MSCI Agency Fixed Rate Refinance Prepayment Model

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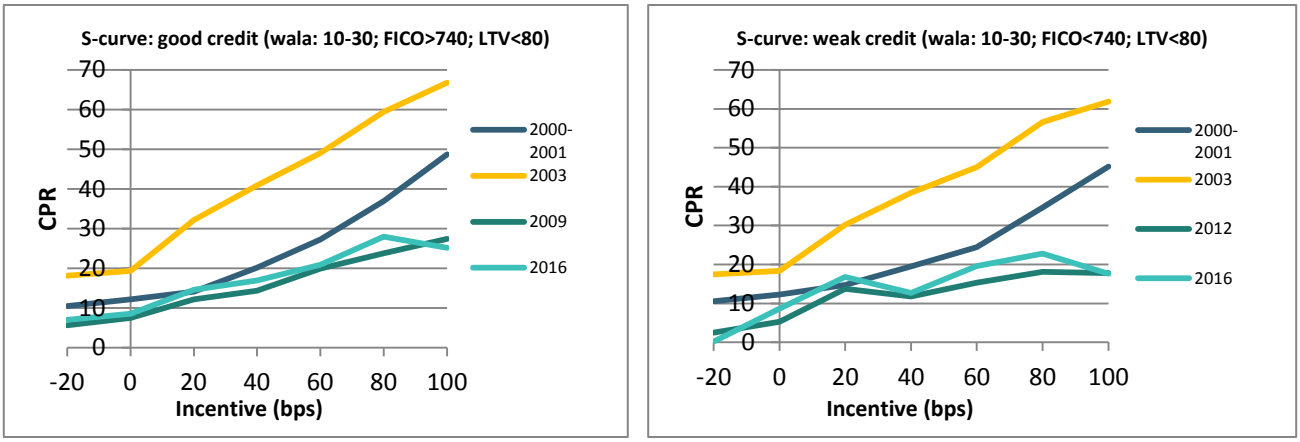
1 Summary

The greatest MBS prepayment risk is driven by borrowers' economic incentive to lower their monthly payments, i.e., to refinance their existing mortgage to lower mortgage rates. Refinance intensity is usually modeled as an S-curve: prepayment SMM (single monthly mortality) vs. economic incentive. For the past 20 years, the shape of the S-curve has changed numerous times due to prepayment regime shifts driven by new government policies/programs, changing underwriting standards, the housing price cycle, consumer behavior adjustments, and technology advancements.

Exhibit 1 displays changing S-curves for good/weak credit borrowers for different periods. 1996-2001 is the benchmark for prepayment efficiency with an average housing credit environment. During the housing boom years (2002-2006), the entire US housing market was flooded with easy credit (i.e., lax underwriting standards, varieties of alternative mortgage products, and a strong housing market). During the 2003 refinance wave, the prepayment reached 70 CPR for certain cohorts. This period is generally considered as the peak efficiency of refinance.

Then, the Great Recession profoundly changed the landscape of the mortgage industry. Since 2008, an unprecedented number of homeowners went delinquent on their mortgage payments. GSE tightened their credit box drastically. Mortgage lenders were forced to buy back massive amounts of default loans. Regulators initiated numerous regulations upon all aspects of the mortgage industry. Banks were fined billions of dollars for their misconduct before the financial crisis. Altogether, mortgage credit became scarce to borrowers, despite the fact that rates kept hitting new lows, thanks to Fed's QE programs. Subsequently, the refinance S-curve after the 2008 financial crisis became heavily suppressed, especially for weak credit borrowers.

Exhibit 1: Changing S-curves across time reveal prepayment regime structures.



Source: Fannie Mae, Freddie Mac, MSCI

As housing prices have been recovering gradually for recent years, underwriting standards have loosened to a certain extent. As a result, the S-curve for recent years has steepened mildly. Exhibit 2 summarizes the CPR ratios for good/weak borrowers' refinance intensity with respect to the benchmark years 2000-2001.

Exhibit 2: CPR ratios for refinance intensity across different prepayment regimes

	2000-2001	2003	2009-2012	Current
Good Credit Borrowers	1	1.70	0.66	0.72
Weak Credit Borrowers	1	1.70	0.54	0.62

Source: Fannie Mae, Freddie Mac, MSCI

An accurately calibrated and well-behaved refinance prepayment model is critical for MBS valuation and risk management. This Model Insight details how the MSCI Fixed Rate Prepayment Model captures the complex dynamics of refinance behavior in a consistent and responsive way.

2 Refinance Prepayment Model

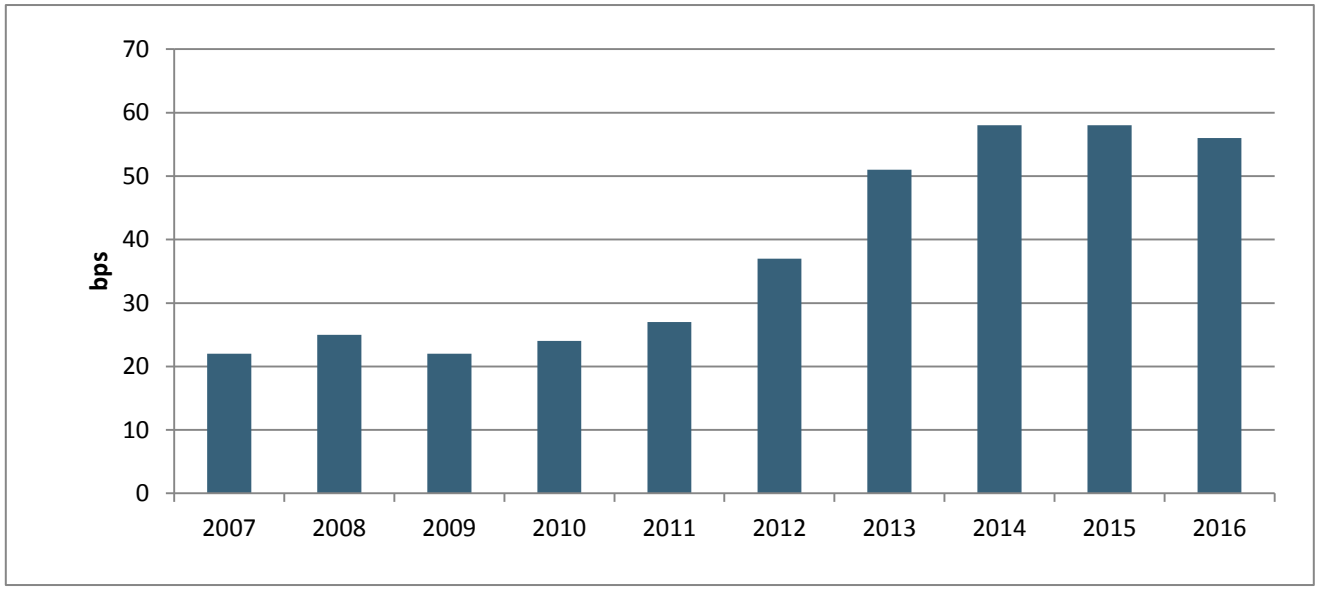
2.1 Economic Incentive

We define the economic incentive as the monthly payment ratio between the existing mortgage and the prospective mortgage with the prevailing mortgage rate, adjusted by a risk-based, loan-level pricing adjustment and refinancing costs.

$$Economic\ Incentive = \frac{LevelPayment(WAC, Remaining\ Term)}{LevelPayment(Mortgage\ Rate + Refi\ Cost + LLPA, Remaining\ Term)} - 1$$

Historically, the G-fee charged by GSE had been below 25 bps, until the financial crisis forced GSE gradually to raise the fees across different products and risk tiers, including a 10 bps increase beginning in 2012 to fund the payroll tax cut. Exhibit 3 shows the annual average G-fee has increased drastically over the past 10 years. Meanwhile, mortgage originators started to face more underwriting regulations and putback risk. This led to higher refinancing costs for borrowers.

