VantageScore®
a higher level of confidence

VantageScore 4.0
User Guide

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VantageScore User's Guide

INTRODUCTION

VantageScore Solutions, LLC (www.VantageScore.com) is the independently managed company that owns the intellectual property rights to the VantageScore credit scoring models, including the recently announced VantageScore 4.0 model. Initially developed by America's three national credit reporting companies (CRCs) — Equifax, Experian and TransUnion — VantageScore Solutions' highly predictive models use an innovative, patented and patent-pending scoring methodology that provides lenders and consumers with more consistent credit scores across all three national credit reporting companies.

VantageScore 4.0

VantageScore 4.0 was launched in fall 2017 and leverages the core VantageScore platform to deliver superior predictive performance. The impetus for the updated model came from opportunities to enhance predictive performance through the credit bureau trended data solutions, utilizing machine learning techniques for attribute design to model the universe expansion population and aligning with the reduction in public record information available in consumer credit files.

The VantageScore 4.0 model was built with a lender's implementation and risk management needs in mind. Thus, this User Guide provides insight into the development process and optimal use of VantageScore 4.0.

Overview

VantageScore 4.0 Overview:

VantageScore 4.0 is an empirically driven and statistically sound risk prediction model that enables lenders to rank consumers by their potential risk for default, 90 or more days past due.

The model was developed from a national sample of approximately 45 million consumer credit reports – 15 million consumers pulled from each of the three CRCs simultaneously. The credit information uses more granular data over prior VantageScore models, including public record information, collection and tradeline data, plus inquiries, to achieve more accuracy.

VantageScore 4.0 Features:

- Built with seven consumer scorecards, including a scorecard for consumers with no updates to their credit file in the last six months and a scorecard for consumers with no useable trades (but who have public records and unpaid collections).
- Leverages tri-CRC leveled trended data attributes to capture consumer trajectories on balances, utilization and payments across major industries, resulting in substantial predictive performance in account management and Prime and Super Prime credit tiers.
- Enhanced predictive insight in universe expansion populations from attributes designed through machine learning techniques.
- Attributes were redesigned to account for reduction in public records and collections information.
- Ignores all paid collections and applies a lesser penalty for unpaid medical collections.
- Built with a score range of 300 - 850, which is more familiar to consumers and often embedded in lenders' systems and applications.
- Development sample consisted of 45 million anonymous consumer credit files for 2014-2016 timeframe.
- Consumer tools describing what goes into their VantageScore credit score and a website to explain reason codes at: www.ReasonCode.org (English) and esp.reasoncode.org (Spanish).
- VantageScore 4.0 and all VantageScore models are FCRA- and ECOA-compliant.

VantageScore 4.0 Key Benefits:

- Significant performance lift over VantageScore 3.0, most especially in mortgage and bankcard originations.
- Optimized to account for reduced presence of derogatory public record information.
- Scores approximately 40 million more consumers than conventional credit scoring models.
- Retains features and strengths of prior VantageScore models.
- Developed in order to more easily facilitate lender implementation.
- There are 89 adverse action reason code statements written in "plain English" to facilitate greater consumer understanding. Similarly, there are 93 positive reason code statements.
- Generates more consistent scores across the three national credit reporting companies (Equifax, Experian and TransUnion), allowing lenders to have confidence in default probabilities regardless of which credit reporting company calculates the score.

Implementation & Decisioning Overview

The VantageScore 4.0 model is odds-aligned with VantageScore 3.0 to facilitate transition and implementation. The 300 – 850 score range makes implementation of the VantageScore 4.0 model easier for lenders. As with all VantageScore models, the same VantageScore 4.0 model is deployed across all three national CRCs, reducing score variance and producing nearly identical risk alignment, leading to added confidence in lending decisions.

Model development

OVERALL

VantageScore 4.0 is a generic credit risk score. It is an empirically driven and statistically sound risk prediction model that enables lenders to rank consumers by their potential risk for becoming 90 or more days late on their debt repayment. No reject inference process was used.

DEVELOPMENT SAMPLE DESIGN

Initial Dataset

- Consumer behavior data from the 2014-2016 timeframe was used to represent consumer perspective on financial debt management.
- 15 million consumer credit files from each CRC (Experian, Equifax and Trans Union) were contributed for the development dataset, for a total of 45 million consumer credit files.
  - Credit files for June 2014 — June 2016 timeframe were selected.
  - The sample represents current consumer and lender behaviors.
  - 50% of the sample was used for development and 50% is retained for the holdout validation
- Each CRC contributed randomly-selected depersonalized data on the same credit files at the same points in time. The wide-ranging sample results in a model that reflects the diversity within each CRC database and encompasses the following credit populations:
  - Credit files from all markets (national sample)
  - All types of products (installment, mortgage, revolving, finance, etc.)
  - All types of consumers (thin file, thick file, clean, tarnished, previous bankruptcies, etc.)
  - Credit files from all markets (national sample)
  - All types of credit information (tradelines, inquiries, public records, collections)
  - Trended data series were included from each CRC for each consumer in the sample
- Specifically, trended data was considered for the mortgage, installment, bankcard, student loan and auto industry over a 24-month timeframe. Specific fields considered were:
  - Original loan amount, high credit amount, credit limit
  - Balance
  - Actual amount paid
  - Scheduled amount due, minimum pay due

Exclusion Criteria

- The following exclusions are applied:
  - Deceased (file excluded)
  - Bad at Observation (90+ dpd) – performance only
  - Closed at Observation – performance only
  - Performance Unclassifiable
- The following trades were excluded from receiving a valid score:
  - Bankruptcy of other party trades
  - Checking trades
  - Child support trades
  - Commercial trades
  - Disputed trades/collections
  - Insurance claim pending trades
  - Medical trades
  - Refinanced/transferred/sold collections
  - Victim statement trades
- Approximately 32% of trades are excluded

Data Integrity

- The datasets are validated for the following:
  - Correct data and format interpretation
  - Reporting consistency
  - Tri-CRC filter frequencies for value and range alignment
- A comprehensive discussion of the data extraction and dataset composition process is available in the "Tri-Credit Reporting Company – Modeling Data Design" white paper.

Performance definitions

Consumer credit performance was calibrated using a randomly selected account per credit file in the sample, providing more refined risk assessment among consumers currently delinquent. In addition, the method more accurately reflects an individual lender's experience of risk.

VantageScore examined credit-related information from files in the development sample and assessed credit performance over a 24-month period. First, the credit performance was identified through the credit files as of the observation date. Then, the credit files for these consumers were evaluated as they appeared 24 months later. This second point in time is the performance date, as illustrated in Figure 1.

Figure 1: Performance period (24 months)

Dependent variable

- When the credit files in the development sample were evaluated at the performance date, each tradeline was classified as either "good" or "bad." For VantageScore, the classification was defined as follows:
  - Goods: Accounts that had no delinquency greater than 30 days past due within the performance period
  - Bads: Accounts that had a delinquency of 90 or more days past due within the performance period
  - All accounts other than mortgage orginations that had a delinquency of 60 days late, but no greater, within the performance period were considered "indeterminant"
  - Mortgage originations were defined as "good" if current or 30 days delinquent and bad if 60 or more days delinquent
  - Indeterminant accounts were not included in the development of VantageScore 4.0, but were included in the validation sample
- Consumer performance is determined based on the classification of a randomly selected trade from their credit file

Other Considerations

- Trades were identified as "New" if they were opened within the first three months of the performance period (July to September). All other accounts were identified as "Existing."

Figure 2: Dataset Composition ("Through the Door")

By account type	
New	20%
Existing	80%
By performance flag	
Good	90%
Bad*	8%
Indeterminant	2%

*90+ dpd or Real Estate Originations 60+ dpd

- The development dataset was stratified to reflect a 3:1 good to bad ratio.

