Risk Analysis Report: Comparative Evaluation of Lending Options for Crawford Development CO.

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1. Executive Summary

This report comprehensively analyzes two potential projects that Crawford Development Corporation (CDC) is considering: an office building project and a residential development project. Southeast Bank of Texas (SBT) is evaluating the risks and potential profits of offering a loan to CDC for either of these projects.

For the office building project, our analysts built a regression model using the historical sales data and simulated the market conditions by the given series of probabilities, to estimate the sales by the regression function and calculate the net present value of the profits for both CDC and SBT, and the associated risks. The results indicate that the average profit Net Present Value (NPV) for CDC is \$8,873.231k, while the average profit NPV for SBT is \$1,037.715k.

Regarding the residential development project, our analysts simulated the sales and costs of the residential buildings from the CDC's perspective, and simulated the uncertainty of whether CDC will accept the loan offer based on different interest rates from the SBT's perspective. Sensitivity analysis and optimization models determined the ideal interest rate for SBT's loan offer. The first optimization model suggests an interest rate of 9.92% to achieve the highest expected NPV of SBT, but with higher risks for a deal breaker or negative returns. The second model recommends an interest rate of 7% to ensure the highest possibility of SBT getting a positive profit NPV but with a risk that the NPV of the expected profit being negative.

In summary, after conducting a thorough analysis and comparison of the two optional projects, our team recommends that Crawford utilize the loan to build an office. The office market in Houston is projected to have a positive future, with a growing demand for offices and a decreasing unemployment rate. In contrast, the residential market is deemed riskier and offers an uncertain return.

From SBT's perspective, it is preferable for Crawford to build an office to avoid high risk and prevent the loan from becoming bad debt. Therefore, we suggest that SBT encourage Crawford to pursue the office project to ensure benefits for both parties.

2. Introduction

2.1 Background and Problem Statement

Crawford Development CO., a real estate development company led by Andy Crawford, having a long-standing relationship and having worked on several successful projects with SBT, is currently considering two different development projects in Houston. The first project is an office building, a market with solid growth and low vacancy rates in recent years. The second project is a residential development, which, while potentially offering higher returns, is also considered riskier due to the ongoing challenges faced by the residential market in the United States.

In 2007, Houston's real estate market was booming, mainly driven by high oil prices and a strong local economy. The city experienced significant job growth and economic expansion. The office market was thriving, with low vacancy rates and increasing rental rates. However, an influx of new developments led analysts to predict limited upside potential for office development.

At the same time, the residential market faced challenges due to the credit crunch, high-risk loans, and an oversupply of homes, causing housing prices to fall. Despite these issues, Houston's residential market showed resilience compared to the rest of the country. Some analysts believed that if the local economy remained strong, the residential market could bring in higher sales than the office market in three years.

Despite acknowledging that historical data of office projects may not be entirely applicable to the current residential market due to its turbulence, we have estimated that the initial construction costs for the residential project would likely fall within 10% of the expected cost, which is 20 million dollars, with a 95% probability.

To make a well-informed decision, we will need to carefully consider various factors, such as the current economic outlook, the performance of past deals, and the overall market trends in both the office and residential sectors. We must also weigh each project's potential risks and rewards, considering CDC's capabilities and the bank's financial objectives. With these factors in mind, our challenge is determining the best course of action for the bank regarding a loan offer to CDC, including adjusting the interest rate.

2.2 Overall Goals and Objectives of the Report

As analysts, we provide accurate and reliable data to support SBT's decision-making process while safeguarding the bank's interests and fostering a solid relationship between SBT and CDC. Our objectives include conducting a comprehensive analysis of the risks and potential profits associated with both the office building and residential development projects under consideration by the CDC. We will evaluate the impact of current economic conditions, market trends, and historical data on the feasibility and profitability of each project, as well as assess the implications of adjusting the interest rate offered by the bank on the loan and its potential effect on CDC's decision-making process.

We aim to identify and recommend the optimal course of action for the bank in offering a loan to CDC, ensuring that the decision is in the best interest of both parties while preserving their strong, long-standing relationship. Additionally, we will establish guidelines for future collaborations between the bank and CDC, incorporating the lessons learned from the analysis and decision-making process outlined in this report.

3 Option 1: Building an Office

3.1 Methodology for Analysis

Initially, the current macroeconomic marketing of business has a strong sign that oil and gas companies will have less risks than other businesses, which means building a new office project for company usage will be a safe strategy for real estate companies like Crawford to make profit. Therefore, analyzing the potential risks of office projects and simulating profits for both Crawford and Southeast Bank will be very crucial for both parties to make a better decision.

The first step is to preprocess the data. The team loads Exhibit 3 which is the historical data about the three-year business development loans SBT provided for CDC for the development of office buildings into the R environment to have the initial data frame “df”. By viewing the structure of the “df”, the variable “Outlook” needs to be converted into factors as dummy variables because all "-1" "1" and "0" represent the different economy categories, not numbers. Failing to convert "Outlook" variables into dummy variables will hugely decrease the accuracy of the office project model here.

```
> df <- read_excel("616data.xlsx")
> str(df)
tibble [32 x 4] (S3: tbl_df/tbl/data.frame)
 $ LoanID       : num [1:32] 1 2 3 4 5 6 7 8 9 10 ...
 $ ExpectedSales: chr [1:32] "66382.350000000006" "60852.39" "65872.3" "64541.97" ...
 $ Outlook      : num [1:32] -1 0 0 1 1 -1 -1 1 0 1 ...
 $ RealizedSales: num [1:32] 51302 63452 67932 79689 70408 ...
> df$Outlook<-as.factor(df$Outlook)
> str(df)
tibble [32 x 4] (S3: tbl_df/tbl/data.frame)
 $ LoanID       : num [1:32] 1 2 3 4 5 6 7 8 9 10 ...
 $ ExpectedSales: chr [1:32] "66382.350000000006" "60852.39" "65872.3" "64541.97" ...
 $ Outlook      : Factor w/ 3 levels "-1","0","1": 1 2 2 3 3 1 1 3 2 3 ...
 $ RealizedSales: num [1:32] 51302 63452 67932 79689 70408 ...
> df$ExpectedSales<-as.numeric(df$ExpectedSales)
Warning message:
NAs introduced by coercion
> df[27,2]<-61969.04
> str(df)
tibble [32 x 4] (S3: tbl_df/tbl/data.frame)
 $ LoanID       : num [1:32] 1 2 3 4 5 6 7 8 9 10 ...
 $ ExpectedSales: num [1:32] 66382 60852 65872 64542 73871 ...
 $ Outlook      : Factor w/ 3 levels "-1","0","1": 1 2 2 3 3 1 1 3 2 3 ...
 $ RealizedSales: num [1:32] 51302 63452 67932 79689 70408 ...
```

After preprocessing the data, the next step is to create a regression model to find out the relationships between the outcome variable 'realized sales' with independent variables 'expected sales' and 'Outlook'. By running the summary of the regression model, the equations for different 'Outlook' can be concluded that:

For 'Outlook' as "-1": the realized sale (y) = expected sales rate (0.9277) * expected sales (x=65153.54) – Intercept (6217.2255);

For 'Outlook' as "0": the realized sale (y) = expected sales rate (0.9277) * expected sales (x=65153.54) – Intercept (6217.2255) + "Outlook0" (12352.2688);