Exhibit 3: Annual Average Guarantee Fees by GSE

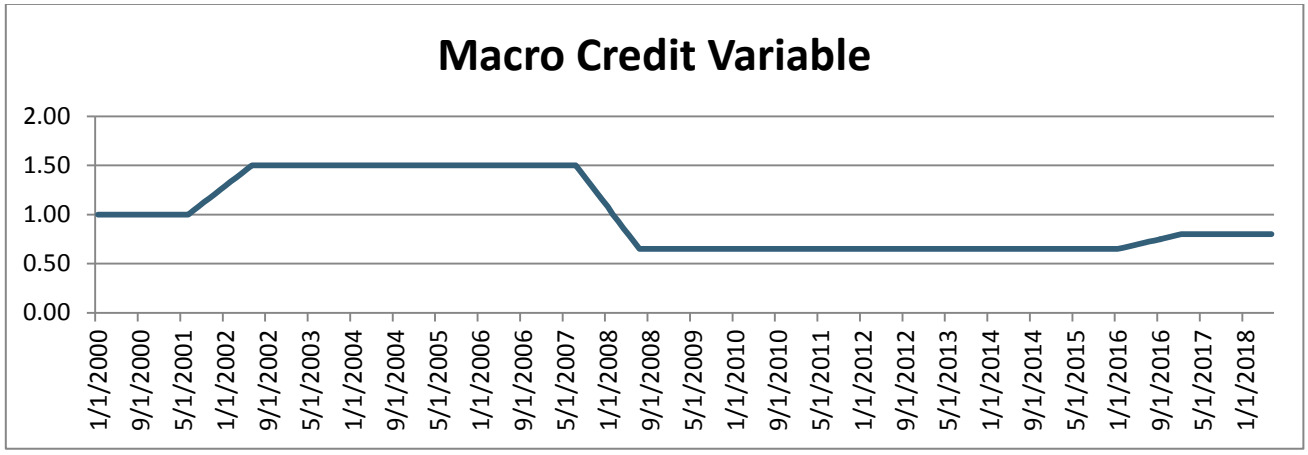


Source: FHFA

2.2 Macro Credit Variable (MCV)

The overall refinance S-curve is driven by the availability of housing credit. We extract the historical housing credit availability based on an historical credit profile of new originations, the abundance of alternative mortgage products, and rolling empirical S-curves across different collateral attributes. The resulting time series of Macro Credit Variable (MCV) is shown in Exhibit 4. The MCV ramps up as the housing bubble started to form. As housing credit became excessive during the boom years, MCV reached an unusually high level. The financial crisis in 2008 deflated the credit bubble and kept the MCV at a suppressed level for an extended period. MCV has inched up in the past three years, as the housing market rebounded and the US economy proved to be resilient.

Exhibit 4: MCV evolves through credit cycles.



Source: MSCI

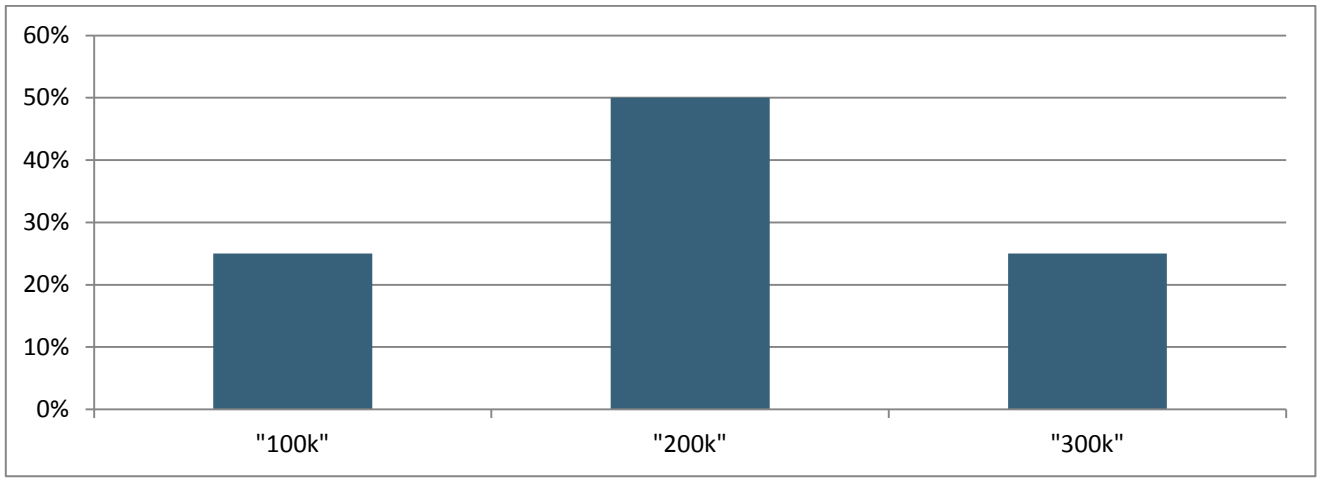
2.3 Dynamic Population Burnout Approach

Refinance intensity is driven by macroeconomic variables and loan/borrower attributes. As a MBS bond ages, the underlying collateral composition evolves. Loans with "faster prepayment" attributes will retire from the group at a "faster" pace. Hence, the average collateral attributes will drift toward the "slower prepayment" side. We define this phenomenon as "explicit burnout." In addition to explicit loan/borrower attributes, there are non-disclosed "implicit" loan/borrower attributes, such as the borrower's financial sophistication, hidden debt/income, etc. As the collateral group experiences refinance opportunities over time, these "implicit" attributes will also gear toward the "slower prepayment" side. We define this as "implicit burnout." We employ a dynamic population burnout approach to model "explicit burnout" and "implicit burnout" simultaneously and interactively.

Our dynamic population burnout approach evolves nine pseudo subpopulations. The two-dimensional ("explicit" and "implicit") pseudo subpopulation matrix consists of three sets of values for "explicit" and "implicit" loan/borrower attributes, respectively.

The "explicit" dimension is driven mostly by loan size distribution. We approximate the loan size distribution by agency quartile distribution data. Exhibit 3 shows a sample loan size distribution with three subpopulations. As the group goes through a refinance wave and loans with a larger remaining balance prepay faster, the proportion of the higher loan size subpopulation will decrease. This design subsequently tracks the "explicit burnout" naturally.

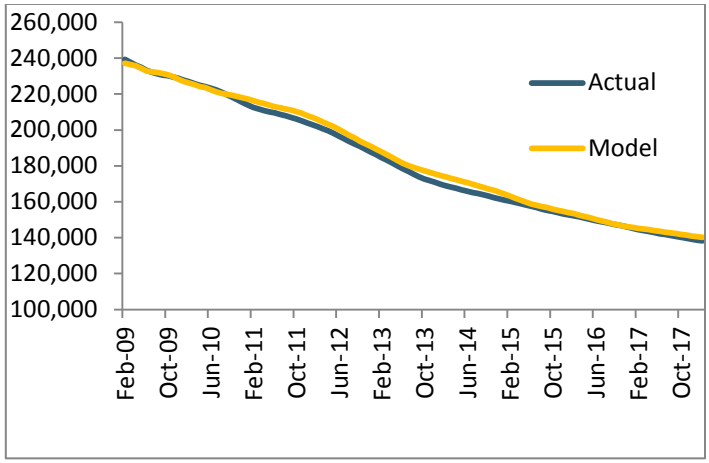
Exhibit 5: Sample loan size distribution



