White Paper

ANDREW DAVIDSON & CO

INSIGHTS ON MORTGAGE DELINQUENCIES AND PREPAYMENTS FROM TRENDED DATA

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Executive Summary

Mortgage prepayment and credit models generally use a standard set of variables describing the borrower, loan features, collateral (property) characteristics, and macroeconomic factors to forecast prepayments, delinquencies, defaults, and losses. Credit bureau data has the potential to improve predictability beyond that provided by credit scores through the use of additional information about borrowers. Trended data, which reflects borrowers' credit behavior over time, has only recently been included in credit scoring models. Experian has developed a suite of attributes that track consumer's trended financial behavior. In this article, we show the additional explanatory power for prepayments and delinquencies when using those attributes relative to a credit score, VantageScore 3.0, which did not incorporate trended data. More generally this analysis shows how credit bureau data can be used to refine and improve model forecasts and provide additional insight into borrower behavior.

The bulk of this research was performed within Experian's Ascend Analytical Sandbox™, which includes over 2000 *Trended 3D* attributes for each consumer that describe payment, balance, and credit utilization behaviors over time, across all loan types. The Ascend Sandbox also includes Experian's Mortgage Loan Performance Insights dataset, which uniquely integrates residential property data with loan origination, mortgage performance, and consumer data to offer a comprehensive view of consumer financial behavior. This integration provides a clear view of the performance of nationwide mortgages across all mortgage types over time; from this baseline, analytics firms and investors may augment origination details such as LTV, consumer DTI, loan type, and loan purpose with loan payment performance and consumer trended credit behavior to establish a rich record for all mortgages. The resulting combination of origination and updated credit and property details offers potential for deep analytical insights and enhanced predictability for investors and other stakeholders.

We selected a handful of consumer trended attributes to study for the potential to improve forecasts of mortgage delinquencies and prepayments relative to a credit score that does not utilize these attributes. The main attribute we examine here is *PaymentBehaviorSeg*, which segments consumers according to balance transfer/consolidation or payment activity on bankcard revolving and charge cards during the prior 12 months. Our results consistently show that even when controlling for credit scores, this attribute provides a meaningful impact on future mortgage prepayments and delinquencies.

Some important findings include:

1) Holding credit scores fixed, the PaymentBehaviorSeg at loan origination increases accuracy in predicting CtoD (Current to Delinquent) rates among certain consumer segments.
2) Being a current Revolver with a close to minimum payment ratio is highly predictive of going delinquent in the subsequent month, especially if the consumer's PaymentBehaviorSeg was different at origination (i.e., the consumer became a lower paying Revolver sometime after origination).
3) PaymentBehaviorSeg is also predictive of CtoT (Current to Terminated; voluntary prepayments).

Table 1 displays some sample CtoD multipliers that illustrate the first finding for two PaymentBehaviorSeg groups: consumers with balance consolidation or transfer activity and consumers that were Revolvers with higher payment ratios (i.e., exceeding the minimum monthly payment, but not at the level of Transactors, who tend to pay off most of their balance each month). The multipliers show, for example, that when controlling for 20-point VantageScore 3.0 score bin at origination, the CtoD rate for consumers in the Balance Consolidate/Transfer group is roughly 25% lower than the bin average. Meanwhile, consumers in the High Pay Ratio Revolver group have a higher than average CtoD rate, about 39% higher within the lower credit bins and

23% higher in the higher bins. This paper discusses additional findings along these lines. While more research is planned to flesh out some of our findings, a significant upshot is that credit bureau datasets may be mined for insight beyond what is included in credit scores.

Table 1. Approximate CtoD Multipliers for FNMA loans by two PaymentBehaviorSeg Groups at Origination, Compared with Average CtoD within 20-Point VantageScore 3.0 Bin

	Balance Consolidate/Transfer	Revolver with High Pay Ratio
Low credit bins (600–699)	0.73	1.39
High credit bins (720–799)	0.74	1.23

Background

The basic data elements used as inputs in most mortgage credit models are borrower (original credit score), loan (rate, term), collateral (LTV, location), and macro variables such as interest rates, home prices, and unemployment. It is interesting that generally, the only borrower credit information available to an investor is the credit score.

Credit bureaus like Experian have thousands of data points for every borrower, most of which are currently not being used in these models. Upon studying some of the additional variables available in a borrower's credit file, we found that their use can enable significant separation in prepayment speeds and delinquencies.

