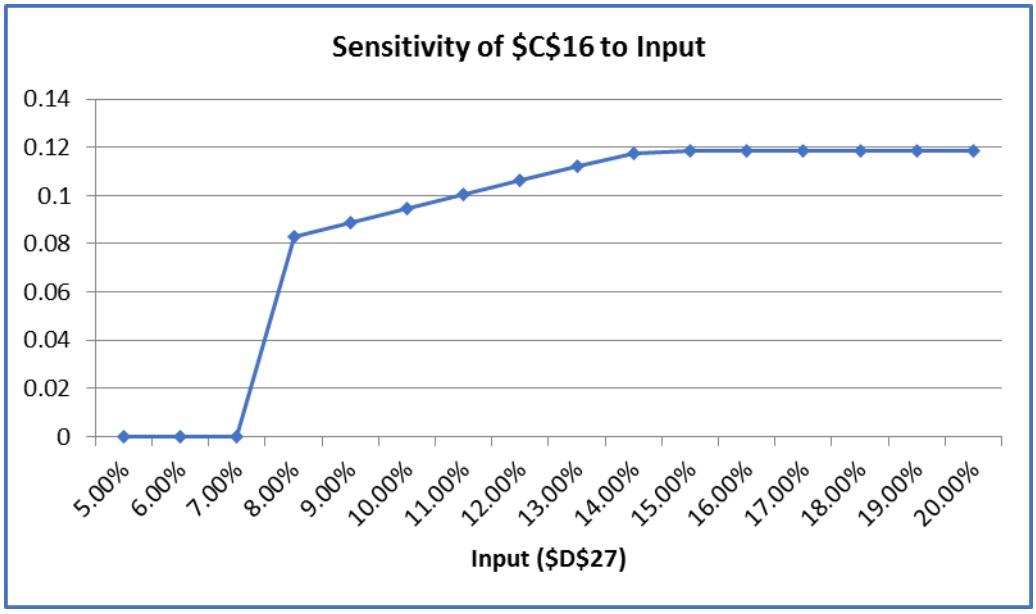
Cell	Name	Final Value	Shadow Price	Constraint R.H. Side	Allowable Increase	Allowable Decrease
B19	Total investor distribution = 1 LHS	1	0.03875208	1	0.065155995	0.050718456
B20	Investment A LHS	0.56959176	0	0.3	0.26959176	1E+30
B21	Investment B LHS	0.384910049	0	0.2	0.184910049	1E+30
B22	Investment C LHS	0	0	0.1	1E+30	0.1
B23	Investment D LHS	0	0	0.1	1E+30	0.1
B24	Investment E LHS	0	0	0.1	1E+30	0.1
B25	Investment F LHS	0	0	0.1	1E+30	0.1
B26	Investment G LHS	0.045498192	0	0.1	1E+30	0.054501808
B27	Default Rate LHS	0.1	0.589953908	0.1	0.029629239	0.025270846
B28	Homeownership LHS	0.684537365	0	0.642256054	0.042281311	1E+30
B29	DTI LHS	0.164064226	0	0.187055009	1E+30	0.022990784
B30	car LHS	0.269067968	0	0.2	0.069067968	1E+30
B31	wedding LHS	0.2	-0.015730945	0.2	0.018087169	0.011648505
B32	Home Improvement LHS	0.217948442	0	0.2	0.017948442	1E+30

Looking at the sensitivity analysis report, I'm interested in the default rate constraint. So if we increase the constraint for default rate by 1% then the annual rate of return would go up by 0.58995%. The allowable increase and decrease for default rate is 0.0296% and 0.0253%. This means that we can only increase it up to 0.0296% which is very small. This means if we change the default rate constraint slightly, decision variables and objective value will change. In other words, the default rate constraint is very sensitive in our model.

One-Way Sensitivity Analysis

According to the SolverTable one-way sensitivity analysis, we see that if the default rate is at 5% to 7%, there won't have any feasible solution. We can keep increasing the default rate from 8% to 15%, the annual rate of return will keep increasing along with it from 8.28% to 11.87%. Now if we increase the default rate any more than 15%, we won't see any increase in the annual rate of return anymore. In short given all of our constraints, we can have the annual rate of return as high as 11.87% by increasing the default rate constraint to 15% and this is as high as we can increase our annual rate of return by increasing the default rate while keeping other constraints constant.

Default Rate	Rate of Return	A	B	C	D	E	F	G
5.00%	Not feasible							
6.00%	Not feasible							
7.00%	Not feasible							
8.00%	8.28%	75.16%	23.86%	0.00%	0.00%	0.00%	0.00%	0.99%
9.00%	8.87%	66.06%	31.17%	0.00%	0.00%	0.00%	0.00%	2.77%
10.00%	9.46%	56.96%	38.49%	0.00%	0.00%	0.00%	0.00%	4.55%
11.00%	10.05%	47.86%	45.81%	0.00%	0.00%	0.00%	0.00%	6.33%
12.00%	10.64%	38.76%	53.13%	0.00%	0.00%	0.00%	0.00%	8.11%
13.00%	11.23%	30.00%	59.84%	0.00%	0.37%	0.00%	0.00%	9.80%
14.00%	11.72%	30.00%	50.50%	0.62%	10.00%	0.00%	0.00%	8.88%
15.00%	11.87%	30.00%	40.87%	10.00%	10.00%	0.00%	9.13%	0.00%
16.00%	11.87%	30.00%	40.87%	10.00%	10.00%	0.00%	9.13%	0.00%
17.00%	11.87%	30.00%	40.87%	10.00%	10.00%	0.00%	9.13%	0.00%
18.00%	11.87%	30.00%	40.87%	10.00%	10.00%	0.00%	9.13%	0.00%
19.00%	11.87%	30.00%	40.87%	10.00%	10.00%	0.00%	9.13%	0.00%
20.00%	11.87%	30.00%	40.87%	10.00%	10.00%	0.00%	9.13%	0.00%



4, Conclusion

I think Lending Club is a really great platform to generate income if we are careful. Risk-averse investors should choose loan grade A or B and should only choose the borrowers who own a home and have low debt-to-income ratio. They should only fund the loans whose purposes are for buying a car or having a wedding or home improvement. This will help them find the best investment plan because those variables are associated with low default rate.

5, Bibliography

https://www.lendingclub.com/info/download-data.action