Source: MSCI

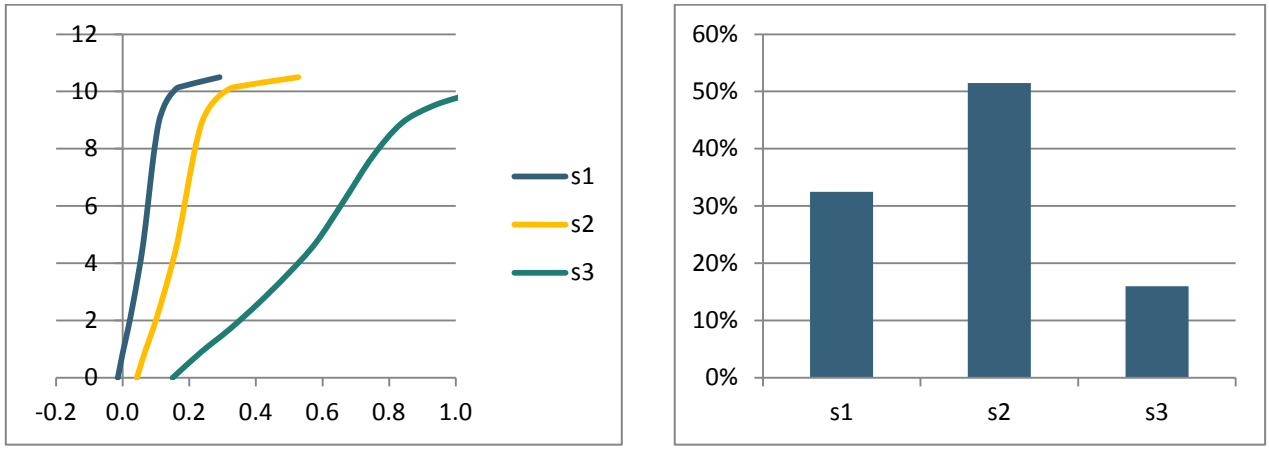
Exhibit 6 shows the average loan size evolution for the FNCL 2008 5 cohort across time. As the underlying loans went through refinance, the average loan size of the cohort drifted downward, i.e., loan size burnout. Model-projected loan size evolution tracks the actual path accurately.

Exhibit 6: Loan size burnout model performance



The "implicit" dimension is represented by three subpopulations with different refinance propensities: fast, medium, and slow, as illustrated in Exhibit 7.

Exhibit 7: S-curve and initial distribution for the three subpopulations



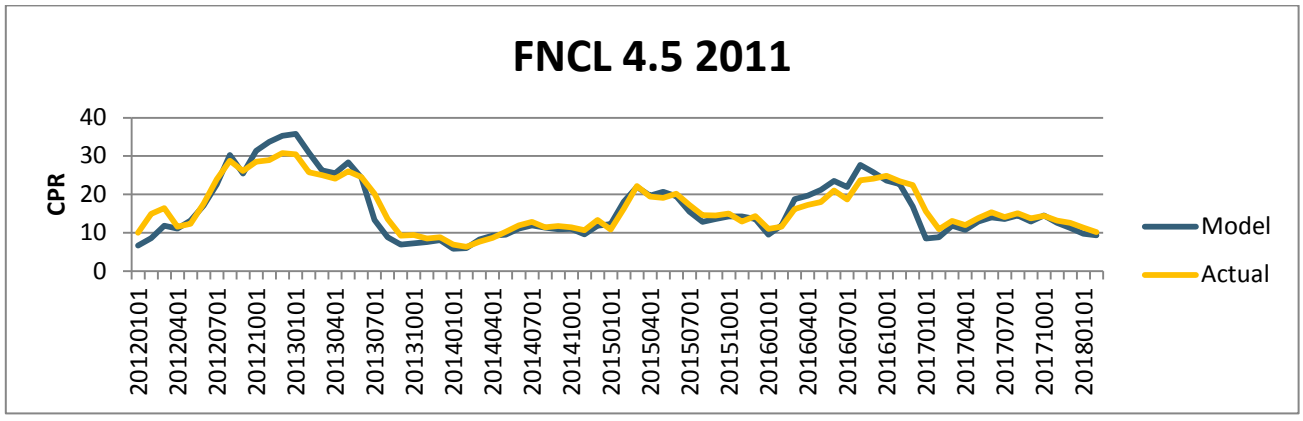
Source: MSCI

The evolution of the S-curve subpopulation is path dependent, as the borrowers/loans go through a changing rate environment. When the refinance speed picks up, the proportion of S1 will decrease relative to the slower S2/S3 subpopulation. Thus, the aggregated prepayment speed of the entire population will naturally decrease as the burnout effect.

Our dynamic population burnout approach very naturally models the interaction between "explicit burnout" and "implicit burnout." The additive nature of our population approach enables a consistent burnout effect when dealing with multiple pool variables and when combining multiple pools, especially during refinance waves.

Exhibit 8 shows FN 30yr 5 2010 burnout error tracking, and the model tracks the actual slowdown very well.

Exhibit 8: Good error tracking of FNCL 4.5 2011 shows that the model captures the refinance burnout accurately.

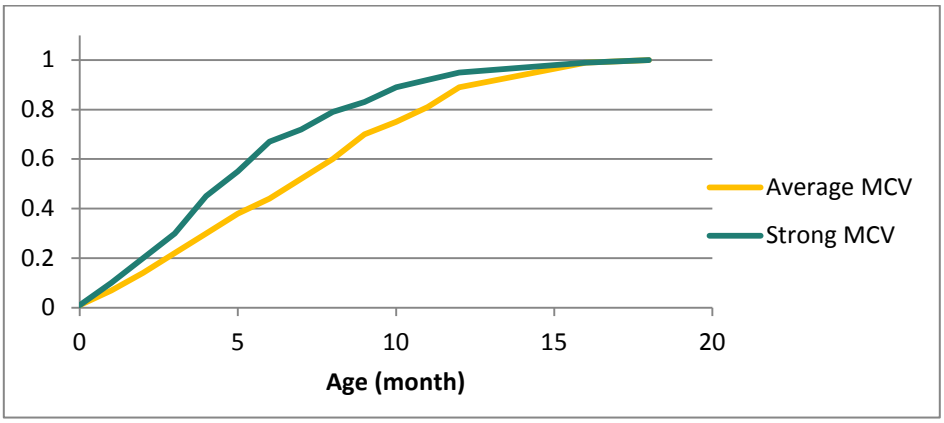


Source: MSCI

2.4 Refinance Age Curves

Borrowers may choose to refinance shortly after the loan is closed if the opportunity arises. The ramp also depends on the aggressiveness of servicers. When the underwriting standard is tighter, servicers tend to be more conservative in soliciting borrowers.

Exhibit 9: Refinance Age Curves



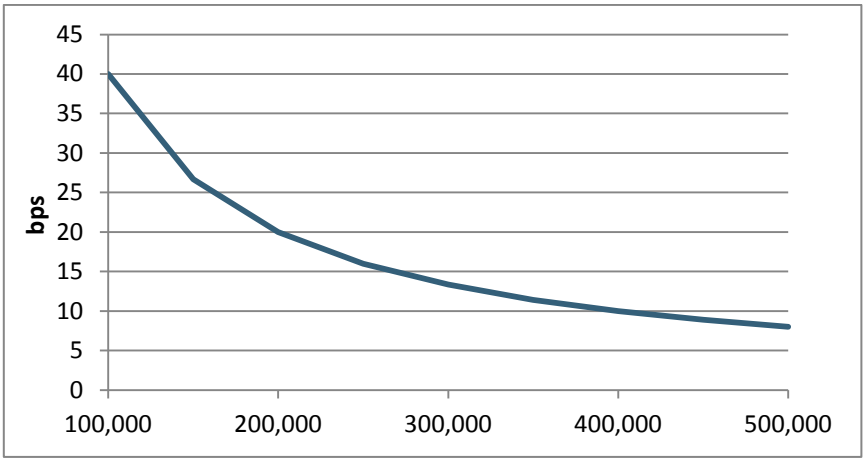
Source: MSCI

2.5 Loan Size Effect

2.5.1 Average Loan Size

For the same incentive, larger loan sizes will generate greater dollar savings and incur less refinance costs in terms of the fixed cost as a percentage of the loan balance. Higher loan size also indicates that the borrower is more financially sophisticated.