It is important to note that credit scores are already used in the models, so we should avoid using those variables that might already be used to compute a credit score. Rather, we should look at the effect of variables that are orthogonal to credit score. In this paper, we have used VantageScore 3.0, which does not include trended data in the calculation of credit score. In the first case, we found that some raw trended variables provide lift, in addition to what we get from VantageScore 3.0.

Data and Methodology

For this study, we analyzed a random sample of conventional, FHA, and VA mortgages with terms of 360 months, originated between 2012 and 2019, and still active at some point during the two-year period 2018/01–2020/01. To attain sufficient data for consumers having lower credit scores, we sampled the conventional and FHA consumers at different rates by credit score (40% for < 720 vs. 10% for ≥ 720); our analysis generally controls for credit score, thus avoiding bias while also demonstrating the additional lift that can be gained by various new data elements. While we initially analyzed all the origination years in our sample, we ultimately focused on the more recent originations (2016–2019) to minimize the impact of seasoned loans in the study.

Our two-year time series combines anonymized data elements available within Experian's Ascend Analytical Sandbox that contains credit data, scores, and loan attributes, as well as nationwide property data matched at loan level. Specifically, the following information is used:

- Monthly mortgage balances and payment performance from 2018/01–2020/01 pulled from Experian's trade table
- LTV at origination, pulled from Experian's property-matched mortgage-level performance dataset
- Consumer VantageScore 3.0 at loan origination
- A selection of consumer trended attributes at loan origination
- For mortgages identified as FNMA, a selection of updated consumer trended attributes each *month* during the two-year period 2018/01–2020/01

We initially selected about 40 trended fields for consideration; then, after examining their frequency distributions within our dataset, we identified a handful to study for possible lift in improving forecasts of prepayments and delinquencies. Specifically, for given mortgage segments, we calculated monthly transition rates from current to prepaid (CtoT) and from current to 60+ days delinquent (CtoD). We also considered cures (i.e., DtoC transitions); however, we did not find a strong signal for cures in the attributes that we studied.

The main attribute we will discuss in this paper is Experian's PaymentBehaviorSeg, a trended attribute that segments consumers according to balance transfer/consolidation or payment activity on bankcard revolving and charge cards. This metric extends the binary Transactor/Revolver metric into more granular categories of revolving credit balance management and expanded coverage, which we describe below.

Consumer PaymentBehaviorSeg Details

The trended 3D attribute PaymentBehaviorSeg categorizes each consumer based on balance transfer/ consolidation or payment activity on bankcard revolving and charge cards during the prior 12 months. Consumers with any known relevant bankcard and charge card activity typically fall into one of 5 categories:

- Balance consolidation – At least one balance consolidation activity from multiple trades to one
- Balance transfer – At least one balance transfer activity
- Revolver with low payment ratio – Payment ratio is less than 15% (close to minimum)
- Revolver with high payment ratio – Payment ratio is at least 15%, but less than 85%
- Transactor – Payment ratio is greater than or equal to 85%

Here, payment ratio refers to the sum of the actual payments divided by the sum of the balances each month over the 12-month period. Note that these categories are assigned in order from top to bottom; for example, if a consumer has balance consolidation/transfer activity then they will not be classified as a Transactor or a Revolver. These early balance-specific categories allow more consumers to be classified overall compared with a pure Transactor/Revolver metric since many credit card companies do not report payment amounts. At the same time, assigning the balance-specific categories first means that the Transactor/Revolver classifications are conditional on not meeting them, which could change the nature of the consumers therein. Note also that the division of Revolvers into two categories provides for a more granular classification than a pure Transactor/ Revolver metric; and one could conceive of including yet an even finer gradation of payment behavior.

In our subsequent analysis, we typically combine the balance consolidation/transfer categories since their performance tends to be similar. Figure 1 below shows how many of the younger (2016–2019) FNMA mortgages in our time series fall into each of the four resulting categories based on the consumer's PaymentBehaviorSeg and VantageScore 3.0 bucket at origination. As can be seen, FNMA consumers with low credit scores are most likely to be Revolvers, especially Revolvers with low payment ratios; consumers with higher credit scores are more likely to be Revolvers with high payment ratios, Balance Consolidation/Transferers, or Transactors.

