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Stress Testing of Real Estate Development Loan Risk for Banking Institutions

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Abstract: *Since subprime crisis made a terrible catastrophe to global economy, more and more financial institutions take stress testing as one of the most important tools of risk management. Particularly, banking institutions have direct relation with real estate loans and mortgage so we need to see how would these banking institutions affect when there is an extremely bad real estate development environment. In this paper, we will take Bank of America and China Construction Bank for example. More specifically, the paper is going to find out two relationships. One is the relation between non performing loan rate of real estate and Macro economic factors development, the other one is the total non performing loan rate and non performing loan rate of real estate development. After conducting an analysis, non performing loan rate of real estate is highly related with unemployment rate and house price and real estate gives a significant influence on total company non performing loan rate. What's more, we are also going to show how do we figure out BOA would be sensitive to house price while CCB might be influenced much more on house policy rather than house price.*

Keywords: *stress testing, non performing rate, real estate loan*

1. Introduction

After 2008 subprime crisis, banking institutions realized that real estate development loans are not guaranteed credit incomes anymore. Especially in China, banks become much more careful with the loan on real estate development industry. This paper is going to achieve three main goals. First of all, find a relation between Macro economic factors and non performing loan rate of real estate loan. Next, a relation between the whole Non performing loan rate and Non performing rate of real estate loan. Finally, set an extreme scenario and find out what would happen based on model we established. In the project, we find the real estate loan of BOA are influenced by GDP and unemployment significantly. Also bad performing loan are highly related to the bad performing loan of real estate. We also find that the non performing rate of real estate loan has a critical influence on total non performing loan rate of CCB in the past ten years.

2. Data

Here we use historical account data of Non-performing loan rate and the percentage of loans to conduct the regression. For Bank of America we use charge-off rate to represent Non-performing loan rate. Data period 2002 – 2016 are chose in the paper. For China Construction bank, the data we can find in the annual public account book is so limited for its on the public stock market not so long since 2005. Based on this condition, the regression may not be perfect. For both banks we will use the GDP growth rate, CPI growth rate, M2 velocity, house price index and unemployment rate. Here I decided to use Bank of American data to illustrate the method particularly then to analyze CCB's.

2.1 Data for Bank of America

The data of Bank of America is from 2002 to 2016 quarterly. The total charge-off rate which to some extent can be took as the non-performing rate. Charge-off rate in Percentage of Real-estate (or RE, for short). Also the paper listed the Macro factors which will be used then. They are GDP, M2 velocity (or M2, for short), House Price Index (or HPI, for short) and unemployment rate (or UNEM, for short).

Plot the view of the data (in R):

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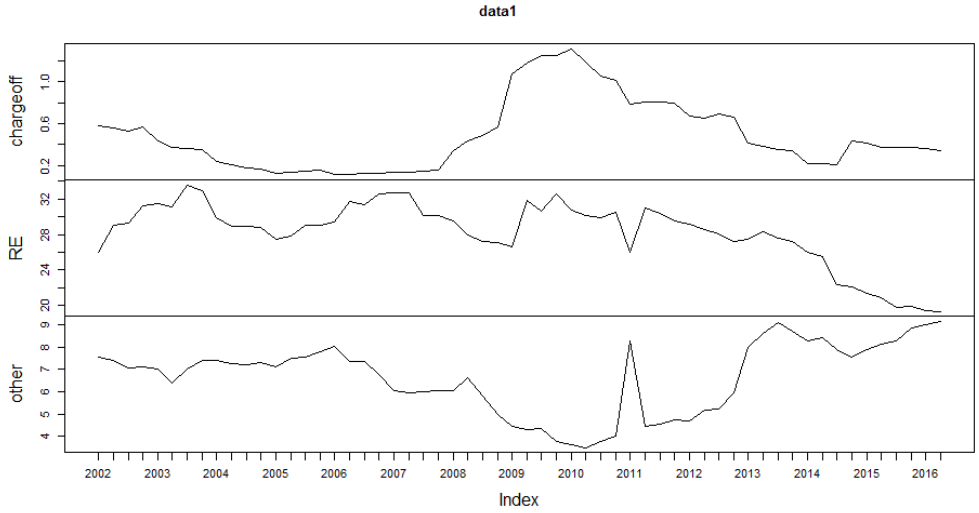

Figure 1: Charge off rate data plot

Charge-off rate can be expressed in detail as the bad performing loan over 118 days since the due day divided by the total loan given out (plus the allowance for doubtful account write off). The expression shows following:$\frac{bad\ performing\ loan\ over\ 118\ days}{total\ loan}$ both of them happen in the same time period. In this program we use quarterly data. Here I want to note that the charge-off rate is something different with the Charge-off ratio which the denominator is total asset.