Exhibit 10: Fixed portion of refinance cost deters low loan balance mortgage

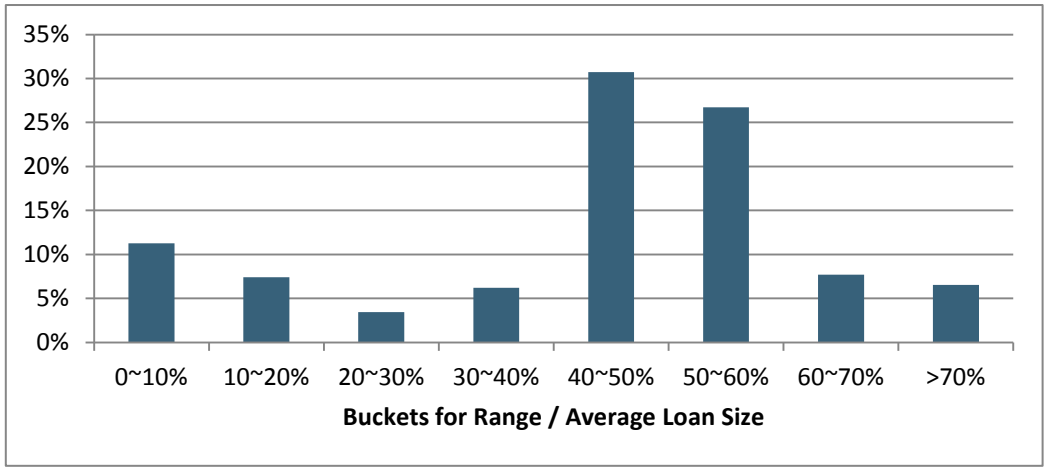


Source: MSCI

2.5.2 Loan Size Distribution

We utilize the GSE quartile loan size distribution data to initialize the loan size subpopulation to evolve the explicit burnout dynamically. As shown in Exhibit 11, the distribution of the loan size varies greatly across pools, as the practice of originators changes over time for different classes of securities. The range/average loan size is centered on 40%~60%, with very fat tails. More than 10% of the pools have a very flat distribution of loan size due to the optimized execution of originators. Introducing this data enrichment into our model, we thus can avoid the expensive calibration of the initial loan size distribution.

Exhibit 11: Loan size distribution for Fannie Mae and Freddie Mac 30yr pools

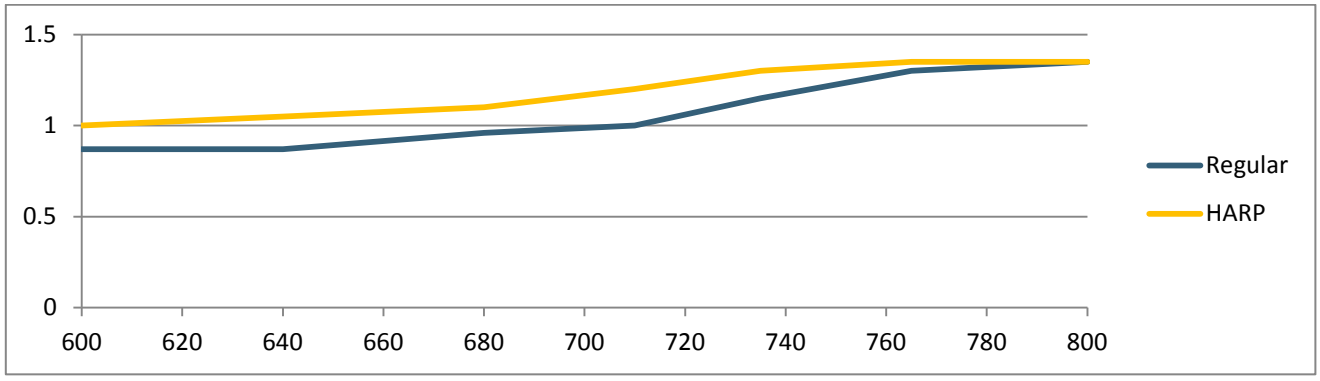


Source: Fannie Mae, Freddie Mac, MSCI

2.6 FICO

FICO score is the most evident attribute for the borrower's credit profile. Loans with a higher FICO score usually have higher refinance propensity. After the 2008 financial crisis, the higher fees for lower FICO due to the risk-based LLPA will also make lower FICO loans slower. As the loan seasons, the borrower's FICO will naturally improve. When mortgage credit is abundant, the FICO curve tends to flatten compared to the tighter mortgage credit environment. FICO curves also flatten for loans eligible for HARP program.

Exhibit 12: FICO curve



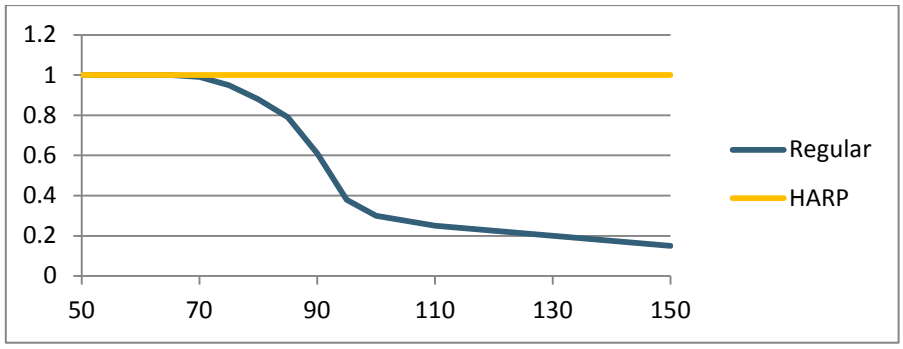
Source: MSCI

2.7 Loan-to-Value (LTV) Ratio

2.7.1 CLTV

We compute the CLTV based on OLTV, amortization, and FHFA state-level housing price indexes. Traditionally, higher CLTV imposes higher hurdles for the loan to refinance, especially when it is underwater. The introduction of the HARP program has flattened the CLTV curve for loans originated before June 2009.

Exhibit 13: CLTV Curves



Source: MSCI

2.7.2 OLTV

Historically, higher original LTV tends to prepay faster to shed the mortgage insurance. We diminish this effect for loans that refinanced through the HARP program.

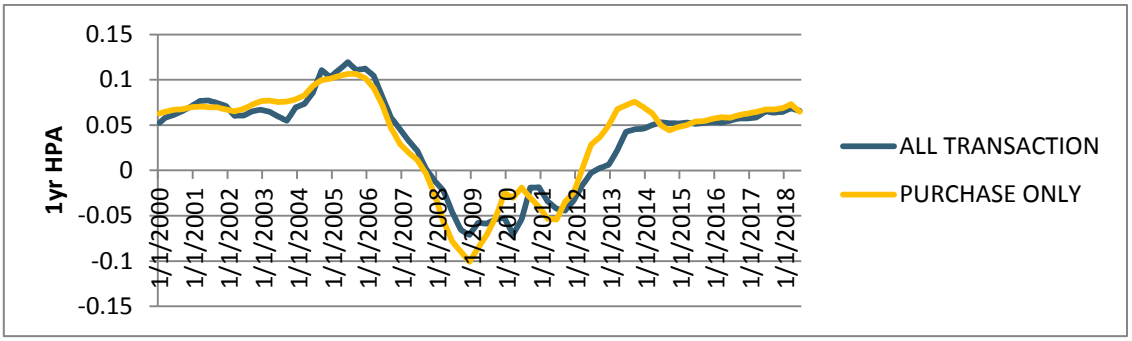
2.7.3 LTV Effect for HARP Loans

According to the current FHFA rules, loans going through the HARP program are not qualified for the same program or the new high-LTV streamline refinance program. However, we caution about the possibility of a new "HARP" program when a new housing downturn throws these HARP loans underwater again. Therefore, we introduced a HPA-dependent auto-HARP feature in the new model to avoid the overvaluation of the high LTV call protection.

2.7.4 Appraisal Bias Adjustment

The reported housing prices for refinanced loans are appraised values via either AVM or an actual appraisal. Therefore, the housing price indexes based on All Transaction could be significantly different from Purchase Only indexes, as shown in exhibit 14. When we mark-to-market for the CLTV calculation, we incorporate this appraisal bias. We use both All Transaction and Purchase Only state-level housing price indexes from FHFA.