Modeling sample treatments

Independent Variable (Attributes)
Design & Selection Process

VantageScore 4.0 uses highly granular and trended data. VantageScore 4.0 uses the latest version of each CRC's data. Due to the granularity of this data, VantageScore was able to design richer attributes. Examples of the granular data used in the VantageScore 4.0 model are:

- Detailed mortgage tradelines separating first mortgage from other mortgage-related transactions, facilitating greater intelligence with regard to a borrower's mortgage-related debt.
- More distinct definitions of installment data, such as the ability to identify student loan accounts from other types of installment accounts.
- More specific measurement of delinquency and default timeframes, which provides for an improved representation of a consumer's payment behaviors.

Figure 3: Attributes are designed to represent behaviors on the following dimensions:

Record Type	Trade Industry	Behavior Type	Function
Trade	First mortgage	Payment status	Average
Inquiries	Home equity - line of credit	Balances	Sum
Collections	Home equity - loan	Utilization	Worst ever
Public records	Installment	Available credit	Highest
Judgment	Auto	Account status	Lowest
Bankruptcy	Personal		Newest/Oldest
Tax lien	Student Loan		Too many/too few
	Revolving credit		Presence of
	Bankcard		
	Secured		
	Unsecured		
	Retail		

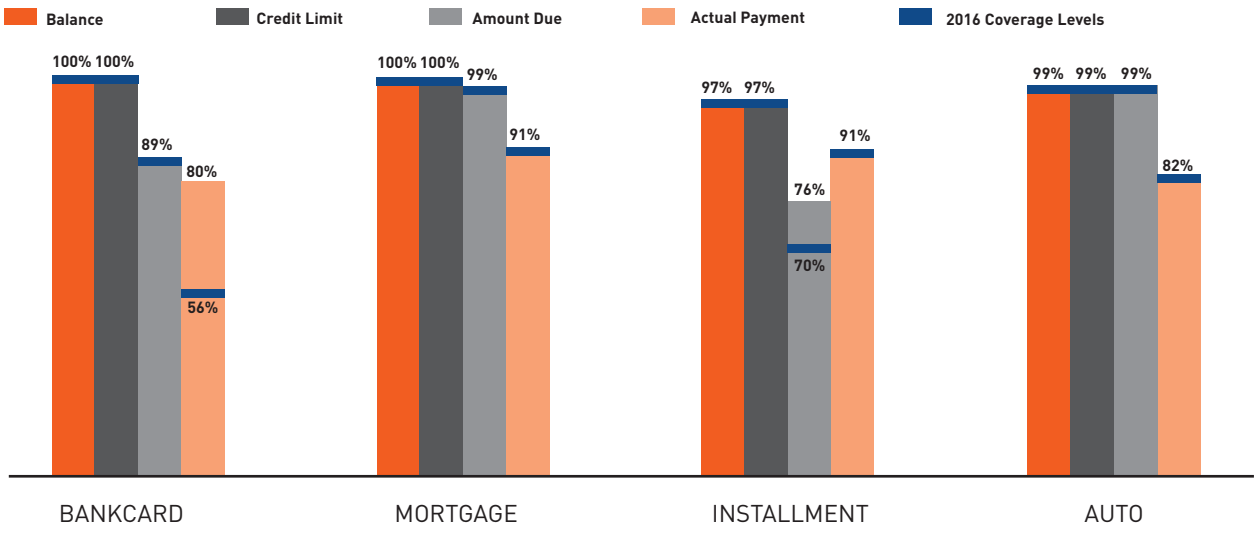
Trended Credit Data

VantageScore 4.0 is the first generic risk scoring model to incorporate tri-CRC leveled trended credit data attributes. Trended credit data enhances the accuracy of credit scoring models by incorporating the consumer behavioral trajectories in addition to the current month (static) information.

Figure 4: Attributes were designed to represent trended behaviors on the following dimensions:

Industry	Behavior	Timeframe
First Mortgage	Number credit limit increase/decrease	3 months
All Mortgages	Number of payments above the amount due	6 months
Home Equity	% change in balance	12 months
Installment	Slope of balance, credit limit	24 months
Personal Installment	Start-End % change in balance	
Auto Loan	Average excess payment in $ or % to prior due amount	
Student Loan	Average monthly utilization	
Bankcard	Time since most recently over limit	
Revolving	Number of times over limit	
Retail	Highest monthly utilization	
	Utilization on highest usage trade	
	Average number of payments as % of balance	
	Number of balance decreases/increases	

Figure 5: Trended data coverage %, by industry and behavior (2014-2016)



Trended credit data reporting for mortgage, installment and auto loans is extremely strong in all categories (Figure 5). For bankcard, actual payment data was available for only 56% of loans in 2016. This reduced level of reporting did not negatively impact attribute design or model performance.

Attributes are leveled across the three CRCs. A comprehensive discussion of VantageScore attribute leveling process is provided in the following "Characteristic Leveling" white paper.

Public Record Attributes & National Consumer Assistance Plan

As part of the previously announced National Consumer Assistance Plan (announced in 2015), the CRCs have enhanced their practices and procedures related to the selection, collection, reporting and updating of public record data included in consumer credit reports. As a result of these enhancements, the volume of public records in consumer credit files has diminished. VantageScore 4.0 has redesigned attributes related to public records to accommodate these shifts in volume while continuing to consider public record information when it is included in the credit file. See the research insights in "Negative Data Suppression and Impacts on Credit Score Models" white paper.

Attribute Selection

Model developers designed 2,000 behavioral credit attributes. These attributes were appended to each consumer outcome flag as of the observation date. Ultimately, approximately 120 were selected for use in VantageScore 4.0 based on the combination of attributes that best predicted performance as of the performance date. A stepwise discriminant process was applied to reduce the attributes to the most predictive subset. All attributes are FCRA compliant.

A comprehensive review of the dependent and independent variables was conducted for the following tests and refinements:

- Leveled interpretation of information across the three CRCs
- Caps and default conditions were applied where appropriate
- Logical validity
- Resolution of multi-collinearity concerns

Segmentation analysis

VantageScore 4.0 incorporates a segmentation scheme combining business-logic, attribute-based segmentation with empirically derived, score-based segmentation. Three internally developed scores are used as part of the segmentation design. The segmentation scores create segments based on a preliminary assessment of the consumer's risk as well as profiling their relative propensity to go to "default" versus "derogatory" status.

Default is defined as 90 days ore more past due but not charge-off or bankruptcy. Derogatory is defined as charge-off or bankruptcy. The use of segmentation scores reduces shifting between scorecards, resulting in a more stable score. It also improves performance across Superprime, Prime, Nearprime, and Subprime credit markets. This segmentation scheme provides significant lift in the score's prediction of risk.

Overall, seven scorecards were developed (Figure 6):

- The full file population is first scored by the derogatory score, which separates the population into high and low likelihood to go to derogatory status. Two default scores further segment each population according to likelihood to default. Four sub-populations are identified representing highest to lowest risk behavior. Scorecards were specifically designed for each of these populations (Segments 4 to 7).

- A "thin file and young" scorecard for consumers with two or fewer trades or who have no trade older than six months in age was developed. (Segment 3).

- Finally, two universe expansion scorecards were developed:

  – Dormant consumers – those who have not had an update to their credit file in the last six months (Segment 2)

  – Consumers with no useable trades but with public record information and unpaid collections (Segment 1)

  Each scorecard calibration dataset is individually optimized, using logistic regression, to provide maximum performance for origination and portfolio management accounts. Key metrics by segment are provided in Figure 7 on the following page.