For 'Outlook' as "1": the realized sale (y) = expected sales rate (0.9277) * expected sales (x=65153.54) – Intercept (6217.2255) + "Outlook1" (19872.5661).

```
> regression <- lm(RealizedSales~ExpectedSales+Outlook, data=df)
> summary(regression)

Call:
lm(formula = RealizedSales ~ ExpectedSales + Outlook, data = df)

Residuals:
     Min       1Q   Median       3Q      Max 
-11776.6  -3031.3    327.5   2802.6   9522.0 

Coefficients:
                Estimate Std. Error t value Pr(>|t|)    
(Intercept)   -6217.2255  7345.9390  -0.846    0.405    
ExpectedSales     0.9277     0.1111   8.348 4.41e-09 ***
Outlook0      12352.2688  2292.8955   5.387 9.63e-06 ***
Outlook1      19872.5661  2176.6458   9.130 6.90e-10 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 5178 on 28 degrees of freedom
Multiple R-squared:  0.8631,	Adjusted R-squared:  0.8485 
F-statistic: 58.86 on 3 and 28 DF,  p-value: 3.278e-12
```

3.2 Monte Carlo Simulation Processing

The third step is to calculate all the variables that are needed to determine the present values and both profits for Crawford and Southeast Bank in the office project. At the beginning of this process, the r discrete distribution will be used to create “Outlook” probabilities based on pessimistic economic “-1” with 12/32, the neutral economic “0” with 9/32, and the positive economic outlook “1” with 11/32. With the distribution of different outlooks, the actual sales can be calculated by applying the regression model from the previous step. Then, the regression model has a residual standard error of 5,178 as the standard deviation with a mean of 0, which needs to be applied to the actual sales so that more precise sales can be calculated to help the team get a more realistic simulation of office sales prediction. As a bank that provides the loan to Crawford, the present values of each trial are the key values that are needed to estimate the risk of the office project.

Moreover, Crawford will spend money on costs like the land, construction, sales & marketing costs, and the interest that needs to be paid to the Southeast Bank. All the costs are required to be converted to present values as well because the value of money in the future is different to the value of today. Therefore, the profits of the Crawford Office project can be more accurately calculated by using the present sales value minus all the present costs values, so that the Southeast Bank can determine each profit of the simulations to consider the risk level of the whole Crawford Office project by calculating how much profit that Crawford has left after paying back the loan and interest. Based on the simulations, the average precise sales that Crawford can make in an office project is $64,443.04k, and the average for the Southeast Bank's profit will be $8,873.231k.

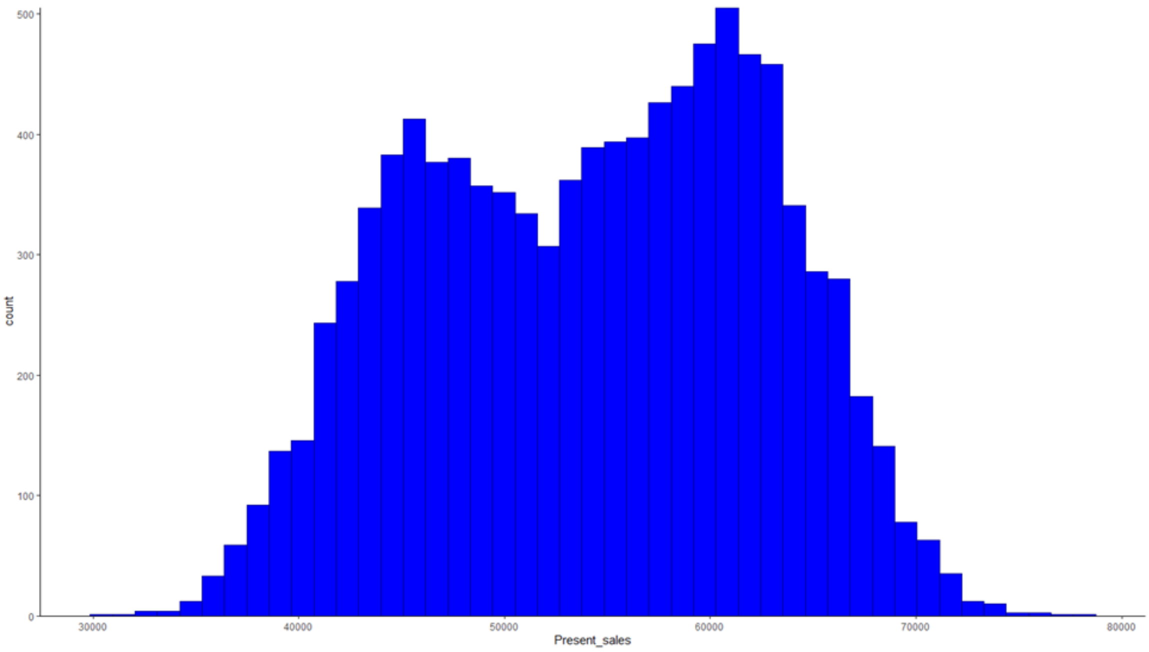
```
> df1 <- data.frame(
+   Outlook=rdiscrete(n,probs=c(12/32, 9/32, 11/32), values=c(-1,0,1))
+ ) %>%
+   mutate(
+     Actual_sales= case_when(
+       Outlook=='-1'~65153.54*0.9277-6217.2255,
+       Outlook=='0'~65153.54*0.9277-6217.2255+12352.2688,
+       Outlook=='1'~65153.54*0.9277-6217.2255+19872.5661
+     ),
+     S_Error=rnorm(n, 0, 5178),
+     Precise_sales= Actual_sales+S_Error,
+     Present_sales= Precise_sales/(1+0.06)^3,
+     Land_cost_Oct=rep(4375/(1+0.06)^0.25,n),
+     Land_cost=rep(500,n),
+     Construction_2007=rep(20000/(1+0.06)^0.25,n),
+     Construction_2008=rep(9000/(1+0.06)^1,n),
+     Construction_2009=rep(10200/(1+0.06)^2,n),
+     Sales_and_marketing_cost=rep(2300/(1+0.06)^2,n),
+     Interest=rep(8636.03/(1+0.06)^3,n),
+     principle=rep(38375/(1+0.06)^3,n),
+     Profit=Present_sales-Land_cost_Oct-Land_cost-Construction_2007-Construction_2008-Construction_2009
+     -Sales_and_marketing_cost-Interest-principle+38375,
+     Interest_and_loan_=rep(38375+8636.03,n),
+     Affordable=pmin(Interest_and_loan_,Precise_sales),
+     Profit_bank_NPV=Affordable/(1+0.06)^3-38375
+   )
> mean(df1$Precise_sales)
[1] 64698.29
> mean(df1$Profit)
[1] 9087.546
> mean(df1$Profit_bank_NPV)
[1] 1037.715
```

3.3 Simulation Findings

Lastly, there are totally three histograms to be drawn. The first histogram will be the distribution of the estimated total 10,000 trials of the sales value of July 2010.

```
ggplot(df1)+geom_histogram(mapping=aes(x=Present_sales),
                           bins = 45,
                           fill="blue",
                           color="dark blue")+scale_y_continuous(expand=c(0,0))+theme_classic()
```