Exhibit 14: US 1yr HPA for All Transaction and Purchase Only indexes



Source: FHFA

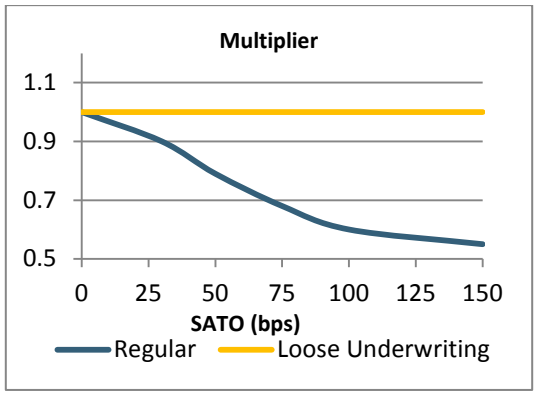
2.7.5 Hidden Debt Adjustment

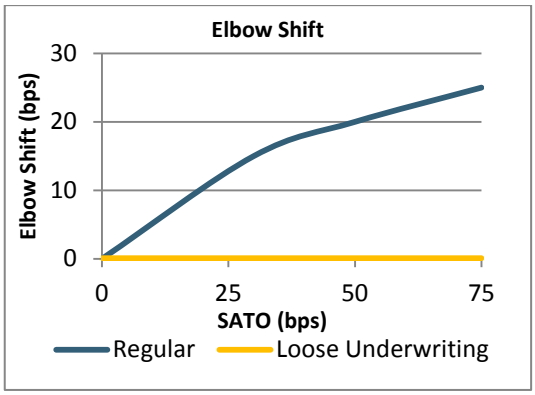
During the years of the housing boom, borrowers took second lien mortgages either to avoid mortgage insurance or to tap into the home equity. This additional hidden debt reduces the refinance intensity of the loans with otherwise seemingly "lower" LTV.

2.8 SATO (Spread at Origination)

SATO represents the residual credit quality of the borrower after the FICO effect. Higher SATO loans tend to prepay slower due to a higher effective rate for these borrowers, as well as hidden credit issues that hinder the borrower's ability to refinance. The SATO effect will diminish when underwriting standards are very loose or when the loan seasons.

Exhibit 15: SATO Curves



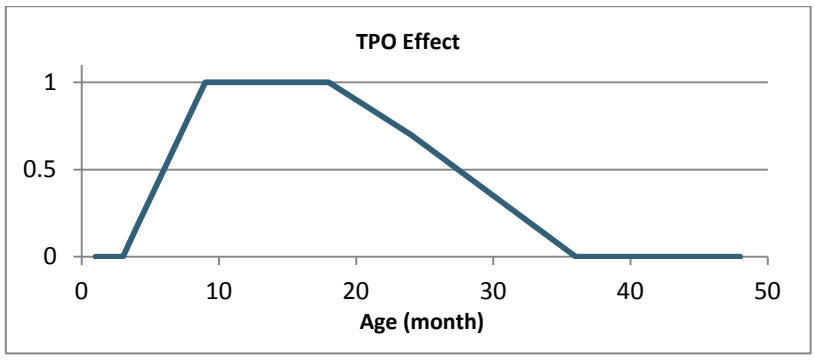


Source: MSCI

2.9 TPO (Third-Party Origination) Effect

Loans originated by a third party, instead of a retail bank, tend to prepay faster. Third-party loan originators have a strong economic incentive to act aggressively to refinance their borrowers' loans, especially when the loans' underwriting documents are still fresh and the rates rally to a new low level.

Exhibit 16: TPO Effect

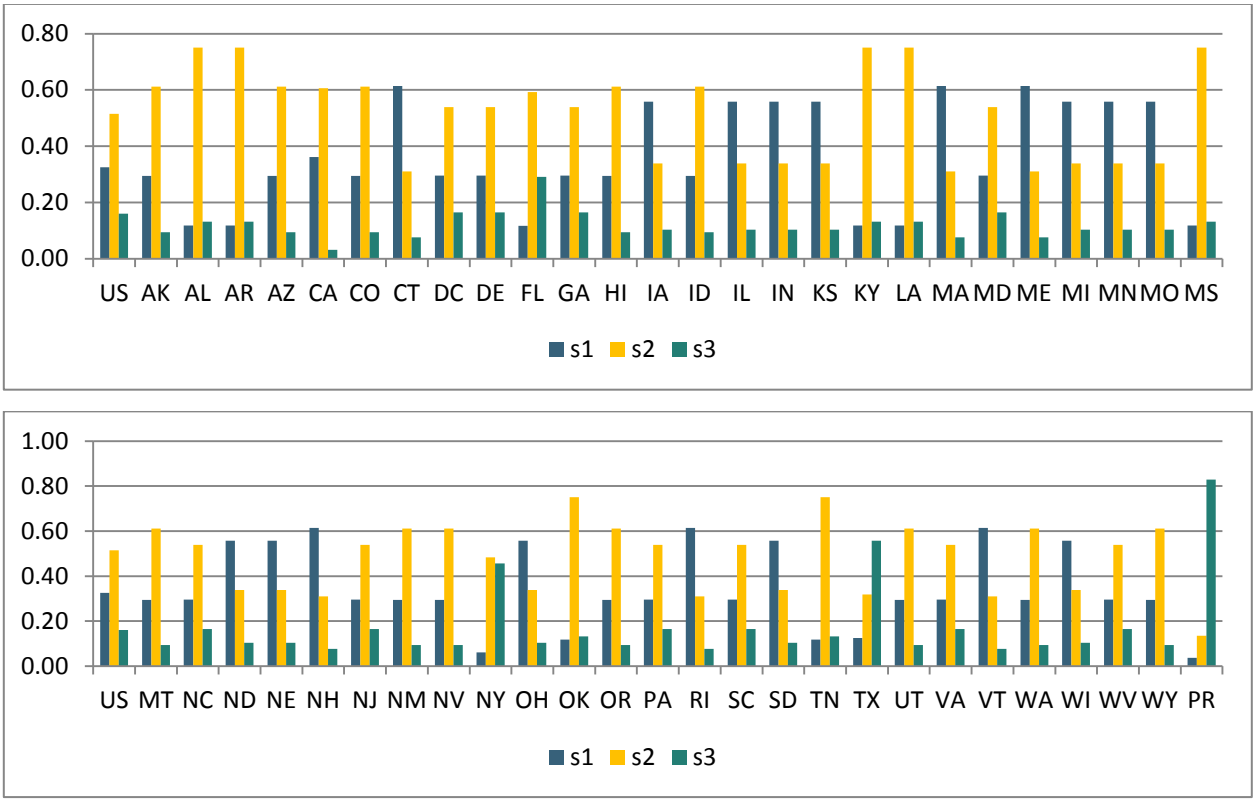


Source: MSCI

2.10 Geographic Effects

The Geographic effect on refinance intensity is very significant, due to different regulations, title insurance, legal fees, and recording tax across different states. For example, New York and Florida require a hefty mortgage recording tax, which increases the refinance cost and slows the prepayment. States such as Michigan historically have lower closing costs and thus higher prepayment propensity. Texas has very strict rules regarding capitalizing the closing cost and thus much lower prepayment propensity. The Geographic model is fitted after isolating out the explicit attribute differences between states, such as loan size and housing price path, based on our S-curve population approach. The resulting S-curve populations for all states are summarized in Exhibit 17.