Figure 6: Scorecard segmentation

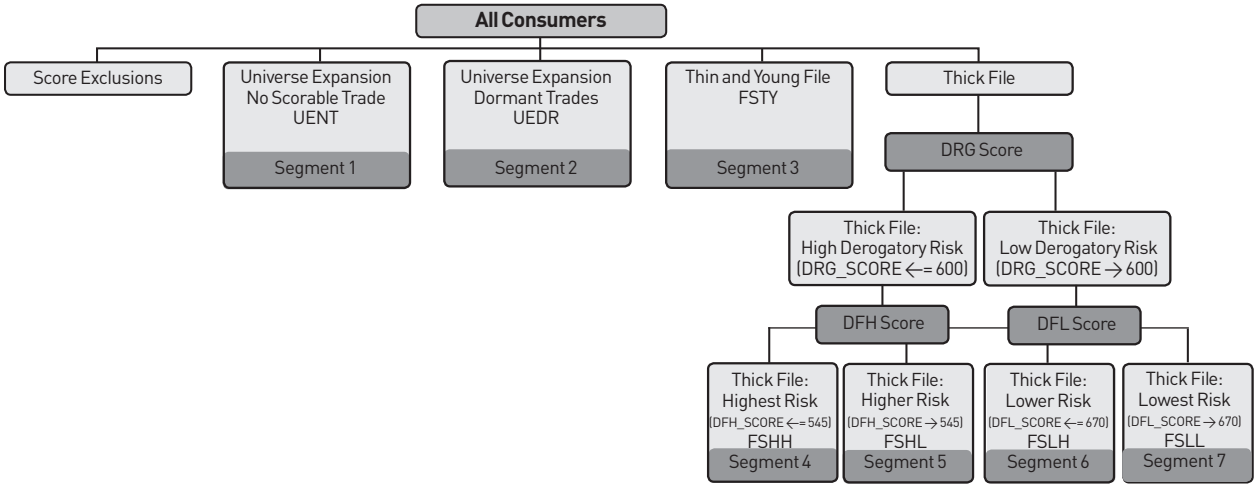


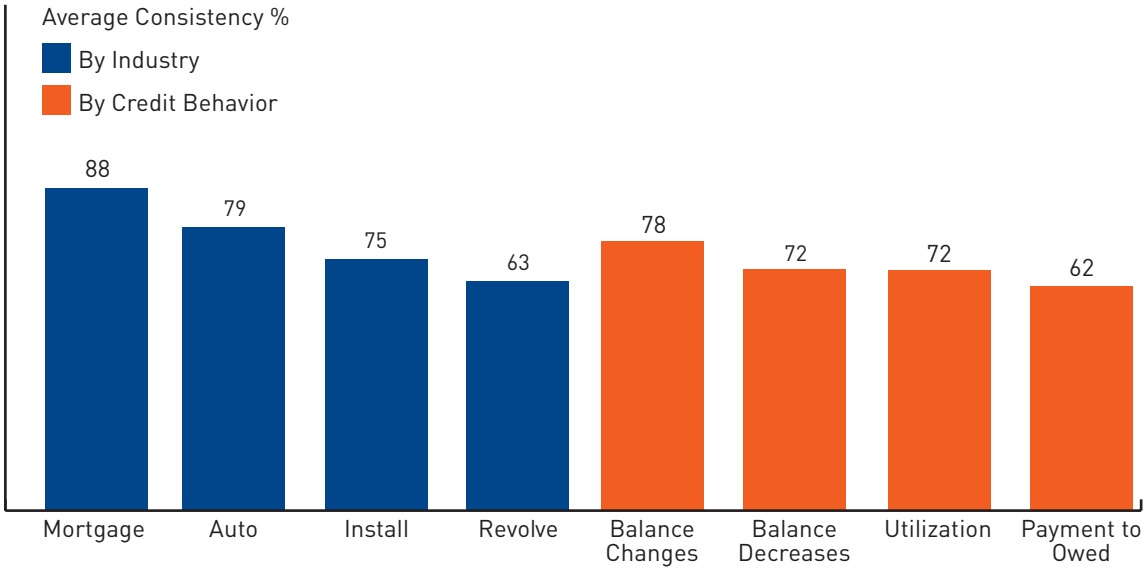
Figure 7: Population and Performance by Segments (2014-2016)

	Segment	Universe Expansion No Scoreable Trades (UENT)	Universe Expansion Dormant Trades (UEDR)	Thin and Young File (FSTY)	Thick File Highest Risk (FSHH)	Thick File Higher Risk (FSHL)	Thick File Lower Risk (FSLH)	Thick File Lowest Risk (FSLL)	OVERALL
Populations	Originations	0.70%	1.60%	7.90%	7.80%	17.70%	23.50%	40.90%	**100.00%**
	Account Mngmt	-	0.50%	9.40%	10.30%	12.60%	19.30%	47.80%	**100.00%**
Default Rates (90+dpd)	Originations	29.90%	20.30%	13.30%	25.80%	11.60%	3.10%	0.60%	**6.60%**
	Account Mngmt	-	25.50%	16.00%	39.60%	13.40%	3.30%	0.40%	**8.30%**
Gini Results	Originations	22.5	39.1	52.3	29.8	30.4	33.3	54.5	**71.2**
	Account Mngmt	-	50.4	76.9	41.1	34.5	39.6	57.1	**83.3**
Percent 90+dpd Captured in Bottom 10% Scores	Originations	15.30%	19.80%	29.50%	17.40%	20.10%	22.70%	42.70%	**44.90%**
	Account Mngmt	-	20.50%	40.90%	18.40%	22.60%	27.70%	46.30%	**57.10%**
Percent 90+dpd Captured in Bottom 20% Scores	Originations	28.10%	35.90%	49.80%	31.50%	35.60%	39.30%	59.60%	**67.60%**
	Account Mngmt	-	37.40%	66.30%	33.20%	38.30%	44.70%	62.00%	**80.60%**
KS Results	Originations	17.7	29.1	39	21.7	22.5	24.2	41.2	**55.8**
	Account Mngmt	-	38.7	61.4	30.3	25.3	29.1	42.9	**68.2**

Trended Data Attributes in VantageScore 4.0

VantageScore 4.0 is the only commercially available risk score with tri-CRC leveled trended data attributes. The leveled attributes continue to ensure consumers receive highly consistent credit scores when requested from multiple CRCs (Figure 8).

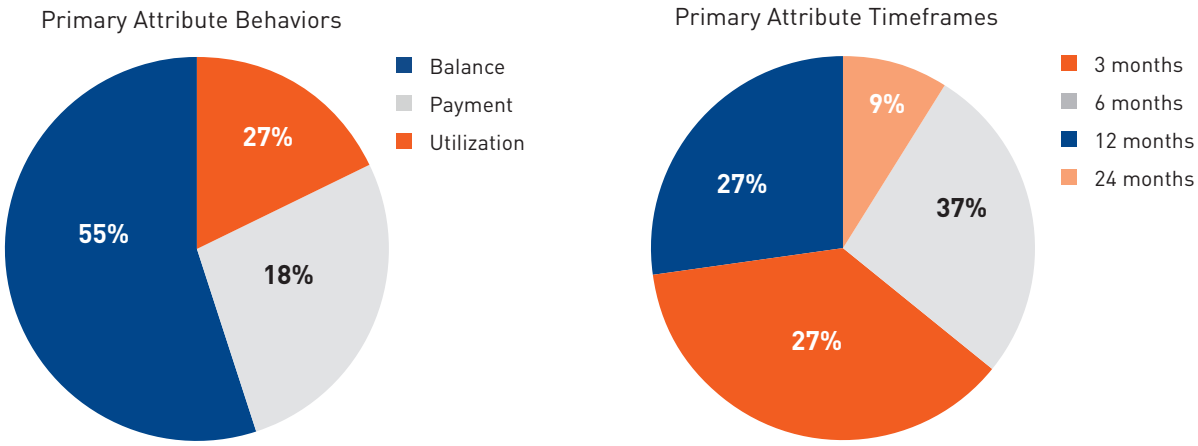
Figure 8: Trended data attributes - Consistency (2014-2016)