To make the data series stationary, we difference the charge off rates which means the new increase of the charge-off rates and take the growth rate of macro factors data. The following is the stationary prepared data for macro factors.

In R, adf-test is used to test the stationary of data series. The non-hypothesis of adf-test is non-stationary which means if the output of P-value is smaller than 0.05 then data is stationary. While sometime adf-test can't tell exactly correct if there are some trends in the series so we also use KPSS test to double check the data stationary. The non-hypothesis of KPSS test is stationary which means if the output of P-value is larger than 0.05 the data is stationary.

After the test, adf-test for the first order difference charge off rates and prepared macro data series both show stationary based on 10% confidence level.

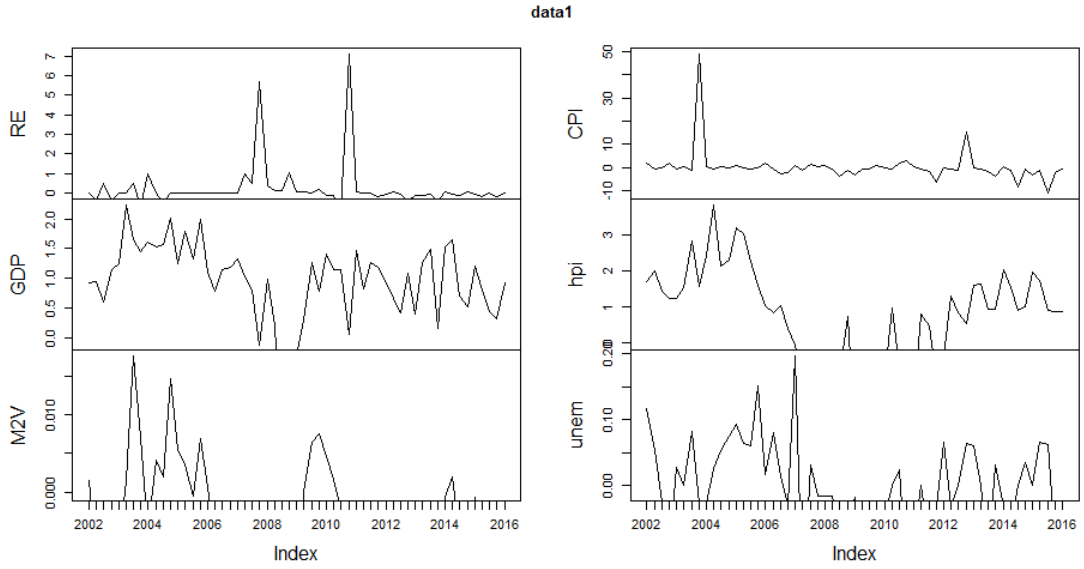

Figure 2: Stationary macro factors and charge off rate of real estate

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2.2 Data for China construction bank

We can get the percentage of real estate loan NPL rate. More specifically, we multiply the percentage and its NPL would come to the percentage NPL of real estate loan. Meanwhile, we find the date of GDP growth rate, CPI growth rate, M2V, house price index growth rate and unemployment growth rate.

The print data plot:

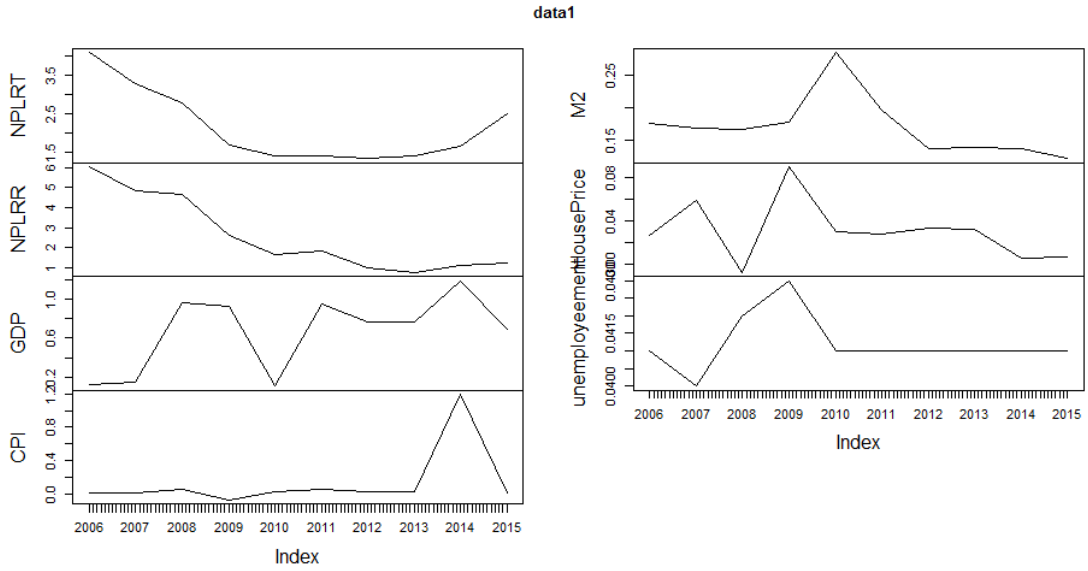

Figure 3: Plot of raw data of CCB

We can also do the first order difference of the data however the number of the data series available are so limited so keep the raw data is OK.

