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Dissecting the Burnout Factor for Modeling Mortgage Refinancing

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ABSTRACT

As an important variable for understanding mortgage prepayment, the burnout factor has two different usages. In pool level analysis it captures how the heterogeneity in borrowers impacts the slowdown in prepayment rates during a cycle of interest rate drop. The term is also employed in behavioral finance to measure borrowers' incentive for refinancing. Using national data published by Freddie Mac, our regression analysis shows that dissecting the burnout factor in terms of incentive and eligibility will make it a good predictor for mortgage refinancing. The two usages are equally valuable and can complement each other for modeling mortgage refinancing and for the valuation of mortgage-backed security (MBS).

INTRODUCTION

If interest rates take a fall, many borrowers will choose to refinance their mortgages. Refinancing results in a higher single monthly mortality (SMM). A massive wave of early payoffs during a low-rate period causes supposedly high-yield assets to lose value. Also, investors are forced to reinvest the proceeds in a lower-rate investment, which means lower returns going forward.

As an important concept for understanding and modeling mortgage prepayment, burnout has two different usages. One is used in pool-level analysis to track the diminishing prepayment speed across a rate drop cycle. The other measures borrowers' incentive – at loan level - for refinancing. This paper explains how the two usages can complement each other for evaluating mortgage-backed securities.

A NOTE ON THE DATA

Freddie Mac¹ and Fannie Mae² publish their single-family loan-level performance data of mortgages originated from 1999 and on for research use. The data contain two parts:

1. Origination information such as FICO, LTV (loan-to-value ratio), CLTV (combined loan-to-value ratio), DTI (debt-to-income ratio), loan term, product type (fixed or variable rate), original loan amount, property type (condo, townhome, single family house, etc.), loan purpose (purchase, cash-out refinance or rate/term refinance), mortgage insurance percentage, zip code and state.
2. Performance data by month. Variables include performance period, current unpaid balance, delinquency status, loan age, repurchase flag, fields related to loss and recoveries.

Prepayment data do not distinguish the reasons between turnover, cash-out refinance and rate/term refinance. Our study only uses the origination data, which contains flags for loan purposes.

BURNOUT IN POOL-LEVEL TREND ANALYSIS

Burnout originally means the reduction of a fuel to nothing through combustion. In mortgage business, burnout refers to the gradual exhaustion of eligible loans during a period of persistent low interest rates. In such a period, the prepayment speed is not expected to remain flat across all months. Borrowers with higher credit score and a lower loan-to-value (LTV) can have their mortgages refinanced more quickly than others who are unable to do so due to lower credit scores or lack of equity in the property.

Using Freddie Mac rate program³, we ran a study on how the trend of burnout for rate/term refinance differ from turnover. The following loans were selected for the analysis:

- 30-year fixed rate

¹ http://www.freddiemac.com/research/datasets/sf_loanlevel_dataset.html

² <http://www.fanniemae.com/portal/funding-the-market/data/loan-performance-data.html>

³ [https://www.pbmwholesale.com/rates/CA-Wholesale-Conv99\(2\).pdf](https://www.pbmwholesale.com/rates/CA-Wholesale-Conv99(2).pdf)

- One-unit single family home
- Loan amount below \$425,000 (to exclude jumbo loans)
- Primary residence
- FICO \geq 600
- LTV \leq 97%

We used the guideline for LLPA (Loan-Level Pricing Adjustment) issued by Freddie Mac and Fannie Mae to make adjustments to the prevailing market rate.

Credit Score	LTV Ratio							
	\leq 60%	60.01-70%	70.01-75%	75.01-80%	80.01-85%	85.01-90%	90.01-95%	95.01-97%
740+	0	0.25	0.25	0.5	0.25	0.25	0.25	0.75
720-739	0	0.25	0.5	0.75	0.5	0.5	0.5	1
700-719	0	0.5	1	1.25	1	1	1	1.5
680-699	0	0.5	1.25	1.75	1.5	1.25	1.25	1.5
660-679	0	1	2.25	2.75	2.75	2.25	2.25	2.25
640-659	0.5	1.25	2.75	3	3.25	2.75	2.75	2.75
620-639	0.5	1.5	3	3	3.25	3.25	3.25	3.5
<620	0.5	1.5	3	3	3.25	3.25	3.25	3.75

Table 1 – Loan-Level Pricing Adjustment (LLPA)

We divided borrowers into five groups by using LLPA as a proxy for measuring creditworthiness:

- 0: Excellent
- \leq 0.5: very good
- \leq 1: good
- \leq 2: fair
- > 2: poor

Using origination data only, we hypothesized the following:

- More eligible borrowers will get their refinances completed at earlier months.
- The prepayment speed will slow down after a few months even if interest rate remains low.