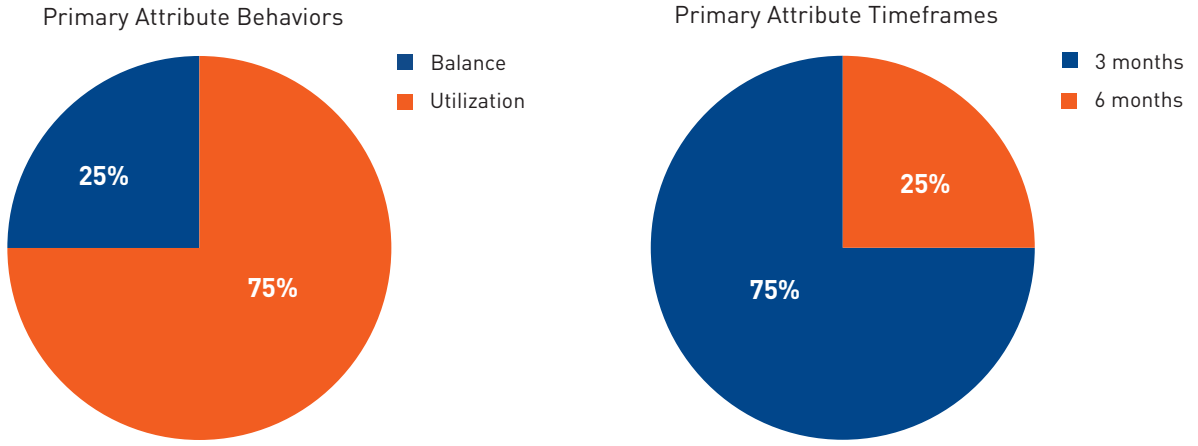
The following trended data attribute profiles were significant for Prime and Subprime credit consumers:

Figure 9: Trended data attribute contribution (2014-2016)

in Prime Scorecards



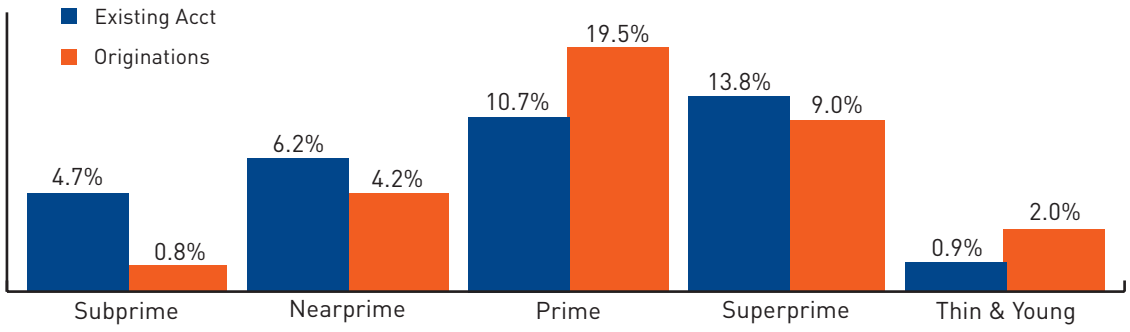
in Subprime Scorecards



Performance Enhancement Using Trended Data Attributes

Trended data attributes substantially improve predictive performance for prime and superprime risk tier consumers, providing a capability to tease out "bads" in overwhelmingly good populations (Figure 10).

Figure 10: Incremental Predictive Performance using trended attributes scorecards compared to non-trended attribute scorecards (2014-2016)



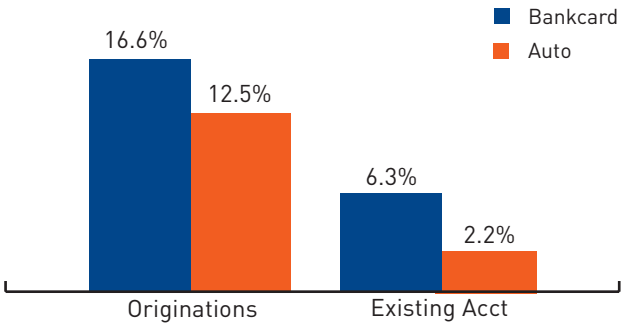
Universe Expansion Using VantageScore

The VantageScore 4.0 model scores approximately 40 million more consumers than conventional scoring models that require a minimum of six months of credit history on the credit file or an update to their credit file in the last six months.

Machine learning techniques were used to develop multi-dimensional attributes that more effectively capture the behavioral nuances of consumers who have sparse data files. Multi-dimensional attributes were designed primarily for revolving products and installment products. Additionally the performance definition for these populations was enhanced to expand the volume of useable performance trades. FCRA compliant reason codes were assigned to each attribute. The attributes were incorporated into structured scorecards and aligned with the overall algorithm.

Performance for these populations was significantly enhanced compared with traditional methods.

Figure 11: DORMANT CONSUMER: Performance lift over VantageScore 3.0 (2014-2016)



See "How Machine Learning Enhances Vantagescore 4.0" white paper on machine learning innovation.

Final Model

Figure 12: Final Attributes

Each attribute was assigned to one of the following generalized scoring factors:

Item	Description
Payment History	Repayment behavior (satisfactory, delinquency, derogatory)
% of Credit Limit Used	Proportion of credit amount used/owed on accounts
Balances	Total amount of recently reported balances (current and delinquent)
Age and Type of Credit	Length of credit history and types of credit
Recent Credit	Number of recently opened credit accounts and credit inquiries
Available Credit	Amount of credit available

Score Calculation Drivers

Contribution to Score Methodology

The scoring factor methodology is based on the percentage of contribution that the value of each attribute (Figure 13), used in the score calculation, makes to the consumers' final score. These values are assigned to one of six general categories identified above in order to provide estimate of how these factors contribute to models' predictive insight.

As an example, the methodology for calculating the contribution to score for a single consumer is described below:

- Assume a consumer has a final score of 700, calculated from a scoring model where the starting score is 300. The credit file attributes used in the calculation therefore delivered 400 points (the final score minus the starting score). Four behavioral attributes, A, B, C and D, were used to calculate the final score and each attribute delivered 100 points of the 400 points. Each attribute therefore contributes 25% (100/400) to the score.
- To provide further clarity on how credit behaviors contribute to the model's predictive insight, similar behavioral attributes are assigned to generalized behavioral factors. Continuing with our example, attributes A and B are assigned to Factor 1, attribute C is assigned to Factor 2 and attribute D is assigned to Factor 3. Consequently Factor 1 contributes to 50% of the model insight (100+100)/400), while Factor 2 and Factor 3 each contribute 25% of the model insight.

Generalized behavioral factors are consistent with prior categorization definitions used in VS3.0. The pie chart below is simply the average of all consumers' individual-level contribution to score calculations, as described in the methodology section above. The figure below shows the final factor contribution percentages for the 2014—2016 holdout population.

Figure 13: Score contribution

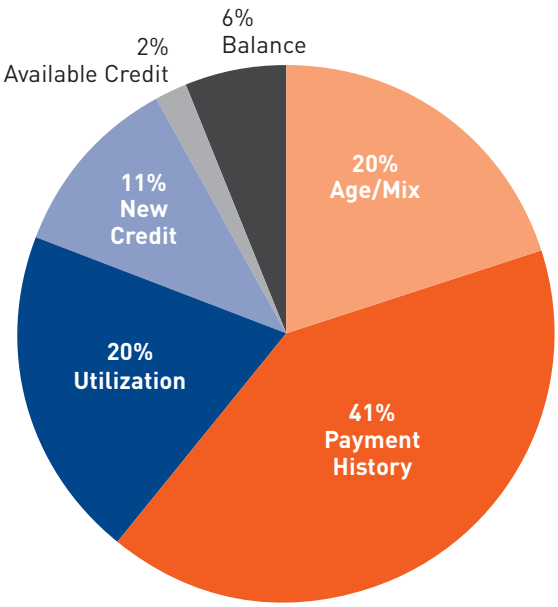


Figure 14: Score Distributions By Segment - Account Management (2014-2016)