Figure 1. FNMA Mortgage Level Counts by Origination PaymentBehaviorSeg and VantageScore 3.0 Bucket, for Origination Years 2016-2019

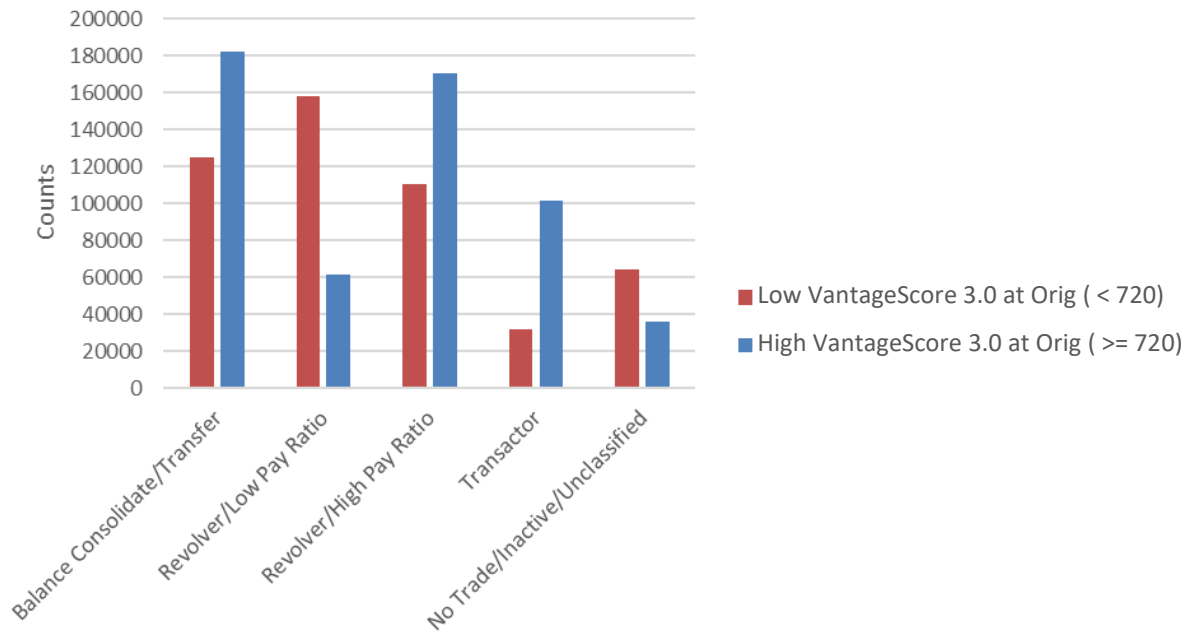

Figure 1. Mortgage Level Counts within our FNMA sample for the four main PaymentBehaviorSeg groups, by Credit Bucket (Low vs. High).

PaymentBehaviorSeg at Origination and its Effect on Delinquencies

Figure 2 below illustrates our first key finding: the PaymentBehaviorSeg attribute increases accuracy in predicting CtoD rates among certain consumer segments when holding credit scores fixed. Each graph in Figure 2 displays CtoD rates for the Balance Consolidate/Transfer segment (in blue), Revolvers with low payment ratios (orange), Revolvers with high payment ratios (green), Transactors (purple), and average over *all* segments (red), while controlling for 20-point VantageScore 3.0 bins (labeled by midpoint) along the X-axis. The charts on the left use a standard Y-axis scale; note that for all mortgage product types (FNMA at the top, VA in the middle, and FHA below), the green curve typically lies above average, and the blue curve below. To demonstrate the magnitude of this effect within the higher credit score bins where the curves appear to merge, the charts on the right use a log scale wherein each Y-axis grid line corresponds to a doubling of the CtoD rate. Since the credit score itself is a logged representation of delinquency rates, this is a natural representation. Here, we can see that the CtoD rate for FNMA consumers in the Balance Consolidate/Transfer group is below average at a roughly similar rate for all credit scores, while the High Paying Revolvers are worse in the lower credit bins than in the higher bins. The trends are similar for VA and FHA consumers.

Figure 2. Current to Delinquent (CtoD) Transition Rate by PaymentBehaviorSeg at Origination, Controlling for Origination Credit Score (VantageScore 3.0)