For our study we chose the period from January 2015 to September 2016. In these months the interest rate remained low with 30-year fixed rate averaged at 3.75%.

```
proc tabulate data=morg.loan_data format=6.5;
where first_payment_month > 201502 and first_payment_month le 201602;
by loan_purpose;
class eligibility_tier first_payment_month;
tables eligibility_tier, (first_payment_month all)*rowpctn; run;
```

As loan volumes for each tier of eligibility are different⁴, we used rowpctn to capture the trend of mortgage originations for each loan purpose. The following is the result for rate/term refinance:

Rate/Term Refinance													
Credit Worthiness	Months of First Payment												All
	201503	201504	201505	201506	201507	201508	201509	201510	201511	201512	201601	201602	
Excellent	7.6	13.3	16.0	12.7	10.7	8.4	7.0	6.0	7.0	3.8	3.7	3.8	100
Very Good	8.8	15.3	16.6	12.2	10.5	7.8	6.2	5.7	6.3	3.6	3.6	3.5	100
Good	9.5	11.5	14.1	12.2	10.6	8.8	6.8	6.8	7.1	4.4	4.1	4.0	100
Fair	8.2	10.5	12.9	12.5	9.7	9.1	7.7	7.1	8.4	4.8	4.6	4.4	100
Poor	7.1	7.8	11.6	10.8	9.9	8.1	7.4	8.3	10.6	6.6	6.1	5.6	100

Table 2 – Prepayment trend for rate/term refinance

⁴ Excellent eligibility and very good eligibility account for 20% and 56% of new originations, respectively.

Even though rate drop occurred at the beginning of the year, it usually takes a month to complete the transaction and another month to start the first month payment, so a lag of two months between the start of rate drop and the rise of prepayment is expected. The table above shows that refinance started to boom in April and May of 2015, and the trend tapered off in subsequent months. Also, borrowers with excellent or very good creditworthiness were more likely to get refinanced in earlier months.

Although cash-out refinance is often associated with increasing housing values, many borrowers will take the advantage of low rates to reduce the cost of borrowing in cashing out a portion of home equity for other uses. In reality, some borrowers who originally intend for a rate/term refinance will change to cash-out refinance after some persuasion by loan officers⁵. Therefore, a certain percentage of cash-out refinance could have mixed purposes. This has also been reflected in our analysis as follows:

Rate/Term Refinance													
Credit Worthiness	Months of First Payment												All
	201503	201504	201505	201506	201507	201508	201509	201510	201511	201512	201601	201602	
Excellent	6.6	8.6	11.6	11.2	10.8	9.6	9.4	8.6	9.3	5.0	4.6	4.8	100
Very Good	7.0	9.4	11.6	11.4	10.5	9.5	9.1	8.5	8.9	5.1	4.5	4.6	100
Good	7.1	8.2	10.8	10.6	10.1	9.5	9.2	9.3	9.2	5.9	4.8	5.1	100
Fair	7.0	7.5	10.2	10.3	9.4	10.2	9.0	9.8	10.5	5.5	5.6	5.1	100
Poor	6.9	7.1	7.9	7.6	7.9	9.1	8.2	11.7	12.2	7.7	6.5	7.2	100

Table 3 – Prepayment trend for cash-out refinance

In contrast, we do not see a similar pattern in turnover/purchase.

Purchase													
Credit Worthiness	Months of First Payment												All
	201503	201504	201505	201506	201507	201508	201509	201510	201511	201512	201601	201602	
Excellent	5.7	6.0	8.5	9.4	10.7	11.4	11.8	11.3	10.8	5.1	4.2	5.0	100
Very Good	5.7	6.6	9.2	9.9	10.8	11.7	11.7	11.2	9.8	4.7	4.0	4.8	100
Good	5.6	6.4	9.0	10.4	10.5	11.4	11.3	11.2	10.1	5.0	4.0	5.1	100
Fair	6.1	6.1	8.9	9.7	10.4	11.3	11.5	11.1	10.4	5.1	4.3	5.2	100
Poor	6.1	5.6	7.5	9.1	9.9	10.5	11.3	11.8	11.1	6.1	5.0	5.9	100

Table 4 – Prepayment trend for turnover/purchase

Insights generated from data analysis as above can be used to estimate the prepayment speed and changes in asset value caused by an expected or hypothesized rate drop in the future.