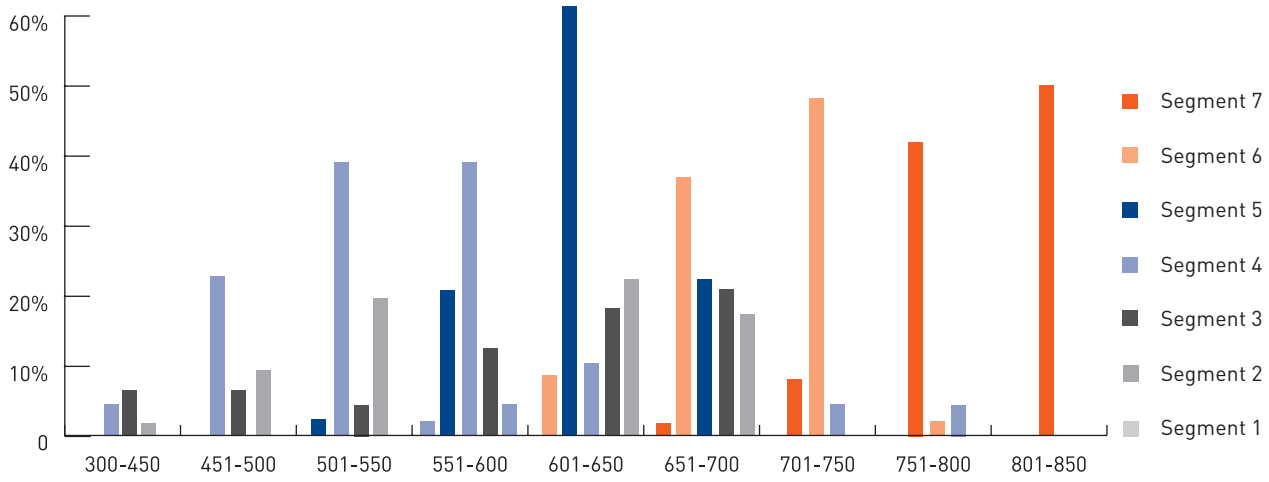
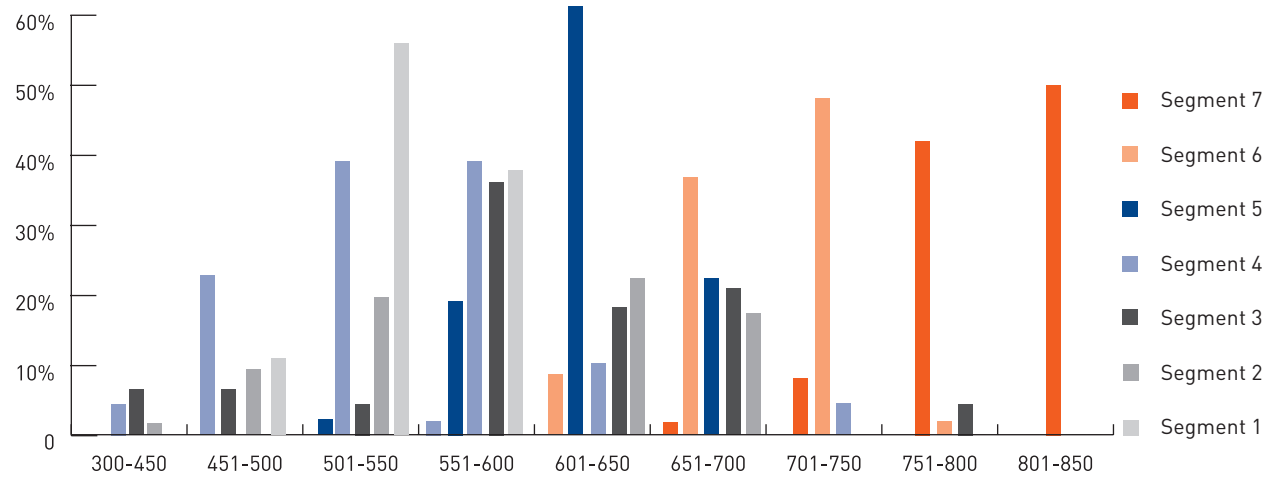


Figure 15: Score Distributions By Segment - Originations (2014-2016)



Population Distribution

Mainstream consumers have a minimum of six months activity on their credit file and have updated their file in the last six months. New Scoring (Universe Expansion - Figure 16) consumers fail these criteria but satisfy one of the following criteria.

- Between one and five months history on their credit file
- Failed to update their credit file in the last six months but have some trade activity beyond that timeframe, six months or more ago
- No useable trades but have unpaid collections or public record information

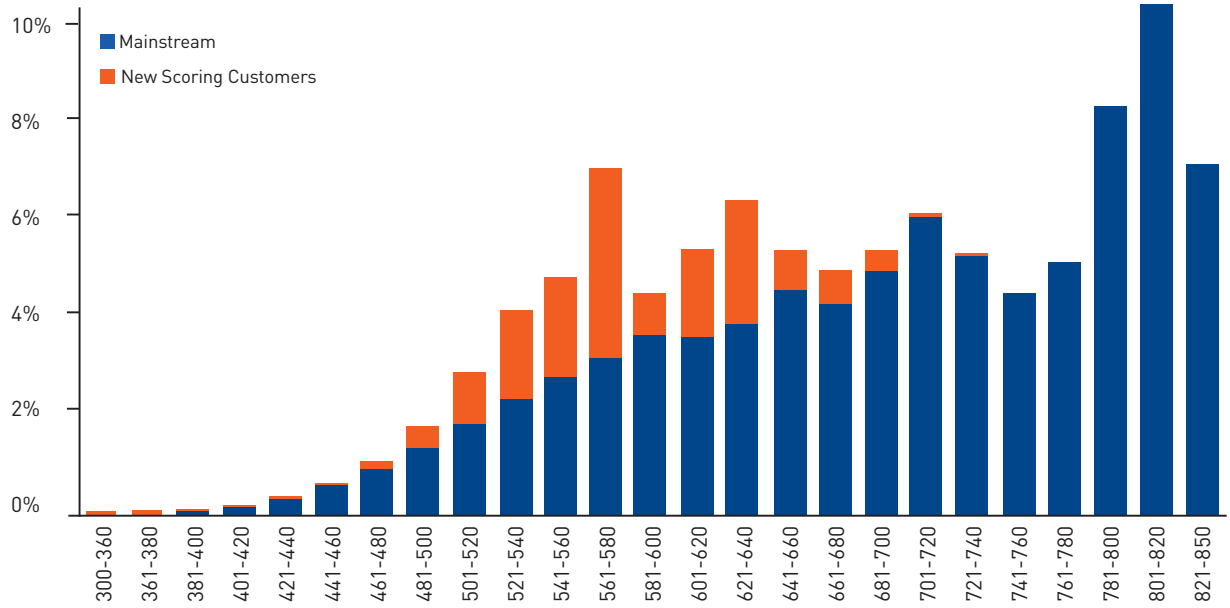
Use of embedded scores & demographic information

- No other commercially available scores are embedded within the score. As previously referenced, three internally developed segmentation scores are used to classify risk. No demographic information is used in model development.

Modeling Limitations

- A model is designed for probability of default risk management for the U.S. population with conventional consumer lending products
- Scores generated by the model may be used as an independent variable in risk/credit tools
- The model is not designed for predicting absolute default rates for the purposes of financial forecasting

Figure 16: VantageScore 4.0 Score Distribution (2014-2016)



Model Performance Evaluation

Predictive Results

VantageScore 4.0 was validated on a holdout sample, June 2014 – June 2016 and the results are detailed below.

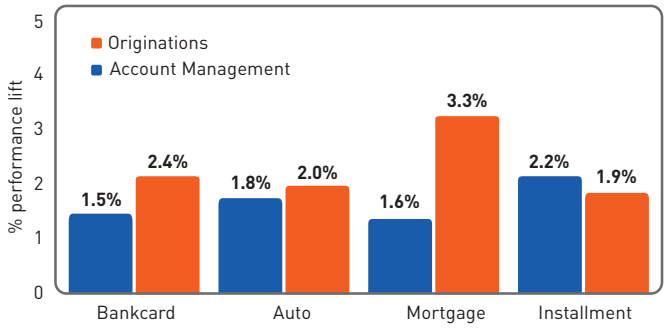
Gini results are presented by industry and at the overall level for account management and originations (Figure 17).

The VantageScore 4.0 model improves upon an already strong VantageScore platform delivered through earlier models (Figure 18).