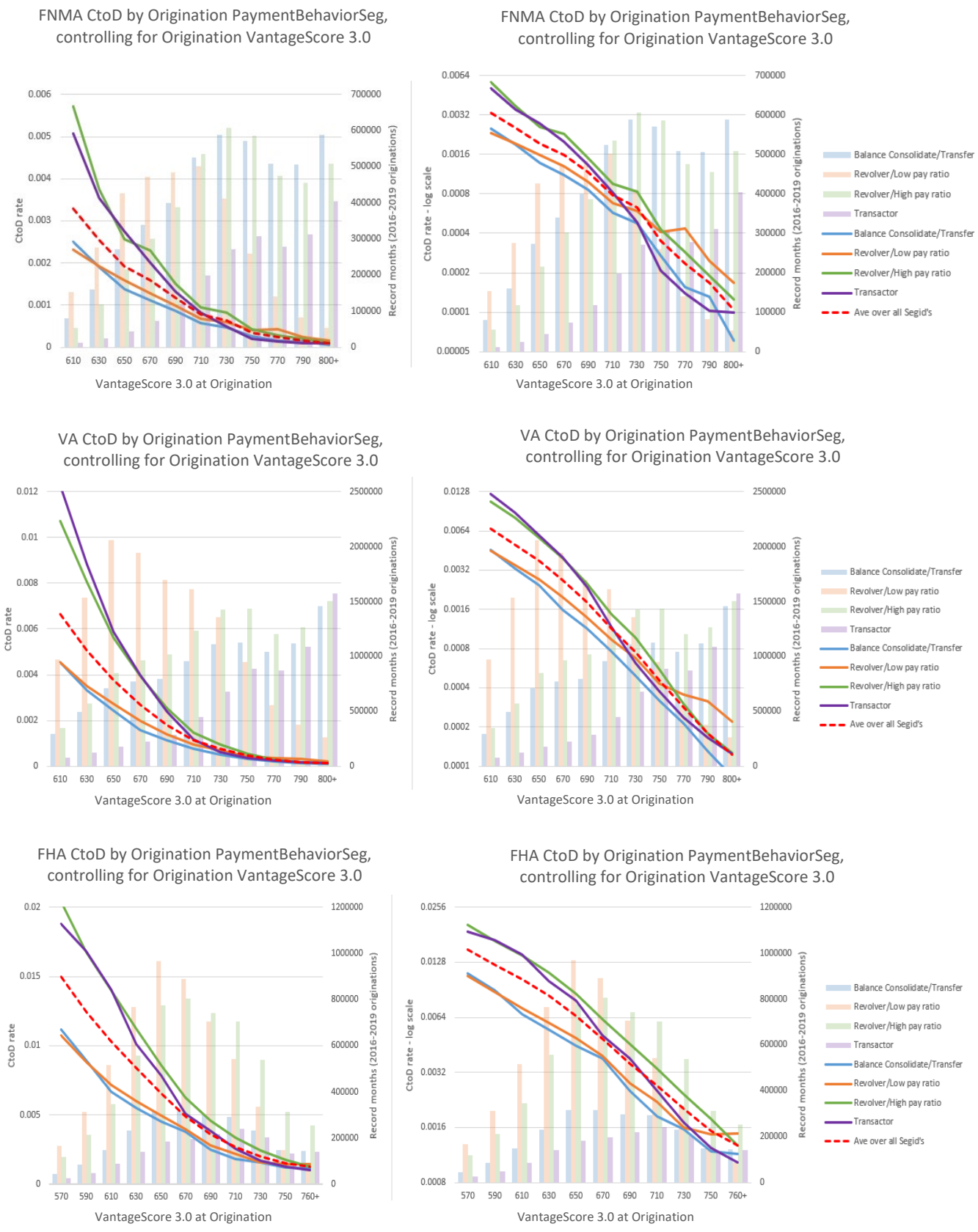

Figure 2. The charts on the left use a standard scale, while those on the right demonstrate the trend on a logarithmic scale, wherein each Y-axis gridline represents doubling of the CtoD rate. Vertical bars illustrate the number of record months for each.

Table 2 below summarizes and quantifies the results found in the graphs above, for two PaymentBehaviorSeg groups (Balance Consolidate/Transfer and High Paying Revolver) and two broad credit buckets: "Low" includes origination VantageScore 3.0 scores between 600 and 699 for FNMA/VA loans and 560–659 for FHA loans, while "High" covers 720–799 for FNMA/VA loans and 680–759 for FHA loans. For each of these credit buckets and loan types, we display the approximate factor by which the CtoD rate for the given PaymentBehaviorSeg group compares to the average within their 20-point VantageScore 3.0 bin. For example, FNMA mortgage consumers in the Low credit bucket had about a 39% higher than average CtoD rate for their 20-point VantageScore 3.0 bin if they were Revolvers with High Pay Ratios at origination; meanwhile, if they were characterized as having Balance Consolidate/Transfer activity then their CtoD rate was 27% lower than average. Overall, within the low credit bucket, the High Pay Ratio Revolvers went delinquent at nearly twice the rate as those who had balance consolidation/transfer activity at origination.