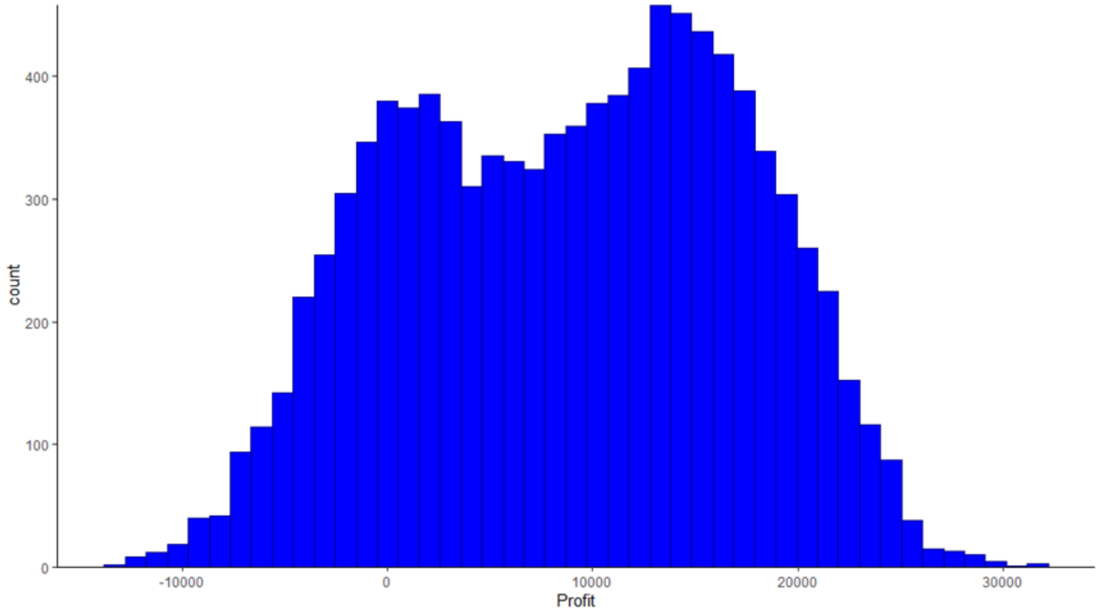
The histogram of all 10,000 present sales value simulation results will be:



From the histogram above, the mean of the NPV of sales in the whole simulation is $54,107.62k, and there are a total of two present sales peaks, which occur at around $45,000k and the highest one at around $61,000k. Also, the lowest downside bottom happens around $52,500k.

The next histogram will be the estimated profits of Crawford in the present value of July 2007, which are calculated by using the NPV of sales value minus the sum of the NPV of a series of cash flows including the land cost, the construction cost, the marketing cost, and the total loan and the interest that needs to be paid to the Southeast Bank.

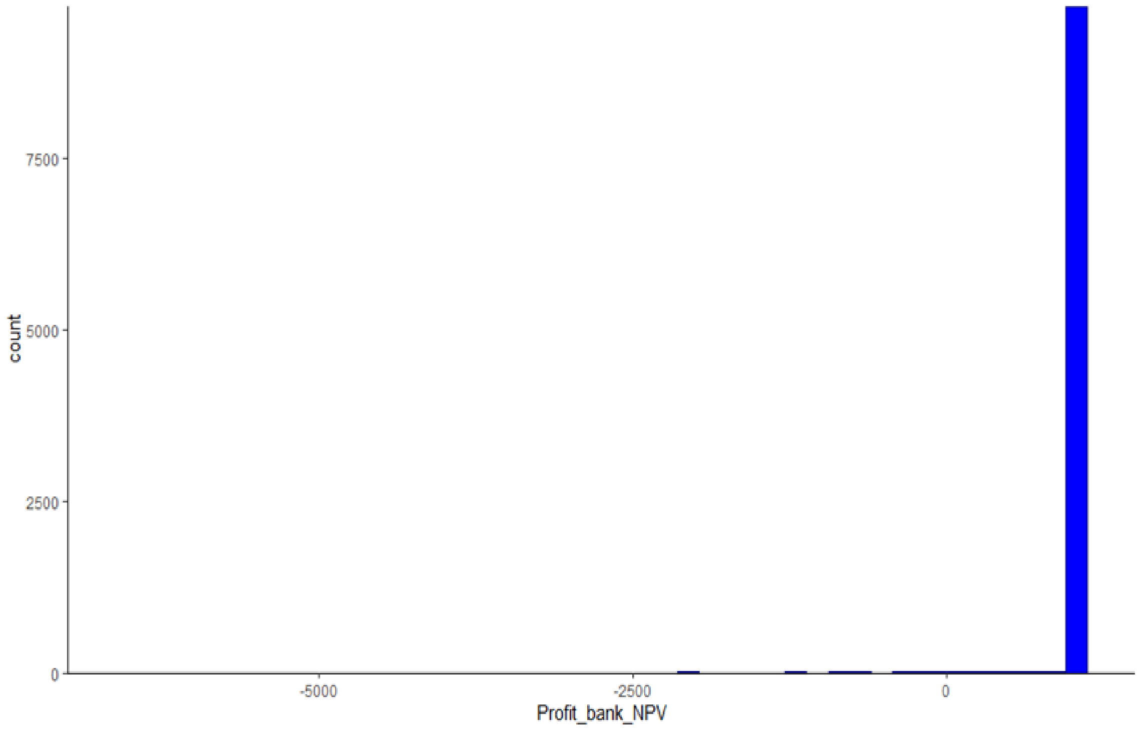
```
ggplot(df1)+geom_histogram(mapping=aes(x=Profit),
                           bins = 45,
                           fill="blue",
                           color="dark blue")+scale_y_continuous(expand=c(0,0))+theme_classic()
```



From the histogram above, the average profit of Crawford from the simulations is $8,873.231k, and there are also two Crawford profit peaks, which occur around $0 and the highest one around $15,000k.

The last histogram is the profit of the Southeast Bank in the present value of July 2007. It is calculated based on whether Southeast Bank can successfully collect the interest from Crawford. If Crawford makes profits from the office project, the bank can get the principal and interest at the end of July 2010. Or if Crawford cannot succeed in the office project and cannot pay off the principal and interest, the bank can only receive whatever values of precise sales of Crawford.

```
ggplot(df1)+geom_histogram(mapping=aes(x=Profit_bank_NPV),
                           bins = 45,
                           fill="blue",
                           color="dark blue")+scale_y_continuous(expand=c(0,0))+theme_classic()
```



From the histogram above, the average profit for the Southeast Bank is $1,037.715k, which indicates the profits of the Southeast Bank are mostly successfully received in the total interest payment from Crawford.

4 Option 2: Building Residential

4.1 Methodology for Analysis

Although the residential real estate market in Houston has bounced back from the crisis, and a promising outlook for profits is expected by Crawford, it is reasonable for SBT to take extra precautionary measures. Taking the residential option into consideration, the analysis aims to provide a thorough evaluation of the expected investment return. Moreover, due to the fact that SBT will take a higher risk by offering loans to Crawford for residential development, a higher interest rate is plausible to offset the potential negative impact and achieve maximum ROI.

4.2 Monte Carlo Simulation Processing

The analysis adapts sensitive analysis and optimization models to simulate and calculate the desired outcomes. For starters, in order to calculate the NPVs of the residential development, two uncertain inputs must be included. According to the information provided in the business case, the expected revenue of residential development will have a maximum value of 130 million, a minimum value of 20 million, and a most likely value of 42.3 million, which can be simulated by triangular distribution with the following parameters:

```
#Sales:triangular_distribution
sales_ml<-42.3*1000
sales_min<-20*1000
sales_max<-130*1000
```

The estimated cost of residential development can be broken into 2 parts, uncertain cost, and fixed cost. In order to simulate the uncertain cost, which according to the provided information, is a normal distribution with a mean of 20, a 95% confidence interval of 20*10%. The parameters are as follows:

```
#construction_cost:normal_distribution
cons_cost_mean=20*1000
cons_cost_sd=20*1000*0.05/1.96
```