Figure 17: Performance by Industry VantageScore 4.0

Industry	Gini Value	
	Account Management	Originations
Bankcard	83.2	70.2
Auto	81.1	72.7
Mortgage	84.0	73.1
Installment	79.9	68.4
Student Loan	76.1	65.8
Revolving	82.6	71.6
Retail	82.5	70.5
Department Store	83.6	70.1
Credit Union	79.6	62.2
Overall	**83.3**	**71.2**

Figure 18: Incremental 90+ Days Past Due accounts captured in bottom 20%: VantageScore 4.0 compared with VantageScore 3.0

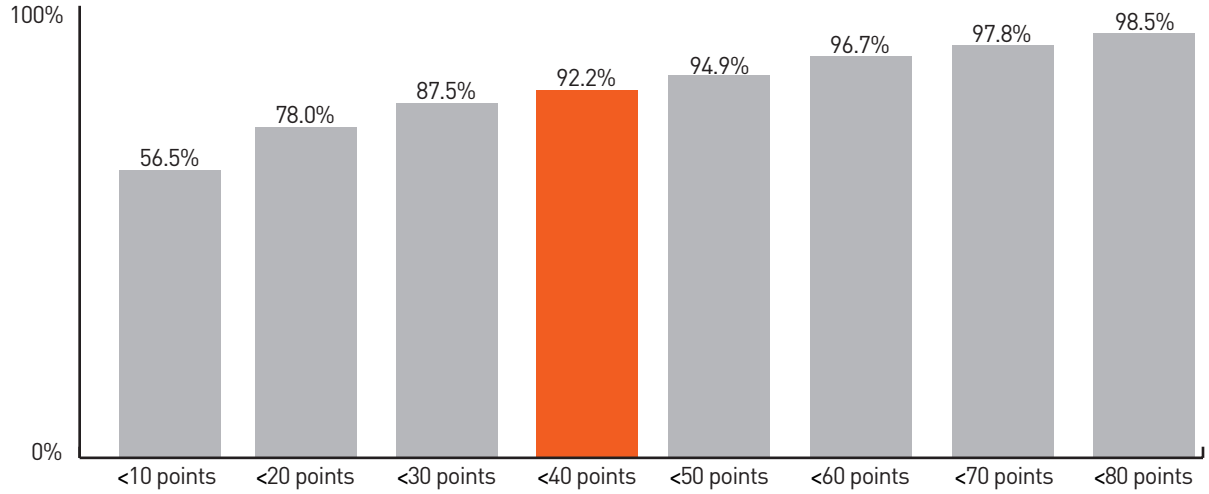


Consistency

All versions of VantageScore are the first and only models to employ the same characteristic information and the same algorithm at each CRC, resulting in a more consistent score for consumers across all three CRCs and providing more consistent risk assessment to lenders from all three CRCs.

As a result, consumer scores are highly consistent across the three CRCs; 92.2% of consumers scores are within a 40-point range when simultaneously pulled at all three CRCs (Figure 19).

Figure 19: Score consistency



Statistical Bias Analysis

Methodology

Statistical bias concerns arise with respect to a credit score used in a credit extension transaction if the model favors an outcome for a group of consumers over another outcome for a different group of consumers, even though they both receive the same score with the same model.

A credit score model without statistical bias requires that the probability of default profiles for each credit score for each group of consumers (population segment) are aligned with the default profiles of other groups of consumers. If there are significant differences between any population segments, the credit score model has a statistical bias (either positive or negative) towards a consumer group. This, in turn, suggests that there is preferential treatment/mistreatment of particular population segments.

A formal statistical test that determines if there differences in default probabilities between population segments is the "Chi-Square" test for multiple probabilities. To perform this test on VantageScore 4.0, score bands are created, ensuring that there is sufficient sample in each band for statistical robustness. In each score band, the Chi-Square probability comparison test is applied to assess if there are statistically significant differences in the actual default probabilities amongst population segments. If the differences between population segments and whole population default probabilities are large (i.e., statistically significant, as measured by comparing to a critical value), then there is a demonstrated measurable bias. If not, then there is no measurable impact. The critical value is set to 95.0%. Test is performed across all score bands; if one band fails the test then there is a bias implication for the model as a whole.

Further, thresholds are produced (lower and upper) based on the Chi-Square test values for each score band to determine where each population segment is considered within normal population boundaries. These thresholds build confidence curves around the difference in probabilities of default between population segments for each score band. For more details on this methodology please refer to "Testing Methodologies for Credit Score Models to Identify Statistical Bias toward Protected Classes," May 2014.

VantageScore Statistical Bias: Ethnicity

The statistical bias bias test is applied on ethnic protected class population segments, namely African-American (AOMC) and Hispanic-American (AOHC) populations. Ethnicity data was appended to the consumer census data based on zip code.

For both secured and unsecured products, graphical comparisons show all ethnic classes essentially default curves that are not statistically different. Both ethnic group curves, African-American (AOMC) and Hispanic-American (AOHC), are well within their confidence intervals. Also, for each VantageScore 4.0 band no Chi-Square test statistics calculation is larger than the critical value (Figure 20 for bankcard products and Figure 21 for first mortgage products), indicating there are no measurable differences between the groups at each credit score value and the overall population default rates for bankcard (Figure 22) or first mortgage (Figure 23).

Figure 20: Statistical Bias: Ethnicity test statistic for BANKCARD products

African American Population

Vantage Score 4.0 Range	Start Point	821	801	781	761	741	721	701	681	661	641	621	601	581	561	541	521	500
	End Point	850	820	800	780	760	740	720	700	680	660	640	620	600	580	560	540	520
Test Chi-Square		0.590	0.028	0.085	3.121	8.307	6.848	2.731	3.858	1.898	5.492	0.001	0.154	1.579	0.968	0.001	1.304	0.058
Critical Value		8.844	8.844	8.844	8.844	8.844	8.844	8.844	8.844	8.844	8.844	8.844	8.844	8.844	8.844	8.844	8.844	8.844
Is Test → Critical Value {If "Yes" then Disparate Impact}		No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No

Hispanic Population

Vantage Score 4.0 Range	Start Point	821	801	781	761	741	721	701	681	661	641	621	601	581	561	541	521	500
	End Point	850	820	800	780	760	740	720	700	680	660	640	620	600	580	560	540	520
Test Chi-Square		0.007	1.608	3.396	0.369	1.806	6.804	1.968	0.070	0.156	0.023	0.202	1.856	0.979	0.180	0.058	0.978	0.050
Critical Value		8.844	8.844	8.844	8.844	8.844	8.844	8.844	8.844	8.844	8.844	8.844	8.844	8.844	8.844	8.844	8.844	8.844
Is Test → Critical Value {If "Yes" then Disparate Impact}		No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No

Figure 21: Statistical Bias: Ethnicity test statistic for FIRST MORTGAGE products

African American Population

Vantage Score 4.0 Range	Start Point	821	801	781	761	741	721	701	681	661	641	621	601	581	561	541	521	500
	End Point	850	820	800	780	760	740	720	700	680	660	640	620	600	580	560	540	520
Test Chi-Square		1.736	3.482	0.059	2.496	4.190	0.896	6.619	4.578	1.317	4.275	0.404	0.424	1.567	0.998	1.294	0.008	0.487
Critical Value		8.844	8.844	8.844	8.844	8.844	8.844	8.844	8.844	8.844	8.844	8.844	8.844	8.844	8.844	8.844	8.844	8.844
Is Test → Critical Value {If "Yes" then Disparate Impact}		No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No

Hispanic Population

Vantage Score 4.0 Range	Start Point	821	801	781	761	741	721	701	681	661	641	621	601	581	561	541	521	500
	End Point	850	820	800	780	760	740	720	700	680	660	640	620	600	580	560	540	520
Test Chi-Square		3.056	1.255	1.831	0.044	3.311	0.001	0.104	0.282	1.126	0.237	1.113	0.723	0.403	0.149	0.235	0.533	0.430
Critical Value		8.844	8.844	8.844	8.844	8.844	8.844	8.844	8.844	8.844	8.844	8.844	8.844	8.844	8.844	8.844	8.844	8.844
Is Test → Critical Value {If "Yes" then Disparate Impact}		No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No

For these secured and unsecured credit products, there is no evidence of bias toward protected classes when using VantageScore 4.0.