Table 2. Approximate CtoD Multipliers vs. VantageScore 3.0 Bin Average for two PaymentBehaviorSeg Groups

Approximate CtoD factors by two PaymentBehaviorSeg groups at origination, compared with average CtoD within 20-point VantageScore 3.0 bin

	Low credit (FNMA/VA 600–699, FHA 560–659)		High credit (FNMA/VA 720–799, FHA 680–759)	
	Balance Consolidate/Transfer	**Revolver w/High Pay Ratio**	**Balance Consolidate/Transfer**	**Revolver w/High Pay Ratio**
FNMA	0.73	1.39	0.74	1.23
FHA	0.68	1.34	0.72	1.24
VA	0.63	1.50	0.71	1.15

Note that Table 2 does not include the Transactor or Low Pay Ratio Revolver segments, although we can visually examine their CtoD curves in Figure 2. A reasonable hypothesis regarding the CtoD transition might have been that consumers who were Transactors at time of origination have a lower delinquency rate than those who were Revolvers, and moreover, the Revolvers with High Pay Ratios have a lower delinquency rate than those with lower payment ratios. Intuition tells us that Low Pay Ratio Revolvers may be financially stretched and have less flexibility and ability to make their payments when economic circumstances change for the worse. However, in Figure 2, we see that especially among the lower credit score consumers, this reasoning doesn't bear out: in fact, the CtoD rate for Transactors and High Paying Revolvers is higher than that of Low Paying Revolvers for these consumers. As credit scores increase, the difference between these segments decreases until eventually, around credit scores of 720–730, the curves cross: the CtoD rate for Low Paying Revolvers becomes noticeably higher than that of Transactors, with High Paying Revolvers ultimately lying in between. These observations hold for all three loan types, although the details differ; one implication may be that low credit score revolvers have more experience with managing debt loads and uncertain timing of income and expenses, compared with higher credit score consumers

Figure 2's solid vertical bars display the total count of "record months" in each VantageScore 3.0/PaymentBehaviorSeg category (i.e., how many data points were available for the calculation of CtoD rate). Despite a clear correlation between PaymentBehaviorSeg and VantageScore 3.0 score, there is enough variation within each VantageScore 3.0 bin to gain a meaningful lift by PaymentBehaviorSeg. That being said, we would first want to conduct further research on the low credit score consumers to fully explain the CtoD trends for

Transactors and Low Pay Ratio Revolvers. Our second key finding, discussed in the next section, is a step in the right direction.

Current PaymentBehaviorSeg and CtoD

For our sample of FNMA mortgages, in addition to collecting several consumer trended 3D attributes at time of loan origination, we also attached the current value of these fields for each month during the two-year period 2018/01–2020/01. Thus, when we refer to a consumer's "current" PaymentBehaviorSeg, we are referring to the real time PaymentBehaviorSeg for the month just before a potential transition may have occurred (i.e., the "C" month for CtoD and CtoT transitions). Given that a consumer is "now" within a given segment and is current on payments, what is the probability of a prepayment or of going delinquent from this month to the next?

Figure 3 below displays the CtoD rates by current PaymentBehaviorSeg, on a log scale and still controlling for the VantageScore 3.0 score at origination. It is not surprising that the *current* PaymentBehaviorSeg provides valuable information above and beyond the credit score at origination since time has passed, and the VantageScore 3.0 score at origination has possibly become stale. As before, the Balance Consolidate/Transfer group has a relatively low delinquency rate across all VantageScore 3.0 scores. Now, however, we observe the behavior we may have expected to see earlier: the Low Pay Ratio Revolvers are delinquent at higher rates than the other segments, across *all* VantageScore 3.0 scores. This is our second key finding: that being a *current* Revolver with a low payment ratio is highly predictive of going delinquent in the subsequent month.

Figure 3. FNMA CtoD by Current PaymentBehaviorSeg, Controlling for Origination VantageScore 3.0