Next, the two uncertain variables can be integrated into the simulation function of NPV of Crawford's residential development as follows:

```
#Finance
discount_rate<-0.06
lowest_i<-0.07
#possible interest rate: 7% - 11%


#simulation of the residential sales & construction cost
install.packages("triangulr")
library(triangulr)
r_sales=rtri(n,min=sales_min,max=sales_max,mode=sales_ml)
r_cons_cost=rnorm(n,mean=cons_cost_mean,sd=cons_cost_sd)
comp_df_r<-as.data.frame(r_sales)%>%
  mutate(cons_cost=r_cons_cost)
names(comp_df_r)[1]<-"sales"
comp_df_r<-comp_df_r%>%
  mutate(cf_0=cf0,
         cf_0.25=cf0.25_1-cons_cost,
         cf_1=cf1,
         cf_2=cf2)
View(comp_df_r)

install.packages("FinancialMath")
library(FinancialMath)
```

```
#cash_flows: see Case Exhibit 2
principal<-38375
cf0<-(principal-500) #Land deposit, at July 2007
cf0.25_1<-(-4375) #Land purchase, at Oct 2007
#cf0.25_2 is the initial construction cost(negative), at Oct 2007
cf1<-(-9000)  #construction cost at July 2008, the end of 1st year
cf2<-(-12500) #construction cost at July 2009, the end of 2nd year
#cf3_1 is the sales (positive), at July 2010
#cf3_2 is the principal and interest of loan (neg), at July 2010
```

```
#A function that add the cash flows that need to
#   be calculated by a given interest rate to the comp_df_r,
#   and calculate the NPV of the profit(company)
comp_prof_npv_func<-function(i){
  comp_df_r<-comp_df_r%>%
    mutate(cf_3=sales-principal*(1+i)^3)
  for (row in 1:n) {
    neg_cf_npv<-NPV(i=discount_rate,
                cf0=0,
                cf=c(comp_df_r[row,4],comp_df_r[row,5],comp_df_r[row,6]),
                times=c(0.25,1,2))

    pos_cf_npv<-NPV(i=discount_rate,
                cf0=0,
                cf=c(comp_df_r[row,7]),
                times=c(3))
    comp_df_r[row,8]=comp_df_r[row,3]+neg_cf_npv+pos_cf_npv
    print(row)
  }
  names(comp_df_r)[8]<-"prof_npv"
  return(comp_df_r$prof_npv)
}
```

In order to test the accuracy of this function, the following codes were used for verification:

```
#Theoretical NPV mean:
theo_npv_mean<-37875+
  ((-24375/1.06+24375)/4-24375)+
  (-9000/1.06)+
  (-12500/(1.06^2))+
  17088.97/(1.06^3)

#NPV mean of simulation
simu_npv_mean<-mean(comp_prof_npv_func(0.07))

list(theo=theo_npv_mean,simu=simu_npv_mean)
```

```
> list(theo=theo_npv_mean,simu=simu_npv_mean)
$theo
[1] 8577.636

$simu
[1] 8562.266
```

According to the above results, the outcome of the simulation is close to the theoretical NPV mean value, which indicates that our simulation can yield accurate simulation results.

After creating the function to simulate the NPVs of Crawford, the next step is to simulate whether Crawford will accept the loan offer based on different interest rates, and SBT's expected NPVs accordingly. Based on Kloeckner's past experience with one of his oldest clients, the interest rate SBT could offer falls into the range of 7% to 11%. Starting from 7%, with each percentage point of increase, there will be a 25% increase in the possibility that Crawford would decline the offer. Under such circumstances, the probability of whether Crawford will accept the offer can be simulated as follows:

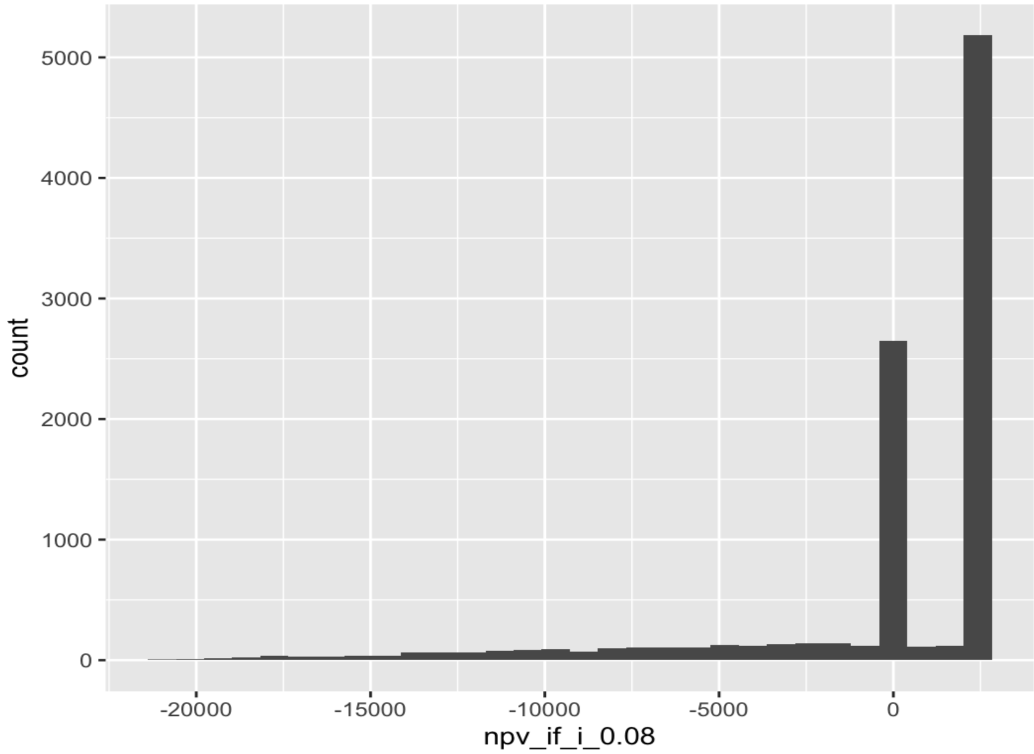
```
leave_index<-runif(n,min=0,max=1)

#A function that calculate whether the company will
#   accept the loan(1) or leave(0), given an interest rate
if_accept<-function(i,index){
  poss_leave<-0.25*(i-lowest_i)/0.01
  return(ifelse(test=(index>poss_leave),yes=1,no=0))
}

bank_df_r<-as.data.frame(r_sales)%>%
  mutate(princ=principal,
         leave_index=leave_index)
names(bank_df_r)[1]<-"sales"
```

Then, we can integrate the above simulation to a new function to simulate and calculate the NPV of SBT, considering two possible situations that Crawford accepting the offer or Crawford refusing the offer:

```
npv_profit_bank<-function(interest){
  bank_df_r<-bank_df_r%>%
    mutate(accept=if_accept(i=interest,index=leave_index),
           should_receive=ifelse(test=accept,
                                 yes=princ*(1+interest)^3,
                                 no=0),
           actual_receive=pmin(sales,should_receive))
  for (row in 1:n) {
    bank_df_r[row,7]<-ifelse(test=bank_df_r[row,4],
                             yes=(-principal)+
                               NPV(i=discount_rate,cf0=0,
                                   cf=c(bank_df_r[row,6]),times=c(3)),
                             no=0)
    print(row)
  }
  names(bank_df_r)[7]<-"npv"
  return(bank_df_r$npv)
}
```

Similarly, the accuracy of the above function can be tested as follows:

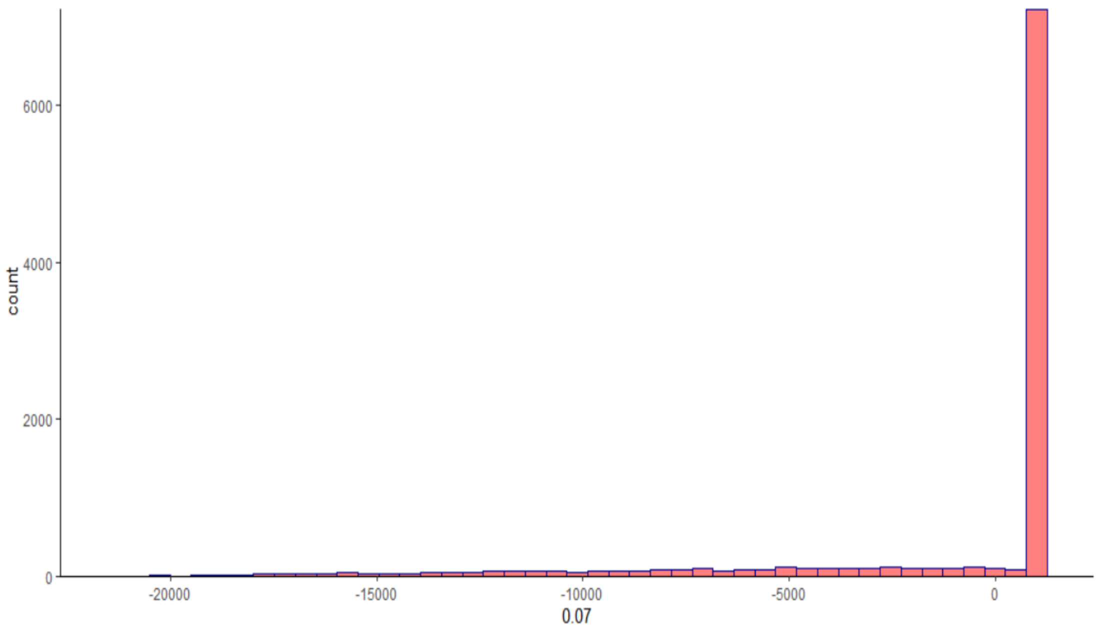
```
#Verify the correctness of the function npv_profit_bank:
test_BankNpvFunc<-npv_profit_bank(interest=0.08)
test_BankNpvFunc<-as.data.frame(test_BankNpvFunc)
names(test_BankNpvFunc)[1]<-"npv_if_i_0.08"
ggplot(data=test_BankNpvFunc,aes(x=npv_if_i_0.08))+geom_histogram()
```

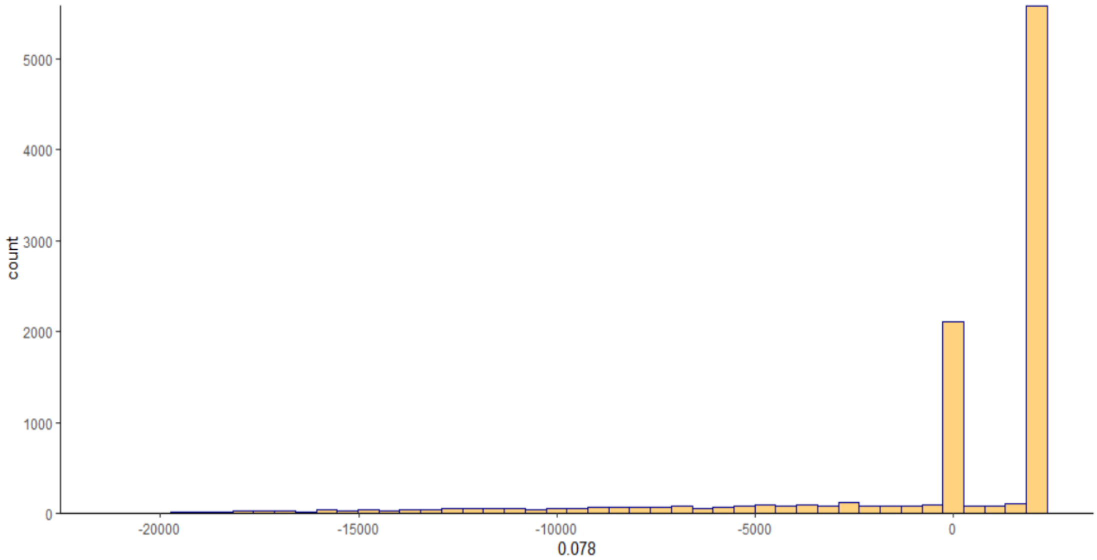


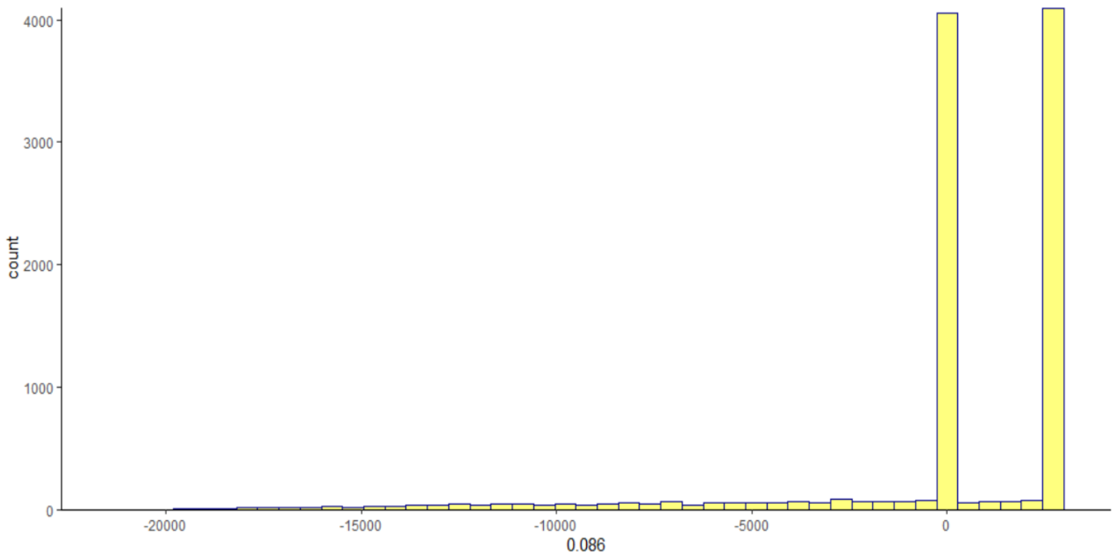
As shown in the above plot, if the bank offers a loan option with an interest rate of 8%, the two most likely outcomes of the NPV for SBT is either Crawford declines the offer, and the bank earns 0 profit from this project, or Crawford accepts and has good sales, so that the bank have a positive expected NPV.

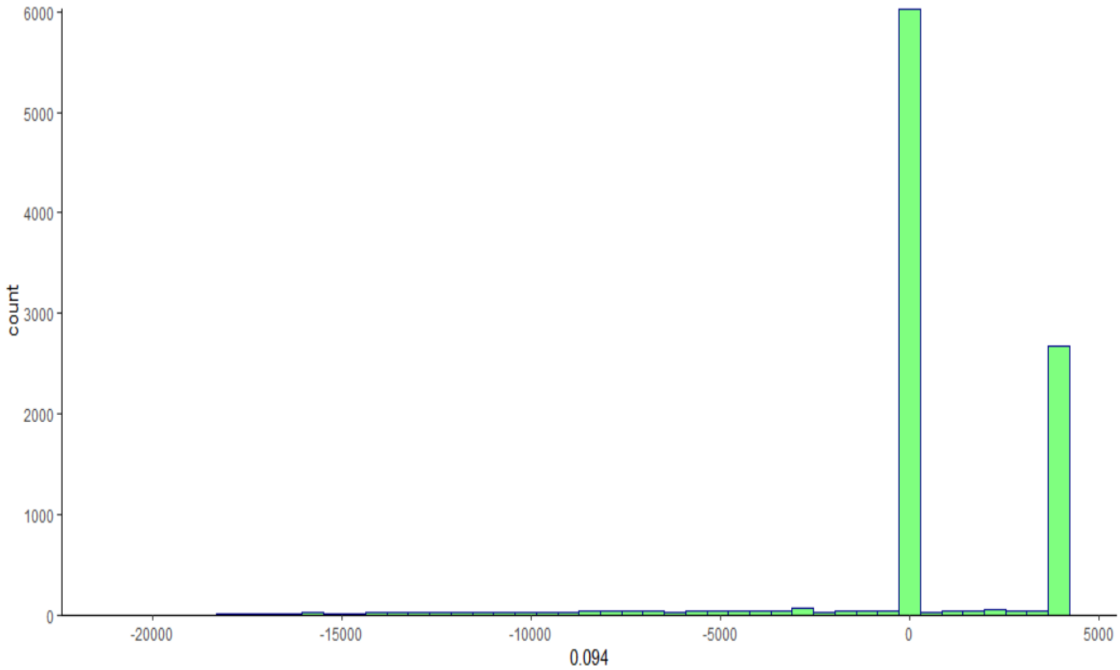
Now that the functions to simulate both Crawford and SBT's expected NPV were built, a series of histograms were generated to explore and obtain a general understanding of the distribution of SBT's expected NPV, with interest rates ranging from 7% to 11%.