Figure 22: Statistical Bias: Bankcard default profiles by ethnicity with confidence intervals

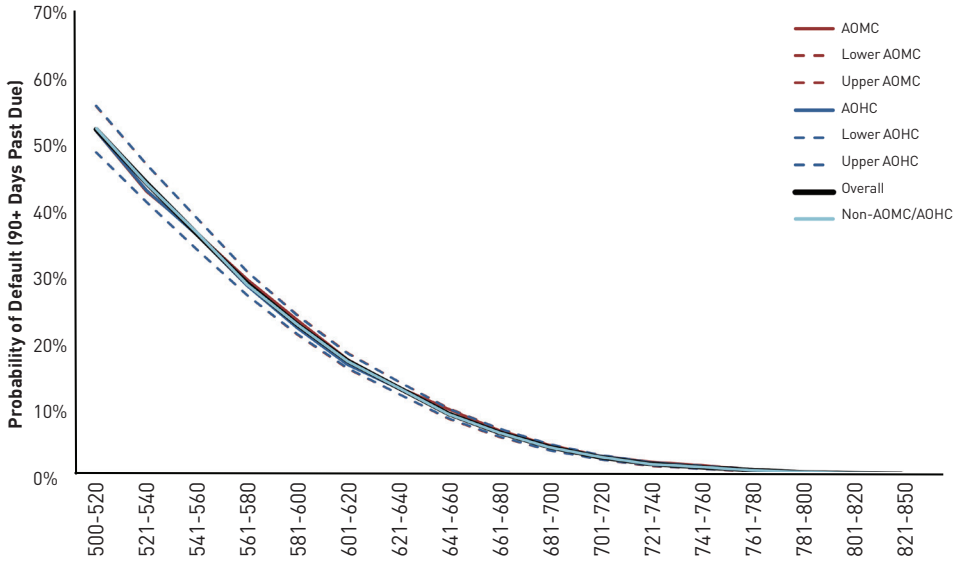
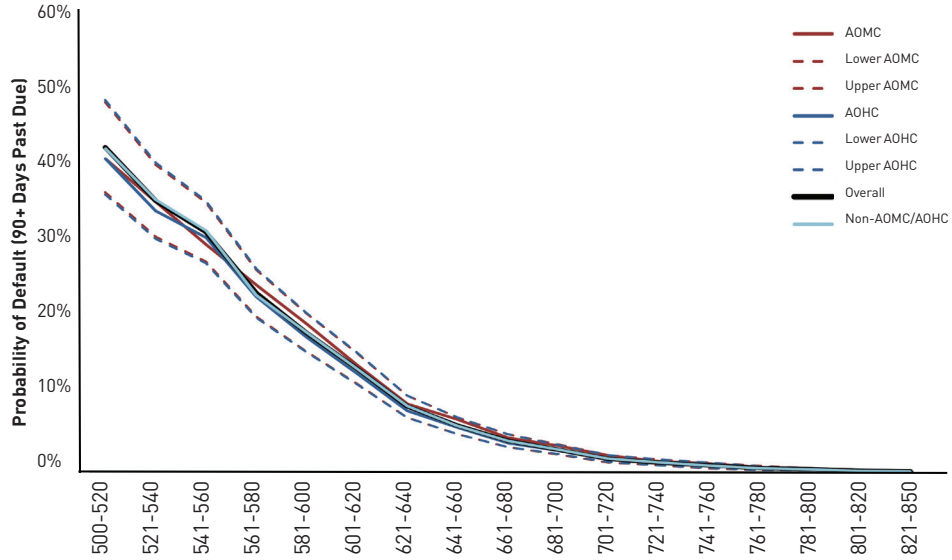


Figure 23: Statistical Bias: First mortgage default profiles by ethnicity with confidence intervals



Risk Alignment

"Risk Alignment" is the degree to which a credit score reflects the same level of risk at different CRCs. Stronger risk alignment between CRCs provides more accurate risk assessment for the lender and additionally reduces the resources required by the lender for strategy management and score maintenance.

As seen in figures 24 and 25, the score distribution for VantageScore 4.0 shows that there is consistency across all three CRCs:

Figure 24: VantageScore 4.0: Consistency of Score Distributions Across CRCs for Overall Account Management

Figure 25: VantageScore 4.0: Consistency of Score Distributions Across CRCs for Overall Originations

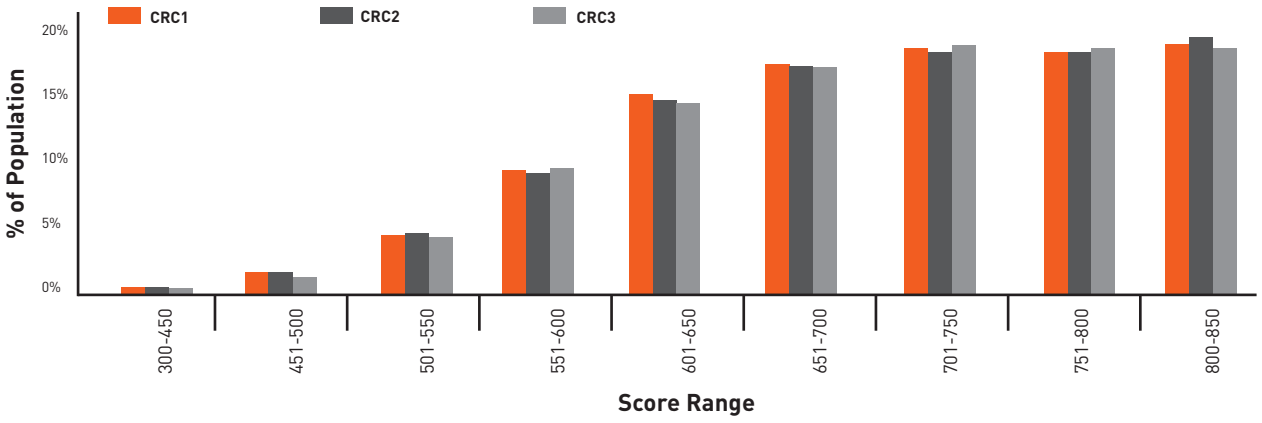
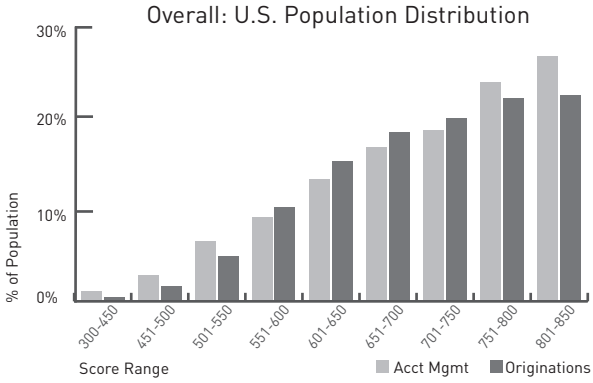
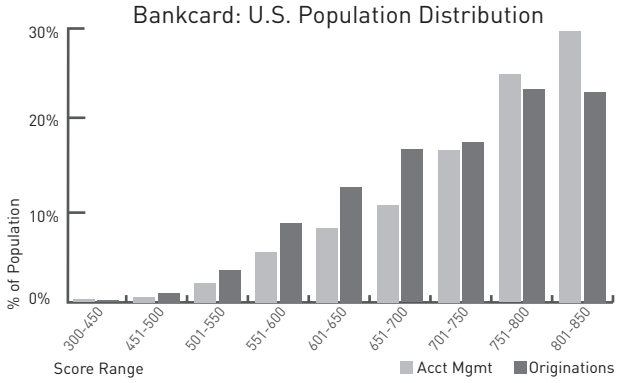
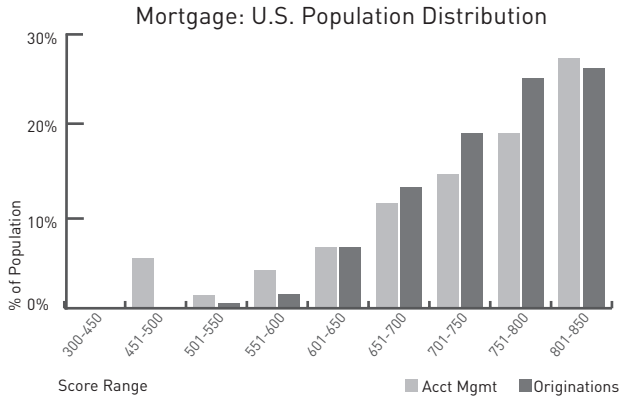
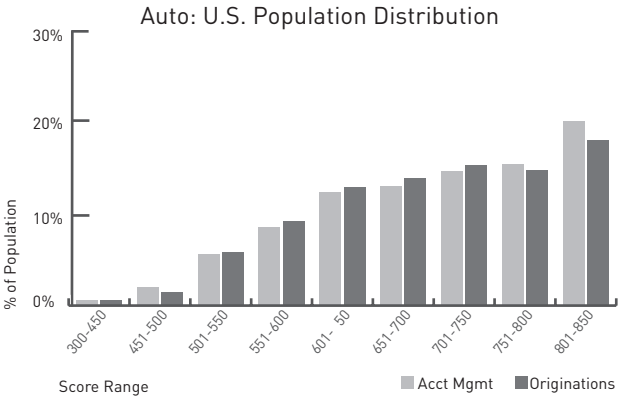