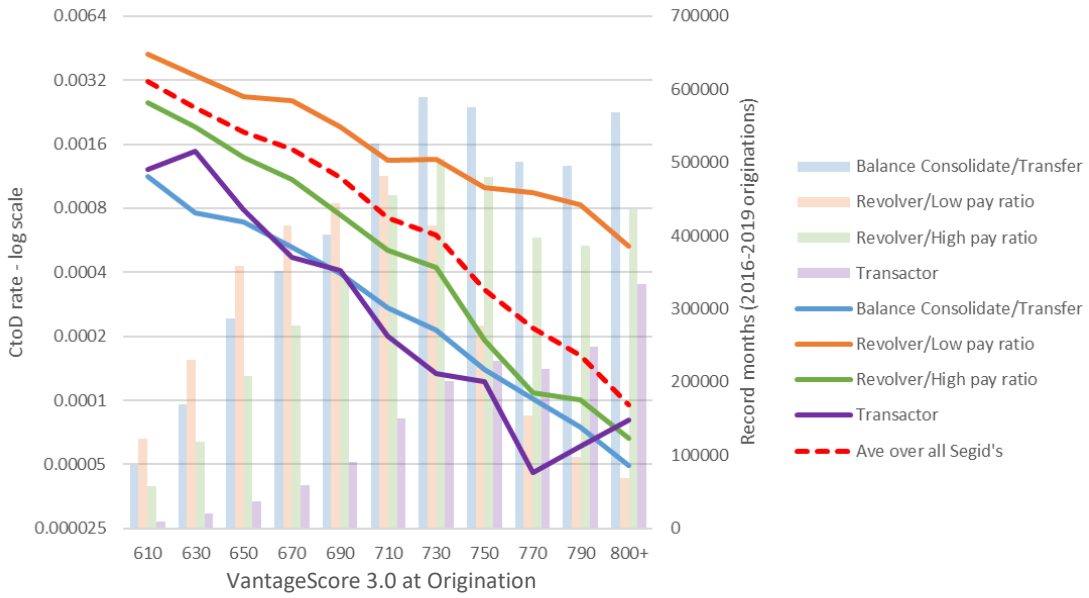

Figure 3. FNMA CtoD transition rate (on a Logarithmic scale) by Current PaymentBehaviorSeg, controlling for Origination VantageScore 3.0 Score; vertical bars illustrate the number of record months for each PaymentBehaviorSeg within each VantageScore 3.0 bin.

This result led us to examine the relationship between a consumer's current PaymentBehaviorSeg and the PaymentBehaviorSeg at origination, in predicting delinquency rates. Consumers move between different PaymentBehaviorSeg classifications over time, and becoming a Low Pay Ratio Revolver sometime after origination is a particularly strong predictor for becoming delinquent. Figure 4 displays the CtoD rate by current PaymentBehaviorSeg, conditional on the origination PaymentBehaviorSeg (along the X-axis), for consumers in the low origination VantageScore 3.0 bucket (< 720); Table 2 displays the matrix of values behind this chart. The very worst delinquency rates are among consumers who were Transactors or High Pay Ratio Revolvers at

origination but later became Low Pay Ratio Revolvers. Specifically, looking at the orange bars (the CtoD rates for current Low Pay Ratio Revolvers), we see that High Pay Ratio Revolvers at origination who later became Low Pay Ratio Revolvers have more than twice the CtoD rate as those who were Low Pay Ratio Revolvers and remained low; for those who started as Transactors and became Low Pay Ratio Revolvers, the increase in delinquency is even worse. It seems that among the lower credit score bins, being a Low Pay Ratio Revolver at origination may indicate some resilience and experience managing debt: transitioning to another group later is associated with improved performance and possibly indicates an improvement in circumstances, but starting in any other group and transitioning to Revolver status may indicate a decline in circumstances that is difficult to overcome. These consumers may have experienced a severe setback, or they may simply be unaccustomed to managing unstable incomes or expenses.

Figure 4. FNMA CtoD Rate by Current PaymentBehaviorSeg, Controlling for Origination PaymentBehaviorSeg – Consumers with Origination VantageScore 3.0 < 720

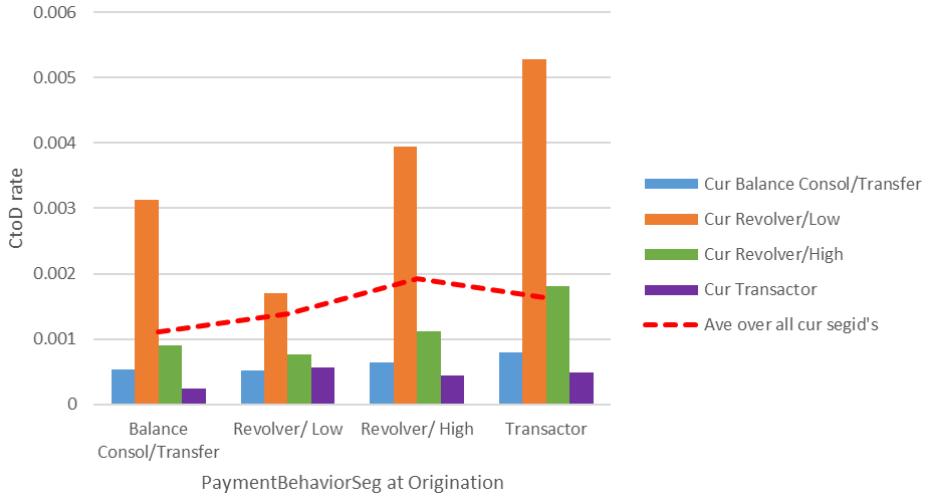

Figure 4. FNMA CtoD transition rate by current PaymentBehaviorSeg, conditional on the origination PaymentBehaviorSeg (along the X axis), for consumers with VantageScore 3.0 scores under 720.