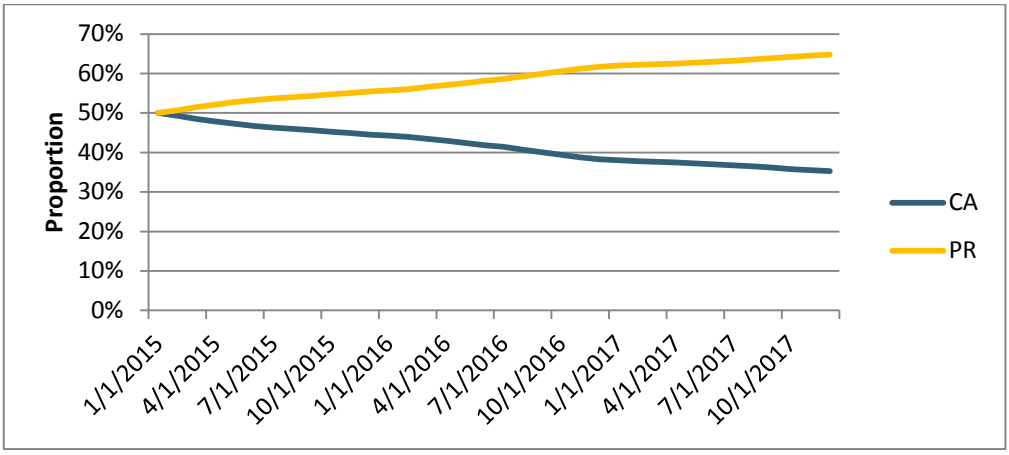
Exhibit 17: Refinance S-curve distribution for all states



Source: MSCI

Our dynamic S-curve population approach naturally incorporates the geographic effect. Exhibit 18 shows how a hypothetical pool (with an initial mix of 50% Puerto Rico and 50% California) went through the 2016 wave and burned out on the dimension of geographic attributes, as California loans are much faster than Puerto Rico loans.

Exhibit 18: CA loans left the cohort faster than PR loans.



Source: MSCI

2.11 Loan Purpose/Property Type/Occupancy

2.11.1 Refi vs. Purchase

Historically, refinance loans are faster than purchase loans due to self-selection. After the 2008 financial crisis, purchase loans tended to be faster, as purchase loans have no appraisal bias, less credit/putback risk, and more newly vetted documentation.

2.11.2 Multi-Unit

Multi-unit loans tend to have a weaker refinance propensity.

2.11.3 Investor

Loans backed by investment properties tend to have flatter S-curves, especially when underwriting standards tighten, partially due to higher delivery fees.

Exhibit 19: Multiplier summary

Type	Multiplier
Refinance	1.1
Multi-unit	0.85
Investor	0.9

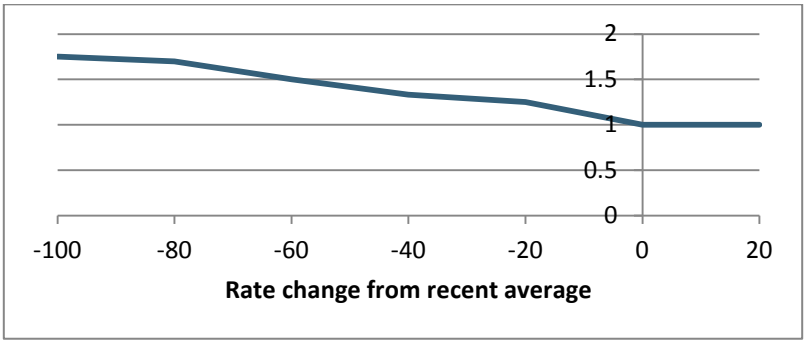
2nd home	0.85

Source: MSCI

2.12 Media Effect

When rates rally substantially, mortgage originators start to advertise and solicit borrowers much more aggressively. Hence, the refinance S-curve will temporarily steepen. We model this phenomenon through a media effect. We proxy the media effect by comparing the prevailing mortgage rate with the recent 2yr average rate.

Exhibit 20: Rate change from recent average

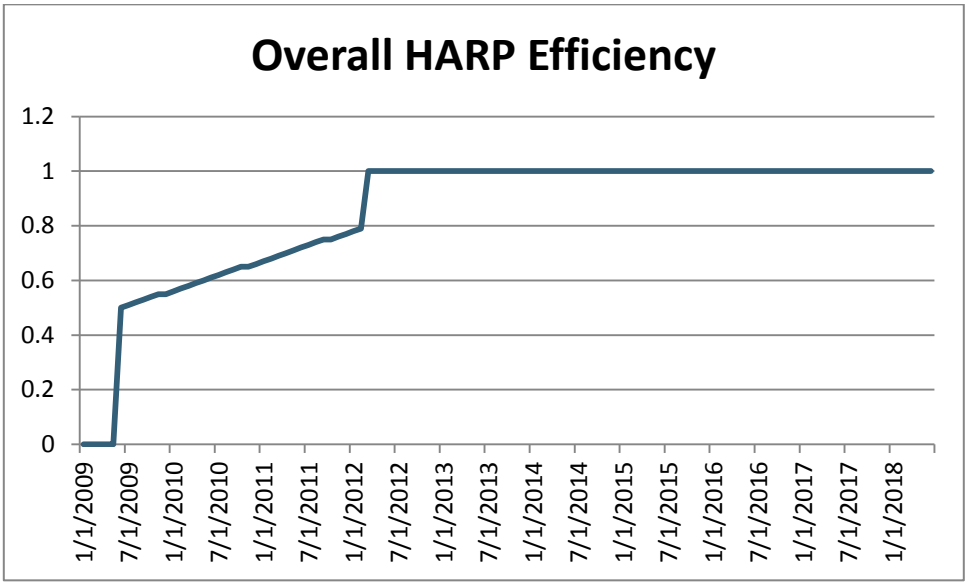


Source: MSCI

2.13 HARP Effect

The HARP program has been a culprit to home owners, policy makers, and investors from its beginning. The purpose of the program is to help underwater borrowers to streamline the refinancing of their mortgages to lower rates, so the homeowner can benefit from the Fed's dovish monetary policy, which ultimately reduces the default rate and saves taxpayers money. However, the increased prepayment speeds adversely affect investors. The overall level of HARP efficiency across time is shown in Exhibit 21. The HARP program also alters the curves of various loan/borrower attributes as described in previous sections.