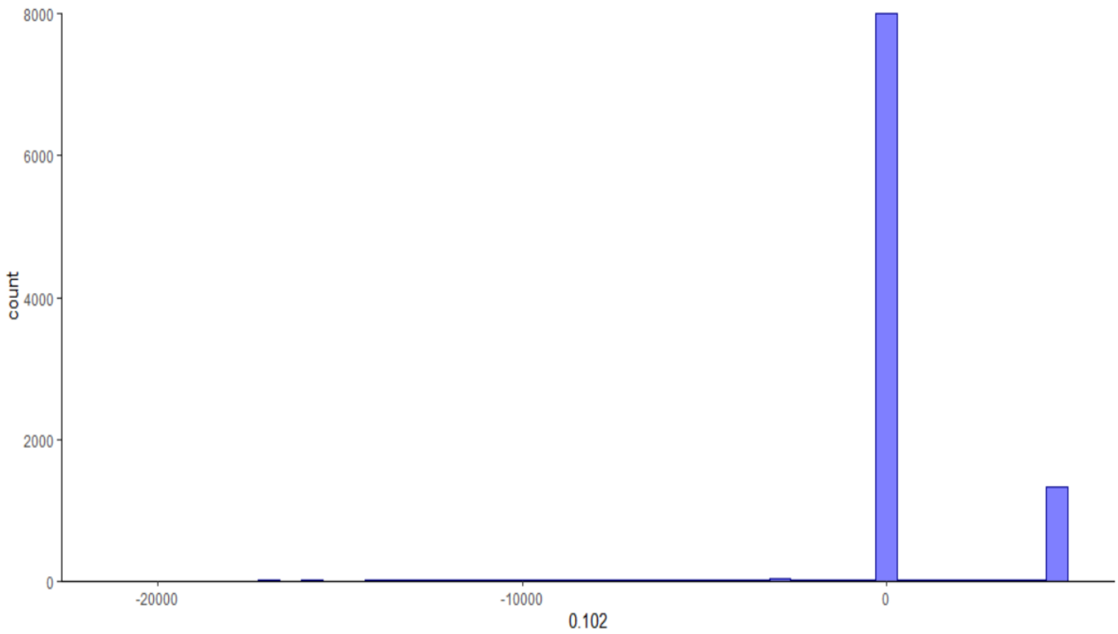
```
interest_list<-seq(0.07,0.11,0.008)
bank_npv_simu<-sapply(interest_list,npv_profit_bank)
bank_npv_simu<-as.data.frame(bank_npv_simu)
colnames(bank_npv_simu)<-interest_list

ggplot(data=bank_npv_simu)+
  geom_histogram(alpha=0.5,fill="red",
                 mapping=aes(x=`0.07`),
                 bins = 45,
                 color="dark blue")+
  scale_y_continuous(expand=c(0,0))+theme_classic()
ggplot(data=bank_npv_simu)+
  geom_histogram(alpha=0.5,fill="orange",
                 mapping=aes(x=`0.078`),
                 bins = 45,
                 color="dark blue")+
  scale_y_continuous(expand=c(0,0))+theme_classic()
ggplot(data=bank_npv_simu)+
  geom_histogram(alpha=0.5,fill="yellow",
                 mapping=aes(x=`0.086`),
                 bins = 45,
                 color="dark blue")+
  scale_y_continuous(expand=c(0,0))+theme_classic()
ggplot(data=bank_npv_simu)+
  geom_histogram(alpha=0.5,fill="green",
                 mapping=aes(x=`0.094`),
                 bins = 45,
                 color="dark blue")+
  scale_y_continuous(expand=c(0,0))+theme_classic()
ggplot(data=bank_npv_simu)+
  geom_histogram(alpha=0.5,fill="blue",
                 mapping=aes(x=`0.102`),
                 bins = 45,
                 color="dark blue")+
  scale_y_continuous(expand=c(0,0))+theme_classic()
ggplot(data=bank_npv_simu)+
  geom_histogram(alpha=0.5,fill="purple",
                 mapping=aes(x=`0.11`),
                 bins = 45,
                 color="dark blue")+
  scale_y_continuous(expand=c(0,0))+theme_classic()+xlim(-20000,5000)
```

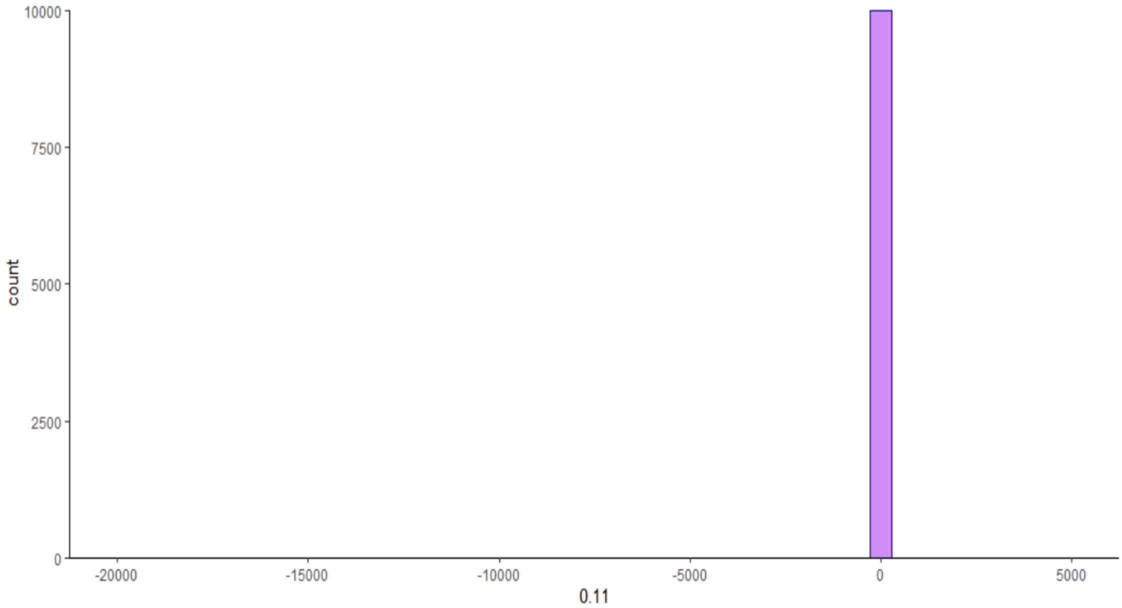



5000
4000
3000
2000
1000
0
count
-20000
-15000
-10000
-5000
0
0.078


4000
3000
2000
1000
0
count
-20000
-15000
-10000
-5000
0
0.086


6000
5000
4000
3000
2000
1000
0
count
-20000
-15000
-10000
-5000
0
5000
0.094





According to the series of histograms listed above, it can be briefly concluded that, with the increase of the given interest rate, the possibility that Crawford will decline the loan option will increase, but the profit of SBT will also increase once Crawford accepts the loan option.