3. Regression

3.1 Bank of America

In this paper we will conduct two levels regressions. For the First level, dependent variable Y would be charge off rates in Percentage of Real-estate(RE). While independent variables X would be Macro factors. GDP growth rate (GDP), CPI growth rate (CPI), M2V growth rate (M2V), House Price Index (HPI) and unemployment rate (UNEM).

For the second level of regression, Y is total charge-off rate, X are charge-off rate in RE,

The sniped result in R for the first level of regressions is listed below:

```
Call:
lm(formula = RE ~ hpi + m2v + gdp + une + cpi)

Residuals:
     Min       1Q   Median       3Q      Max
-0.58824 -0.05181  0.01193  0.04387  0.48126

Coefficients:
             Estimate Std. Error t value Pr(>|t|)
(Intercept) -0.0927994  0.0613830  -1.512  0.13688
hpi         -1.0437270  3.2984266  -0.316  0.75299
m2v         -0.0221599  0.0665633  -0.333  0.74059
gdp         23.9642768 12.2996634   1.948  0.05699 .
une          4.1988139  1.1557150   3.633  0.00066 ***
cpi         -0.0009361  0.0242283  -0.039  0.96933
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.1365 on 50 degrees of freedom
Multiple R-squared:  0.2446,    Adjusted R-squared:  0.169
F-statistic: 3.238 on 5 and 50 DF,  p-value: 0.01309
```

Figure 4: Level one regression of BOA

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From the output of the regression we can see that both the unemployment growth rate and GDP growth rate have significant influence on new increase charge off rate of Real estate significantly (90% confidence level). However, it should be noted the HPI seems not significant, it might be the picked time period has a lag act on HPI. The regression function can be expressed as: $y_{RE} = -0.09 + 23.96x_{gdp} + 1.42x_{une}$ (the intercept is not significant).

The second level regression listed:

```
Call:
lm(formula = chargeoff ~ RE + other)

Residuals:
     Min       1Q   Median       3Q      Max
-0.40697 -0.13132 -0.03345  0.14483  0.56036

Coefficients:
             Estimate Std. Error t value Pr(>|t|)
(Intercept)  2.661796   0.356274   7.471 6.38e-10 ***
RE          -0.031206   0.009223  -3.384  0.00133 **
other       -0.195127   0.021002  -9.291 7.26e-13 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.2141 on 55 degrees of freedom
Multiple R-squared:  0.6201,    Adjusted R-squared:  0.6063
F-statistic: 44.88 on 2 and 55 DF,  p-value: 2.765e-12
```

Figure 5: LEVEL two regression of BOA

The output above implies that Real-estate new increase charge off rate influence the total new increase charge off rate significantly. The regression function can be expressed as $y_{total} = 2.662 + 0.0312x_{RE} + 0.195x_{other}$. Here we need to noted that the new increase charge off rate we did a reverse difference for better regression.

3.2 China construction bank

For level one regression, the dependent variable Y is percentage NPL of RE accord with the X, GDP growth rate, CPI growth rate, M2V, house price growth rate and unemployment rate.

For level two regression, Y is total NPL rate, X are percentage NPL of RE.

R regression output listed:

```
Coefficients:
             Estimate Std. Error t value Pr(>|t|)
(Intercept)  -46.6451    54.8890  -0.850    0.443
gdp           -4.8746     3.4221  -1.424    0.227
cpi            0.6345     2.6206   0.242    0.821
m2           -13.2452    20.2408  -0.654    0.549
hpi          -13.0306    30.7207  -0.424    0.693
unem        1335.3731  1405.2928   0.950    0.396

Residual standard error: 2.237 on 4 degrees of freedom
Multiple R-squared:  0.3899,    Adjusted R-squared:  -0.3728
F-statistic: 0.5112 on 5 and 4 DF,  p-value: 0.7603
```

Figure 6: Level one regression of CCB

According to the R output we can get the function: $y_{re} = -4.875x_{gdp} + 0.635x_{cpi} - 13.031x_{hpi}$ (the intercept is not significant) actually we can see the result is not obvious because of the reason that we mentions the number of the data is limited but we just listed to see if we can still get some thing accord with the fact.