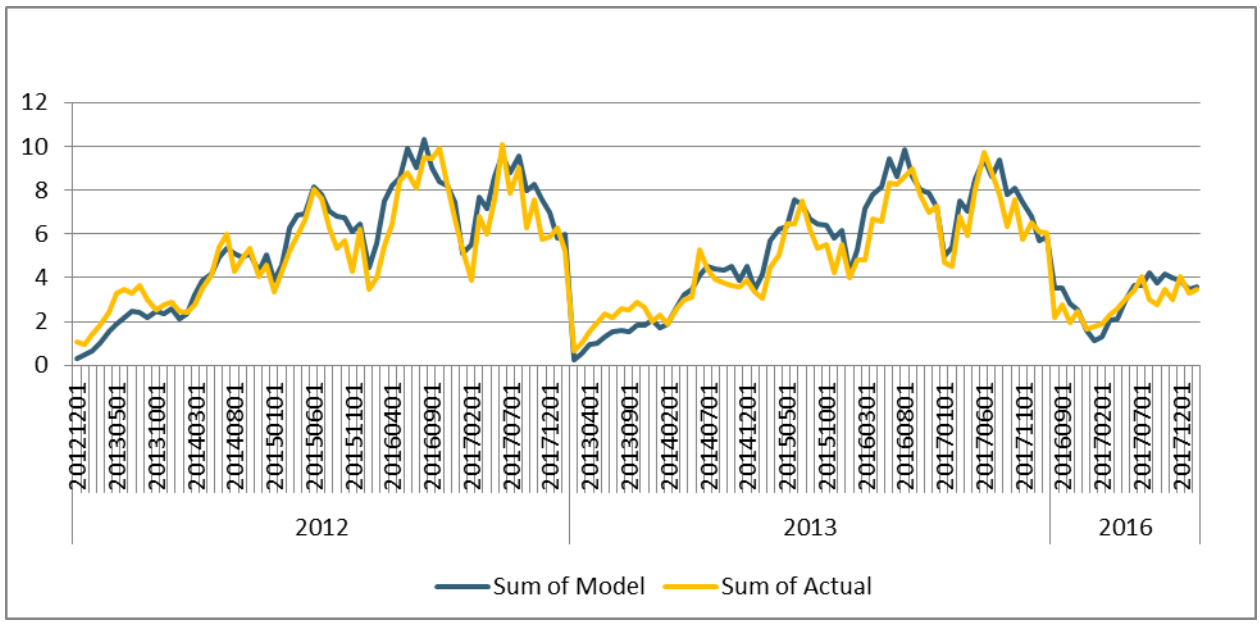
Exhibit 21: Overall HARP efficiency



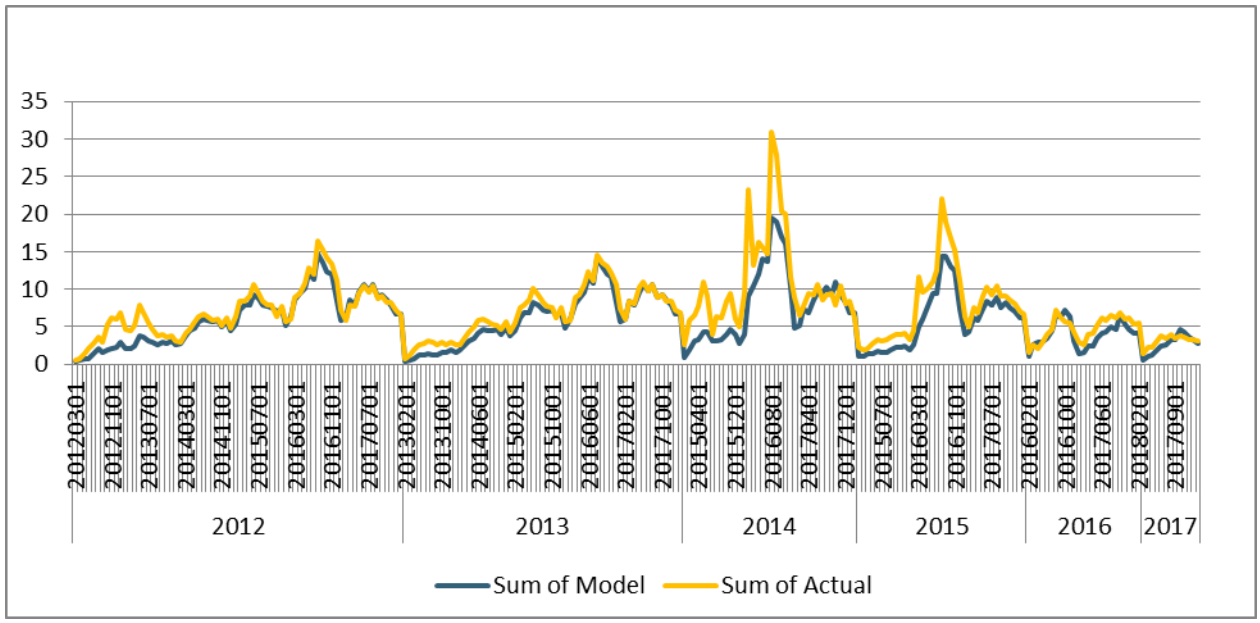
Source: MSCI

3 Error Tracking

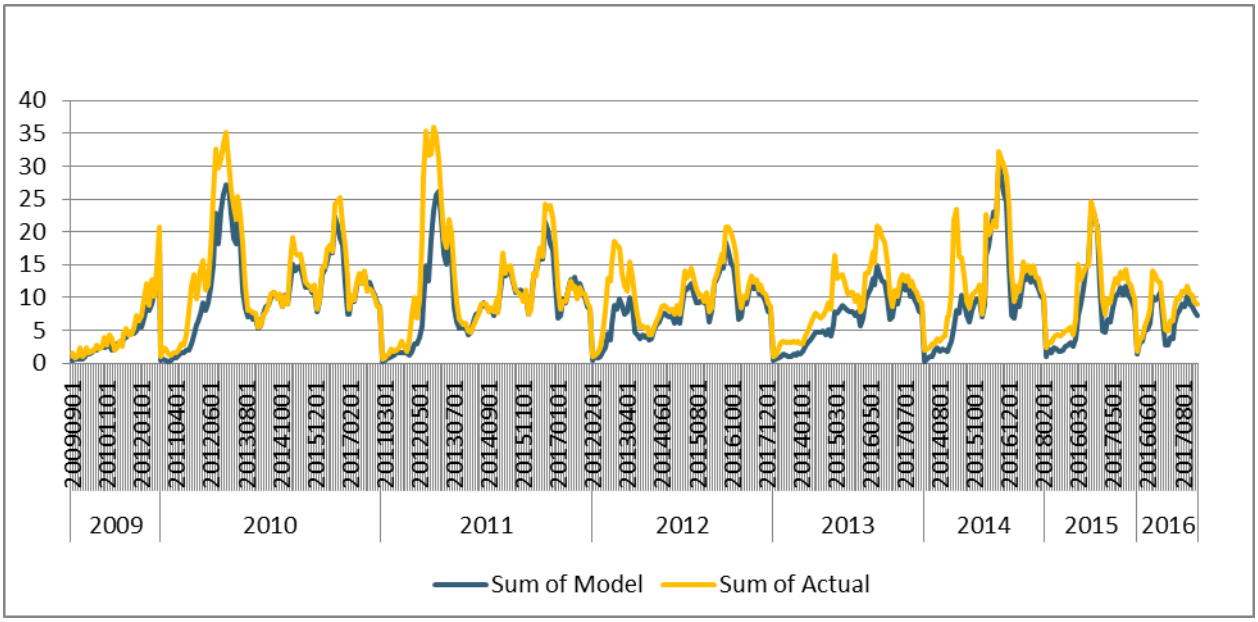
FNCL 2.5s



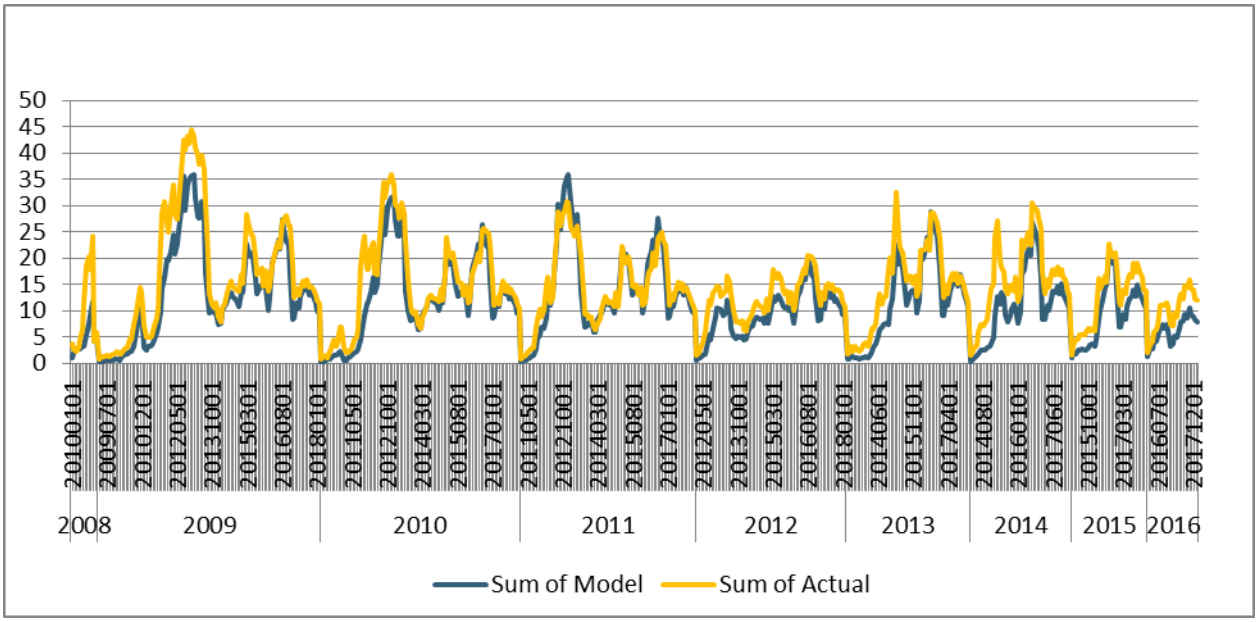