4.3 Sensitivity analysis

In order to further understand the distributions, sensitivity analysis was performed to explore the impact of different interest rates on SBT's expected NPV.

```r
#Sensitivity analysis
interest_list_2<-seq(0.07,0.11,0.004)
bank_npv_simu_2<-sapply(interest_list_2,npv_profit_bank)
bank_npv_simu_2<-as.data.frame(bank_npv_simu_2)
colnames(bank_npv_simu_2)<-interest_list_2
sensi_ana_df<-as.data.frame(colSums(bank_npv_simu_2)/n)
for (column in 1:11) {
  sensi_ana_df[column,2:6]<-
    quantile(bank_npv_simu_2[,column],c(.1,.25,.5,.75,.9))
}
names(sensi_ana_df)<-c("mean","quantile0.1","quantile0.25","quantile0.5",
                       "quantile0.75","quantile0.9")
```

	mean	quantile0.1	quantile0.25	quantile0.5	quantile0.75	quantile0.9
0.07	-1147.80470	-8477.9992	-625.0099	1096.363	1096.363	1096.363
0.074	-742.22470	-7783.8782	0.0000	1540.690	1540.690	1540.690
0.078	-412.16383	-6997.8432	0.0000	1988.338	1988.338	1988.338
0.082	-155.67008	-5962.6353	0.0000	1308.227	2439.321	2439.321
0.086	35.43493	-4806.1279	0.0000	0.000	2893.651	2893.651
0.09	201.63406	-3081.8094	0.0000	0.000	3351.339	3351.339
0.094	280.62531	-638.8326	0.0000	0.000	3812.400	3812.400
0.098	284.52376	0.0000	0.0000	0.000	0.000	4276.844
0.102	282.82061	0.0000	0.0000	0.000	0.000	4744.685
0.106	205.27333	0.0000	0.0000	0.000	0.000	0.000
0.11	0.00000	0.0000	0.0000	0.000	0.000	0.000

According to the above results, it is safe to assume that as the interest rate increases, the mean value and majority of the simulation results of NPV increase, and peak when interest rate reaches around 10%. After that, there will be an increasing possibility that SBT gets a NPV of zero, which indicates that Crawford will decline their offer as the interest rate reaches a threshold that they no longer want to accept, resulting in a decrease in SBT’s expected NPV.

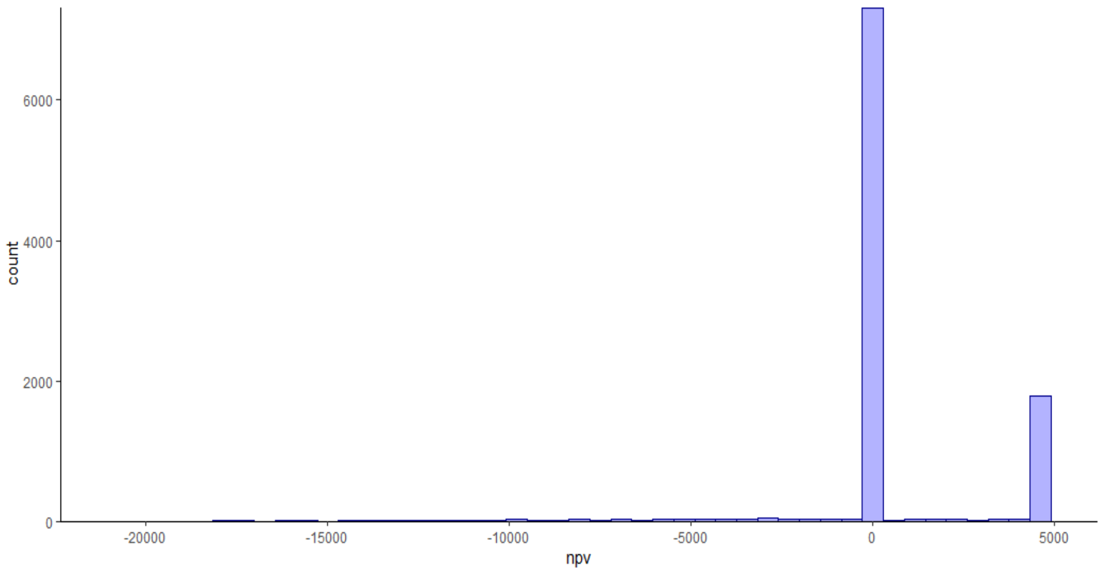
Based on the above analysis, two optimization models have been built to provide reasonable and prudent choices for SBT's final decision. In the first model, the interest rate is tested as an input variable in the range of 7% to 11%, and the interest rate that produces the highest expected NPV is returned.

```r
install.packages("DEoptim")
library(DEoptim)
```

```
npv_mean_opposite<-function(i){
  data<-npv_profit_bank(interest=i)
  return(-mean(data))
}

opt_model_mean<-DEoptim(fn=npv_mean_opposite,
                        lower=0.07,
                        upper=0.11)
opt_model_mean$optim
```

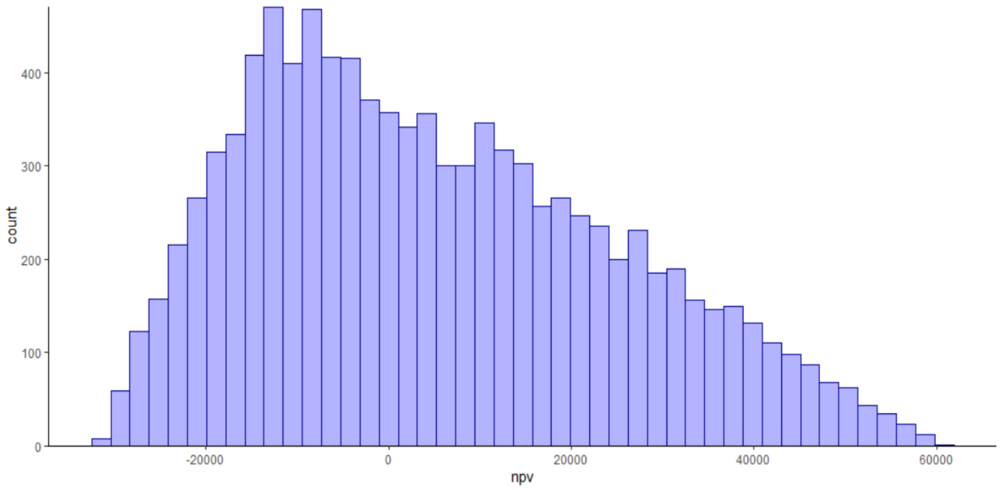
```
> opt_model_mean$optim
$bestmem
      par1
0.09918998

$bestval
[1] -311.8291

$nfeval
[1] 2010

$iter
[1] 200
```

The result of the first optimization model indicates that SBT can expect the highest expected return on their investment when they set the interest rate around 9.92%, and the expected NPV is 311.83 thousand. More specifically, the distribution of NPV of SBT is as follows:



Further, from the perspective of Crawford, if they accept the 9.9919% interest rate loan, their distribution of profit NPV will be:

```
comp_npv_i_0.09919<-as.data.frame(comp_prof_npv_func(i=0.09919))
names(comp_npv_i_0.09919)[1]<-"npv"
mean(comp_npv_i_0.09919$npv)
ggplot(data=comp_npv_i_0.09919)+
  geom_histogram(alpha=0.3,fill="blue",
                 mapping=aes(x=npv),
                 bins = 45,
                 color="dark blue")+
  scale_y_continuous(expand=c(0,0))+theme_classic()
quantile(comp_npv_i_0.09919$npv,c(0.1,0.25,0.5,0.75,0.9))
```




```
> mean(comp_npv_i_0.09919$npv)
[1] 5155.547
```

```
> quantile(comp_npv_i_0.09919$npv,c(0.1,0.25,0.5,0.75,0.9))
       10%        25%        50%        75%        90% 
-18758.791 -10879.939   2341.928  19092.028  34168.056 
```

In this way, however, SBT will have to take into account the higher possibility that Crawford would walk away from the offer, since the sensitivity analysis result indicates that an interest rate higher than 9.95% is highly possible to have a NPV of 0. On the other hand, according to the distribution of expected NPV if Crawford accepts the offer, SBT will also have to be cautious about the risk of negative NPVs, which will result in net loss for both SBT and Crawford.