Table 3. Matrix of FNMA CtoD Transition Rates (%) by Origination and Current PaymentBehaviorSeg, for Consumers with Origination VantageScore 3.0 Scores Under 720

	FNMA CtoD Transition Rates (as %) by Origination and Current PaymentBehaviorSeg, for origination years 2016–2019 and consumers with Origination VantageScore 3.0 < 720				
	Cur Balance Consol/Trans	**Cur Revolver/Low**	**Cur Revolver/High**	**Cur Transactor**	**Overall Ave (by orig status)**
Bal Consol/Trans at Orig	0.053	0.313	0.090	0.024	0.106
Revolver/Low Ratio at Orig	0.052	0.170	0.077	0.056	0.128
Revolver/High Ratio at Orig	0.064	0.394	0.112	0.044	0.179
Transactor at Orig	0.079	0.528	0.182	0.048	0.149
Overall Ave (by cur status)	0.055	0.245	0.105	0.046	0.136

For future research, we plan to conduct a more detailed examination of the relationship between a consumer's PaymentBehaviorSeg at various points in time and the CtoD rate during a subsequent mortgage payment performance interval.

PaymentBehaviorSeg at Origination and CtoT

We now move our attention to the relationship between a consumer's PaymentBehaviorSeg and monthly prepayment rate (CtoT). Figure 5 displays the CtoT rate for FNMA and FHA loans by the consumer's PaymentBehaviorSeg at origination, controlling for VantageScore 3.0 score at origination. Note that each of these charts includes just two years of mortgage originations, in order to illustrate the different behavior of seasoned loans (top row) vs. new loans (bottom row). We see a definite signal here, with consumers in the Balance Consolidate/Transfer group prepaying more quickly across all VantageScore 3.0 bins for both types of loans and both origination periods. The result is especially pronounced for FHA loans, and especially for consumers in the lower credit bins.

Table 3 summarizes these results by displaying the approximate CtoT multipliers for the Balance Consolidate/Transfer group as well as the Transactors, for two broad credit buckets: "Low" includes origination VantageScore 3.0 scores between 600 and 699 for FNMA loans and 560–659 for FHA loans, while "High" covers 720–799 for FNMA loans and 680–759 for FHA loans. For each of these credit buckets and loan types, we display the approximate factor by which the CtoT rate for the given PaymentBehaviorSeg group compares to average within their 20-point VantageScore 3.0 bin.

Figure 5. Voluntary Prepayment (CtoT) Rate for FNMA and FHA Mortgages by the Consumer's PaymentBehaviorSeg at Origination, Controlling for VantageScore 3.0 Score at Origination