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```
Call:
lm(formula = NPLT ~ NPLRE)

Residuals:
     Min       1Q   Median       3Q      Max
-0.46343 -0.33353 -0.01535  0.14242  0.93482

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept)  1.01909    0.24990   4.078 0.003544 **
NPLRE        0.44398    0.07944   5.589 0.000517 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.4551 on 8 degrees of freedom
Multiple R-squared:  0.7961,    Adjusted R-squared:  0.7706
F-statistic: 31.24 on 1 and 8 DF,  p-value: 0.0005167
```

Figure 7: Level two regression of CCB

From the output, we can see that the regression on the total NPL rate and NPL rates of real estate loan can be represented as $y_{\text{total}} = 1.019 + 0.444x_{RE}$.

4. Set a stress scenario

The scenario is a indispensable part of the stress testing and banks can desire different scenario that they want to know about. It is a tool which can be a supplement of VAR. Actually, it helps banks to control its risk expose to a huge loss and makes a efficient capital investment.

4.1 Scenarios for BOA

For the first scenario, we choose 2008 as an important event. The other scenarios are listed below:

For BOA:

Table 1: Level one scenarios of BOA

Growth rate /Scenario 1-3	GDP	Unemployment
2008 crisis	-0.008	0.080
Less risk	0.001	0.080
Extreme risk	-0.01	0.110

Table 2 Level two scenario of BOA

New increase charge off rate /scenario	Other
2008 crisis	0.06
Less risk	0.05
Extreme risk	0.08

These two scenarios frame are according to the historic data and the regression trend. The basis of the design is two levels regressions we got above (figure 4 and figure 5).

4.2 Scenarios for CCB

For CCB:

Table 2: Level one scenario of CCB

factors/scenario(1-3)	GDP growth	HPI growth	CPI growth
2008 crisis	0.96	-0.007	0.059
Less risk	0.96	0	0.026
Extreme risk	0.02	-0.008	-0.07

In this test the second level scenario just need to get the calculated RE from the level one scenario.

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From the scenario we note that 2008 global crisis has little influence on Chinese house price.

5. Analyze the stress test result

5.1 Bank of America analysis

Table 3: Stress test of BOA

Scenario/new increase of total charge-off rates	Senario1	Senario2	Senario3
result	2.668	2.673	2.71

From the stress testing above, we see some points. Frist, real estate development industry plays an important role in America, its charge-off rate keep a relative high level and potential to induce a serious new increase total charge of rate. Second, BOA has a relative stable loan system it wouldn't cause a fata problem only because of the bad performance of real estate industry. Third, there are problems existing in the model. It is reasonable that house price index would be really important to the real estate development industry. On the other hand, we can image that the real estate industry has a slow effect on the house price.

5.2 China Construction Bank analysis

Table 4: Stress test of CCB

Scenario/NPL rate	Senario1	Senario2	Senario3
result	3.15	3.104	3.21

From the result of scenario 1 and scenario 2 we can know that house price has influence on real estate industry but not the most obvious one. GDP and CPI both are relative more significant. Then we can see that when a macro policy which is negative to the real industry the non performing rate of real estate would be go negative rather.

6. Analysis conclusion and suggestion

The real estate development industry as one of the most important indexes to how an economy body performance well is highly concerned by more and more banking institutions. Definitely, as the direct loan creditors banks need to level up their risk management skill especially for real estate development industry. The paper use stress testing to show a simple method to analysis how banks can stand bad shocks in real estate industry.

We find that America and China are not the same. America credit system are relative stable and would not influence sharply by one factor. However, we have asserted a possible reason that may not show the stability of the system. The house price can not immediately influence the NPL rate of the real estate loan. It needs some time for real estate development company to act to the information. The story can be described as a chain effect. When house price goes down, less people can continue to pay their mortgage, more sellers than buyers in the house market, the real estate development industry will face a loss, then NPL rate increase. However, thing we can definitely show is BOA need continue to manage the real estate loan strictly. Real estate loan still influences the total credit risk significantly.

The house price can influence the NPL rate of real estate slightly. One reason is that Chinese house price goes a positive trend the last 10 years no exception. In this case, we can hardly tell what if the price goes down. The other reason is that the government uses policies to control development speed of real estate. Then we can see more influences of policies on NPL rate of real estate rather than of house price.

In conclusion, non performing rate of real estate is highly influenced by Macro economy and the total non performing rate is influenced by non performing rate of real estate loan. Bank of America should keep its strategy of crediting multiple kind of loans but it also need to take care of how house price would cause risk in further future. China Construction Bank need to analyze the policies of real estate more closely and give a relative quick respond also keep the eyes on the macro economics GDP.

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