BURNOUT FROM MENTAL ACCOUNTING PERSPECTIVE

The second usage of burnout is defined in terms of the significantly positive refinance spread cumulated over the rate drop cycle. A most common treatment is as follows:

$$burnout = \sum_{t=1}^j \max(\log(C/R_t), 0) \quad \text{Equation 1}$$

where C = coupon (or contract) rate of a mortgage

R_t = prevailing interest rate available for refinancing at period t

By using both origination data and performance data, the above equation has the following assumptions:

- The bigger the spread between coupon rate and prevailing interest rate, the stronger the incentive.
- The longer the period of rate drop cycle, the more likely a refinance will occur.

⁵ Cash-out refinance usually charges 1% higher in interest rate than rate/term refinance for the same loan, and in general is preferred by investors.

Although the two assumptions make sense, our data analysis shows confusing result as in Figure 1. When burnout factor is below 0.33, larger spread did encourage more refinancing. However, once the burnout factor exceeded 0.33, a stronger incentive induced lower rate of refinancing.

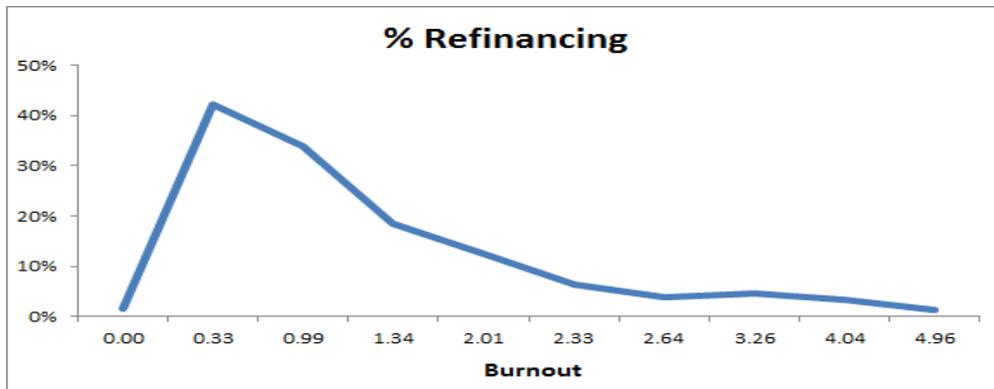


Figure 1 – Burnout and Prepayment

What is the reason behind the reversal? Here are some deficiencies in Equation 1:

- Incentive does not automatically translate into eligibility. The new rate would only apply to borrowers with higher FICO and low LTV. The higher the spread, the lower eligibility for refinancing in general. For example, a borrower whose mortgage originated six months ago with a coupon rate of 6.75% is unlikely to qualify for a new rate of 4%, no matter how high his/her incentive might be.
- Most borrowers have a realistic expectation for their eligible rates. The borrower with a current coupon rate of 6.75% would be happy to get his mortgage refinanced at the rate of 5.75%, knowing that he/she will not be eligible for a market rate of 4%.

Therefore, we added some remedies to Equation 1:

$$burnout = \sum_{t=1}^j \max(\log(C/(1.1 \times (R_t + LLPA))), 0) \quad \text{Equation 2}$$

where *LLPA* = loan-level risk adjustment as stipulated in table 1.

The multiplier 1.1 accounts for all types of costs associated with refinancing, such as closing cost and mental pressure incurred to a borrower. For example, a borrower with coupon rate of 5.5% will only consider refinancing if his eligible rate drops below 5%.

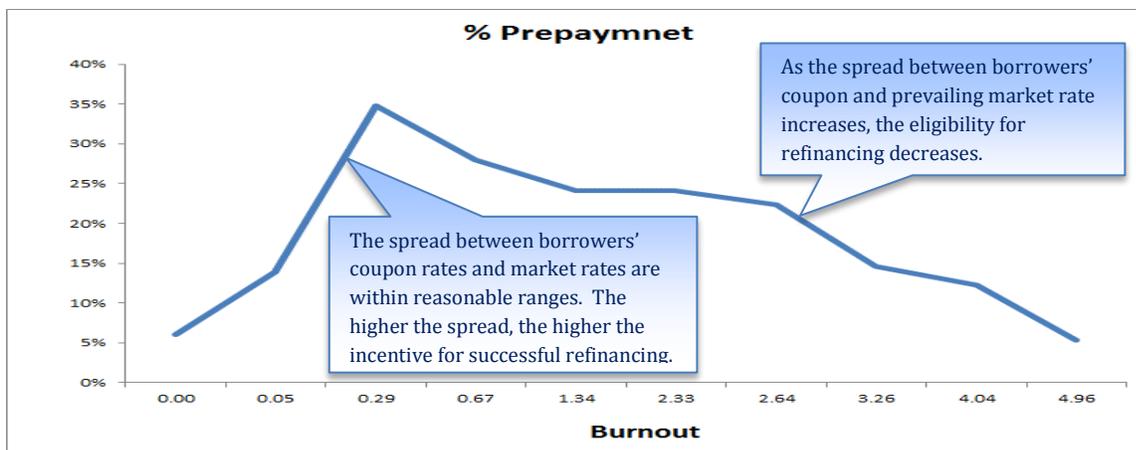


Figure 2 – Dissecting burnout factor

Incorporating both incentive and eligibility into consideration, we refined the burnout factor as follows:

$$\text{burnout_factor} = -\sqrt{|\text{burnout} - 0.3|}$$

We expected its sign to be positive in our regression analysis⁶.

Georgia, Massachusetts and Tennessee were selected to run a regression analysis. Georgia is considered to be most representative of the US market in terms of homeowners. Massachusetts and Tennessee are among the states with highest housing prices and lowest housing prices, respectively. We wanted to see whether some commonality will emerge from separate regressions.

```
proc logistic data=loans_GA descending outest=estout;
model prepaid=
fico
cltv
dti
orig_upb
ltv
loan_age
interest_rate_at_origination
burnout_factor
diff_ltv / selection=stepwise;
run;
```

The following are regression results for our regression analysis based on the sample of Georgia:

Parameter	DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept	1	-9.9697	0.3004	1,101.20	<.0001
FICO at origination	1	0.017	0.000306	3,068.80	<.0001
CLTV at origination	1	0.00315	0.000815	14.9	0.0001
DTI at origination	1	0.00655	0.000974	45.3	<.0001
loan amount at origination	1	3.31E-06	1.23E-07	717.4	<.0001
LTV at refinancing	1	-0.1202	0.00126	9,033.70	<.0001
loan Age	1	-0.0158	0.000442	1,286.80	<.0001
interest Rate at origination	1	1.5287	0.0229	4,471.30	<.0001
burnout_factor	1	1.8789	0.0244	5,922.80	<.0001

Table 5 – Regression summary based on Georgia sample

Parameter	DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept	1	4.0241	0.31	168.5	<.0001
FICO at origination	1	0.00773	0.00027	819.8	<.0001
CLTV at origination	1	0.00427	0.00071	36.2	<.0001
DTI at origination	1	0.00999	0.00103	94.4	<.0001
loan amount at origination	1	3.13E-06	1.09E-07	826.8	<.0001
LTV at refinancing	1	-0.187	0.00172	11,761.70	<.0001
loan Age	1	-0.0302	0.000524	3,312.70	<.0001
interest Rate at origination	1	1.378	0.0235	3,430.10	<.0001
burnout_factor	1	1.7866	0.0323	3,052.90	<.0001

Table 6 – Regression summary based on Massachusetts sample

⁶ The peak of 0.3 is partially determined upon the length of rate drop cycle.

Parameter	DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept	1	-3.5314	0.3861	83.7	<.0001
FICO at origination	1	0.012	0.000366	1077.4	<.0001
DTI at origination	1	0.0102	0.00124	67.2	<.0001
loan amount at origination	1	2.79E-06	1.52E-07	337.2	<.0001
LTV at refinancing	1	-0.1316	0.00178	5455.3	<.0001
loan Age	1	-0.0142	0.000597	566.1	<.0001
interest Rate at origination	1	1.193	0.0284	1762.3	<.0001
burnout_factor	1	1.7199	0.0326	2790	<.0001

Table 7 – Regression summary based on Tennessee sample

We can see the following commonality from the results above:

- The strongest predictor is current LTV. This suggests that eligibility is the main driver for successful refinancing.
- Burnout is the second strongest predictor. The positive sign is consistent with our hypothesis.
- FICO score, loan amount and interest rate at origination play a moderate role.
- CLTV and DTI at origination have a marginal impact on refinancing.

We would like to make one final note. By combining prevailing market rate and LLPA adjustments only, our assumed interest rate available to borrowers are very “bareboned.” As eligible rates for different pools of borrowers are difficult – if not impossible – to collect, usually only the “bareboned” version is available to analysts in the mortgage industry for modeling prepayment.

CONCLUSION

Prepayment model is always less than perfect. The paper examined two different usages of the burnout factor in mortgage analytics. The pool-level analysis gives a straight forward view on how prepayment speed slows in a rate drop cycle that spans multiple months. The regression analysis dissects the burnout factor in terms of incentive and eligibility and makes it a strong predictor for mortgage refinancing. The two usages are equally valuable and both can be applied for modeling mortgage refinancing and for evaluating mortgage-backed security.

CONTACT INFORMATION

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