FNCL 3s



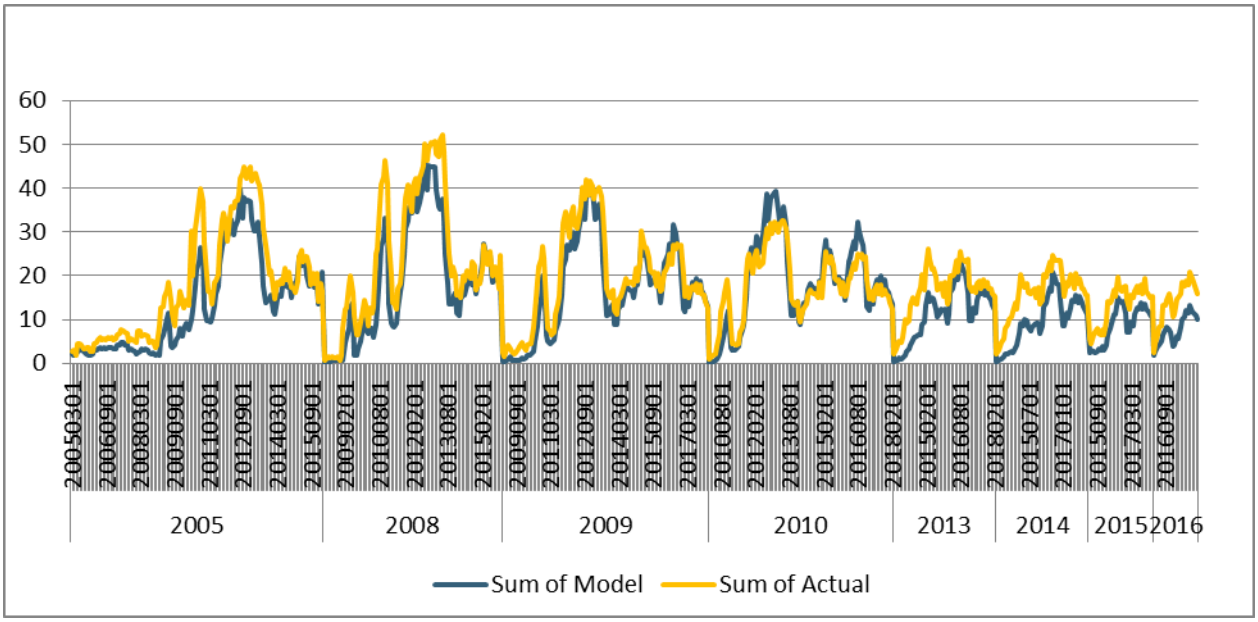
FNCL 3.5s



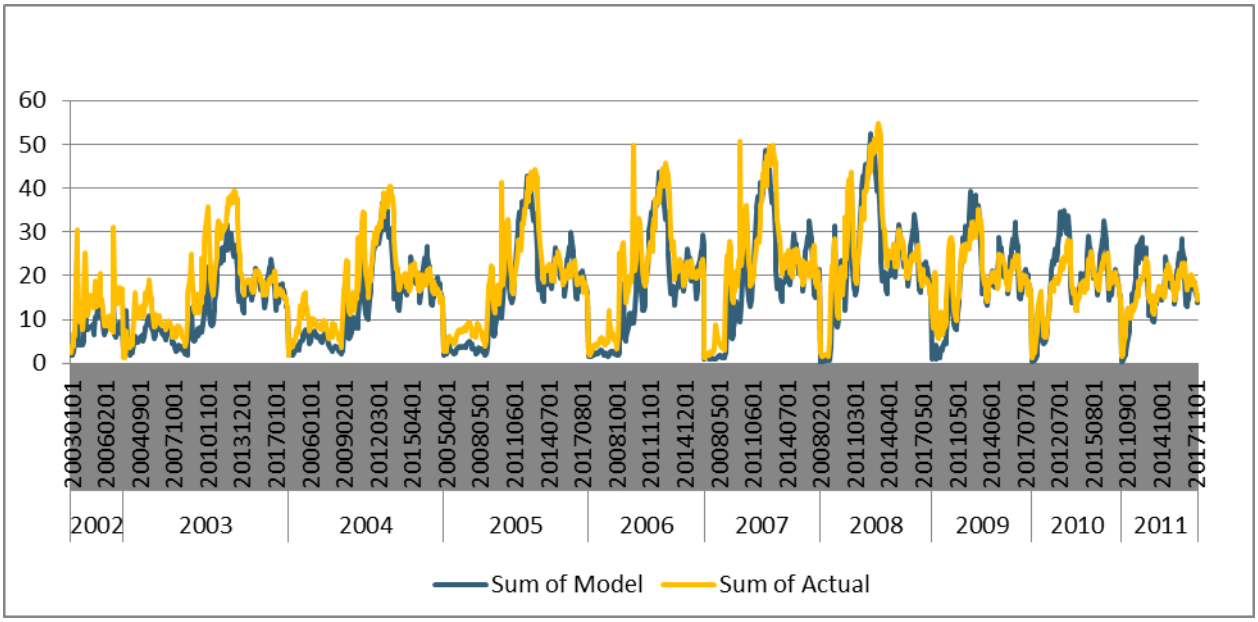
FNCL 4s



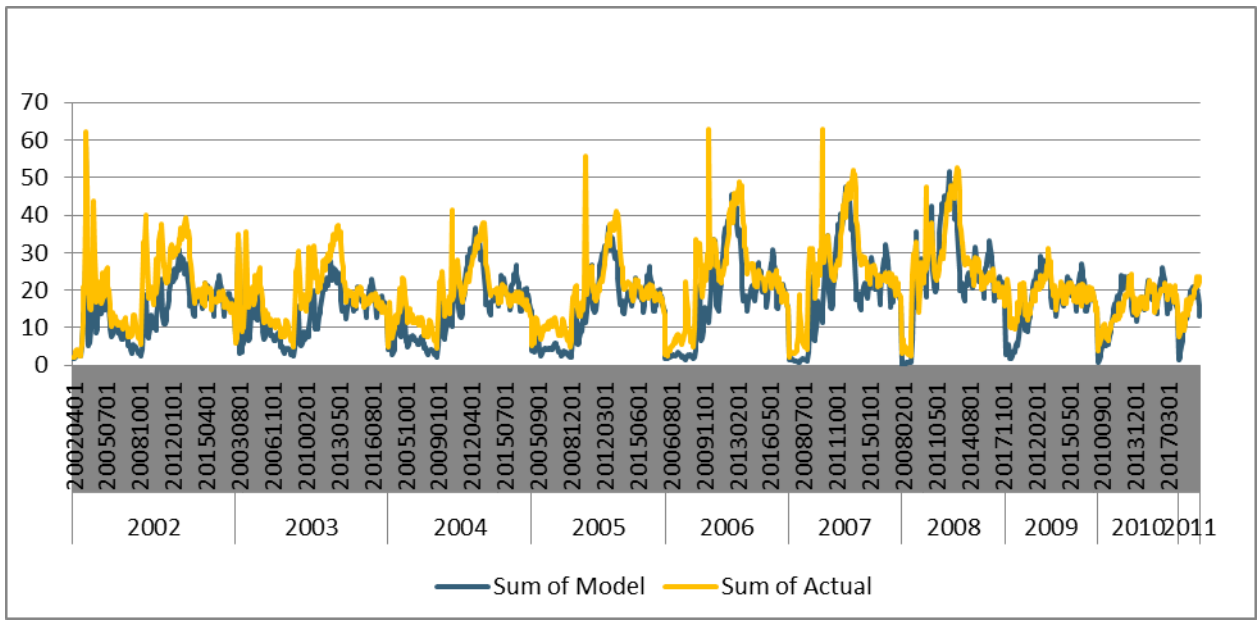
FNCL 4.5s



FNCL 5s



FNCL 5.5s



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