Next, a second optimization model was built to figure out the ideal interest rate that can maximize the possibility that SBT has a positive expected NPV if they offer loans to Crawford to fund the residential development. In order to do so, the model needs to filter out the desired NPV values that are bigger than 0.

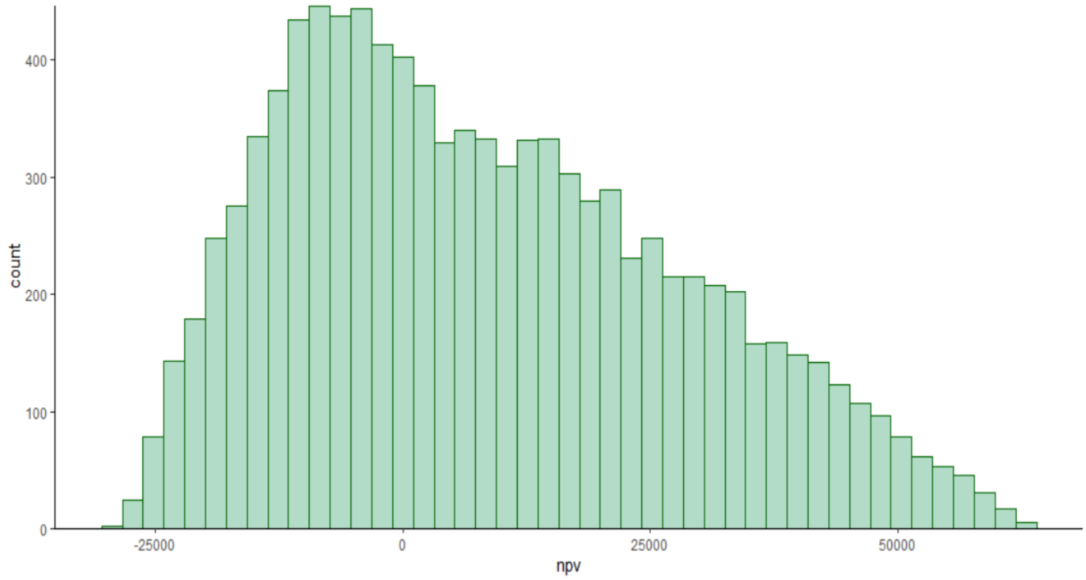
```
poss_npv_is_posi_opposite<-function(i){
  data<-npv_profit_bank(interest=i)
  return(-mean(data>0))
}

opt_model_poss<-DEoptim(fn=poss_npv_is_posi_opposite,
                        lower=0.07,
                        upper=0.11)
opt_model_poss$optim
```

```
> opt_model_poss$optim
$bestmem
      par1
0.07000266

$bestval
[1] -0.7352

$nfeval
[1] 2010

$iter
[1] 200
```

The result indicates that in order to ensure that SBT's investment can achieve the maximum expected possibility of getting a positive return, SBT should set the interest rate at 7%. The maximum expected possibility of getting a positive return is 73.52%.

In this case, from the perspective of Crawford, they will almost certain to accept the 7% interest rate loan, the distribution of profit NPV will be:

```
comp_npv_i_0.07<-as.data.frame(comp_prof_npv_func(i=0.07))
names(comp_npv_i_0.07)[1]<-"npv"
mean(comp_npv_i_0.07$npv)
ggplot(data=comp_npv_i_0.07)+
  geom_histogram(alpha=0.3,fill="springgreen4",
                 mapping=aes(x=npv),
                 bins = 45,
                 color="dark green")+
  scale_y_continuous(expand=c(0,0))+theme_classic()
quantile(comp_npv_i_0.07$npv,c(0.1,0.25,0.5,0.75,0.9))
```




```
> mean(comp_npv_i_0.07$npv)
[1] 8474.855
```

```
> quantile(comp_npv_i_0.07$npv,c(0.1,0.25,0.5,0.75,0.9))
       10%        25%        50%        75%        90% 
-15439.483  -7560.631   5661.236  22411.336  37487.364 
```

Offering a loan option with a 7% interest rate can guarantee customer retention and, in turn, provide SBT with the highest possibility of getting a positive profit NPV. However, implementing this loan option means that the bank is not charging more for the additional risk it takes, and the expected profit NPV of this loan option is negative.

4.4 Simulation Findings

Based on the above analysis, if Crawford decided to choose residential development, Southeast Bank of Texas should offer an interest rate of 9.92% to achieve the highest average investment return. However, they will have to bear higher risk for a deal breaker or negative returns. If SBT decides to adopt a more conservative strategy, they can stick with the 7% interest rate and have a higher possibility of positive return, which is also plausible considering the fierce competition of the loan business market and the negative impact of the subprime mortgage crisis.

5 Conclusion

5.1 Comparison

After thorough analysis and comparison of the two optional projects, it is strongly recommended that Crawford uses the loan in building an office, as it is more likely to generate steady profits that can help them pay the loan and the expected profit is higher.

The office market in Houston has a positive future with decreasing unemployment rate and growing needs in offices. Based on three-year historical data, we established a multiple regression model and Monte Carlo simulation on Crawford's performance. Through 10,000 trials, we estimate that the expected NPV of office sales discounted to July 2007 will be $54,107.62k, with SBT's expected profit being $1,037.715k.

On the other hand, the residential market is deemed riskier and offers an uncertain return. SBT could raise the interest rate to compensate for high risk, and the acceptable rate ranges from 7% to 11%. By utilizing sensitivity analysis and Monte Carlo simulation, we decide various expected profit's NPVs of SBT on different interest rates. The analysis reveals that SBT's expected NPV increases and then decreases with an increase in interest rates. By running two optimization models, it can be concluded that SBT could get the highest expected NPV of $311.83k when interest rate is 9.92%. Or SBT could offer a loan with an interest rate of 7% to get the highest possibility of getting a positive NPV of profit, and at the same time retain the customer to the greatest extent possible. In this case, there is a 73.52% possibility of getting a positive return, but the expected profit NPV is -$1147.80k.

A brief comparison of the three possible loan options is as follows:

Project	Loan Interest	Expected Profit NPV(k)	
		CDC	SBT
Office	7%	$8,873.23	$1,037.72
Residential	9.92%	$5,155.55	$331.00
	7%	$8,474.86	($1,147.80)

In a nutshell, the office market is more stable with higher expected profit compared to the residential market. Choosing the office project is a win-win for both CDC and SBT.

5.2 Recommendation

Our analysts' primary concern is that Crawford may not generate sufficient profits to repay the loan, particularly in an unstable residential market. Based on SBT's perspective, it is preferable that Crawford would choose to build an office. The bank cannot afford the high risk of watching this loan turn into a bad debt and never get money back. On the other hand, high interest rates stop CDC from borrowing the loan, which means there is high risk that SBT might lose this business. Under either situation, it is not optimistic for SBT. Thus, it is highly suggested for SBT to encourage Crawford to decide to invest in constructing an office to maximize benefits for both parties.