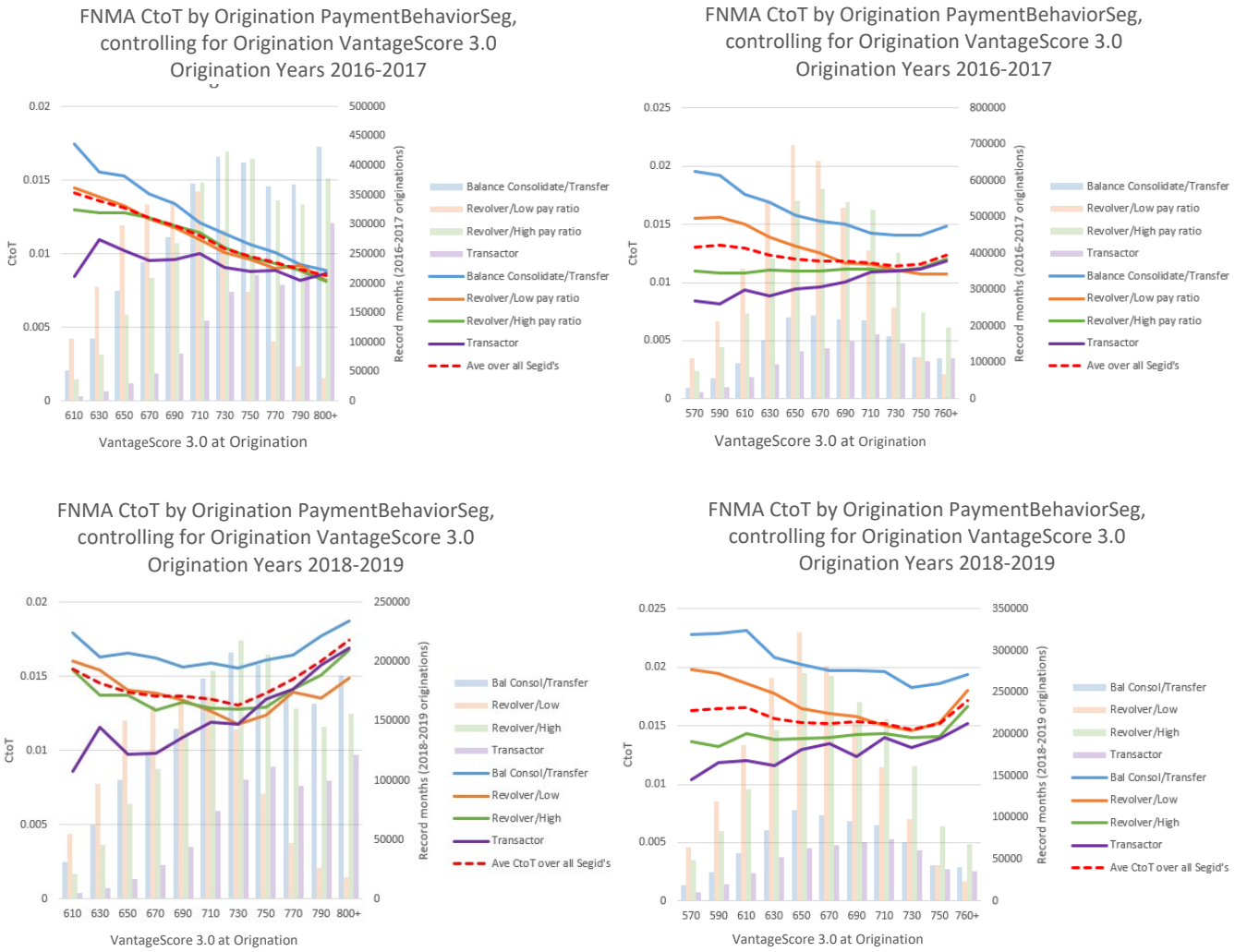

Figure 5. The top row charts include seasoned loans, while the bottom row charts include new loans.

Table 4. Approximate CtoT Multipliers vs. VantageScore 3.0 Bin Average for two PaymentBehaviorSeg Groups

	Approximate CtoT factors by two PaymentBehaviorSeg groups at origination, compared with average CtoT within 20 point VantageScore 3.0 bin			
	Low credit (FNMA 600–699, FHA 560–659)		High credit (FNMA 720–799, FHA 680–759)	
	Balance Consolidate/Transfer	**Transactor**	**Balance Consolidate/Transfer**	**Transactor**
FNMA Orig 2016-2017	1.14	0.78	1.08	0.91
FNMA Orig 2018-2019	1.16	0.74	1.15	0.95
FHA Orig 2016-2017	1.36	0.73	1.24	0.91
FHA Orig 2018–2019	1.35	0.77	1.27	0.87

That consumers with balance consolidation/transfer activity prepay more quickly than average is not surprising, since presumably some of this activity indicates a tendency to be proactive—by seeking out lower rates and better deals, for example—in the handling of debt. It is perhaps more counterintuitive that Transactors prepay more slowly during the two-year period we studied. However, one big caveat here is that the relative prepayment rate for different groups may vary at different times; during this two-year period (2018–2019), consumers with lower origination credit scores tended to prepay more quickly than those with high scores, possibly due to credit curing; however, during other periods characterized by stronger interest rate incentives and/or stricter underwriting standards, the opposite holds. It stands to reason that Transactors and Revolvers may also display different relative tendencies depending on the economic period. For future research, we would want to consider their behavior in a wider variety of economic conditions.

Conclusion

Typically, the primary measure of borrower credit used to model mortgage performance is the credit score. Additional credit bureau data, such as trended data and segmentation categories reflecting specific borrower behaviors, can provide more accurate models and additional insight into borrower behavior and loan performance. This paper provides examples of this type of analysis and sets the stage for additional research and model development. Specifically, we demonstrate that both origination and current trended consumer segments and their transitions over time have a sizable impact on credit transition and prepayment rates. In our future research we will study additional interactions as well as other trended attributes' predictive power for prepayments and delinquencies.