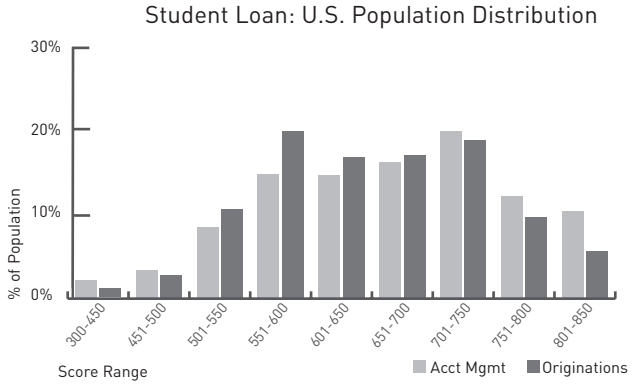
Figure 26: Population Distribution by Industry

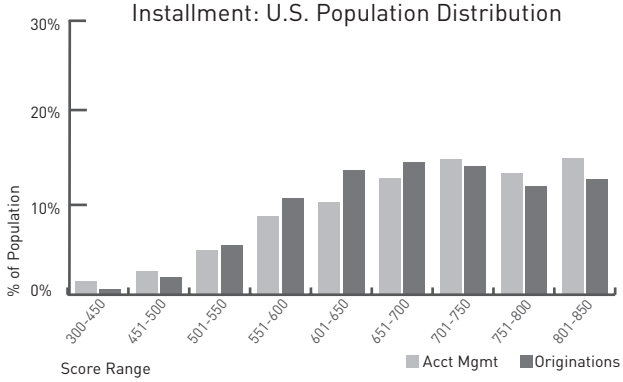












Gains Charts by Industry

Overall	Originations			Existing Account		
	Default Rate		Percent Bads Captured	Default Rate		Percent Bads Captured
Group	Interval	Cumulative		Interval	Cumulative	
1	0.12%	0.12%	0.19%	0.07%	0.07%	0.09%
2	0.24%	0.18%	0.39%	0.14%	0.11%	0.18%
3	0.43%	0.26%	0.69%	0.22%	0.14%	0.27%
4	0.83%	0.40%	1.34%	0.39%	0.20%	0.48%
5	1.69%	0.66%	2.74%	0.85%	0.33%	1.05%
6	2.84%	1.02%	4.60%	1.75%	0.57%	2.17%
7	5.08%	1.60%	8.23%	3.67%	1.01%	4.55%
8	8.33%	2.44%	13.50%	8.06%	1.89%	10.01%
9	13.83%	3.71%	22.41%	18.62%	3.75%	23.13%
10	28.31%	6.17%	45.90%	46.76%	8.05%	58.07%

Bankcard	Originations			Account Management		
	Default Rate		Percent Bads Captured	Default Rate		Percent Bads Captured
Group	Interval	Cumulative		Interval	Cumulative	
1	0.15%	0.15%	0.22%	0.06%	0.06%	0.13%
2	0.26%	0.21%	0.38%	0.11%	0.08%	0.22%
3	0.48%	0.30%	0.71%	0.18%	0.12%	0.37%
4	1.03%	0.48%	1.50%	0.24%	0.15%	0.50%
5	2.05%	0.80%	2.98%	0.42%	0.20%	0.87%
6	3.30%	1.21%	4.80%	0.93%	0.32%	1.94%
7	5.75%	1.86%	8.36%	1.85%	0.54%	3.85%
8	9.77%	2.85%	14.22%	3.84%	0.95%	7.98%
9	15.89%	4.30%	23.12%	9.29%	1.88%	19.28%
10	30.04%	6.87%	43.72%	31.24%	4.82%	64.86%

Mortgage	Originations			Account Management		
	Default Rate		Percent Bads Captured	Default Rate		Percent Bads Captured
Group	Interval	Cumulative		Interval	Cumulative	
1	0.00%	0.00%	0.00%	0.04%	0.04%	0.11%
2	0.01%	0.01%	0.16%	0.08%	0.06%	0.22%
3	0.09%	0.03%	0.97%	0.14%	0.09%	0.37%
4	0.10%	0.05%	1.13%	0.22%	0.12%	0.56%
5	0.19%	0.08%	2.09%	0.44%	0.19%	1.14%
6	0.31%	0.12%	3.38%	0.72%	0.27%	1.88%
7	0.50%	0.17%	5.48%	1.37%	0.43%	3.56%
8	0.99%	0.28%	10.79%	2.64%	0.71%	6.86%
9	1.96%	0.46%	21.26%	6.54%	1.36%	16.97%
10	5.04%	0.92%	54.75%	26.33%	3.85%	68.34%

Auto	Originations			Existing Account		
	Default Rate		Percent Bads Captured	Default Rate		Percent Bads Captured
Group	Interval	Cumulative		Interval	Cumulative	
1	0.10%	0.10%	0.24%	0.06%	0.06%	0.10%
2	0.16%	0.13%	0.37%	0.12%	0.09%	0.20%
3	0.37%	0.21%	0.87%	0.21%	0.13%	0.35%
4	0.52%	0.29%	1.22%	0.44%	0.21%	0.72%
5	1.16%	0.46%	2.73%	0.84%	0.34%	1.38%
6	1.71%	0.67%	4.03%	1.57%	0.54%	2.58%
7	2.98%	1.00%	7.02%	3.14%	0.91%	5.15%
8	5.06%	1.51%	11.92%	6.36%	1.59%	10.44%
9	8.92%	2.33%	21.02%	13.07%	2.94%	22.48%
10	21.47%	4.24%	50.58%	34.49%	6.09%	56.60%

Student Loan	Originations			Account Management		
	Default Rate		Percent Bads Captured	Default Rate		Percent Bads Captured
Group	Interval	Cumulative		Interval	Cumulative	
1	0.78%	0.78%	0.47%	0.57%	0.57%	0.26%
2	1.93%	1.35%	1.16%	0.85%	0.71%	0.39%
3	2.82%	1.84%	1.70%	1.70%	1.04%	0.78%
4	4.37%	2.47%	2.63%	3.41%	1.63%	1.57%
5	8.43%	3.66%	5.08%	6.85%	2.68%	3.15%
6	13.08%	5.23%	7.88%	13.78%	4.53%	6.34%
7	13.03%	6.35%	7.86%	23.83%	7.28%	10.97%
8	26.51%	8.87%	15.98%	39.10%	11.26%	18.00%
9	40.30%	12.36%	24.29%	55.03%	16.12%	25.34%
10	54.66%	16.59%	32.95%	72.08%	21.72%	33.19%

Installment	Originations			Account Management		
	Default Rate		Percent Bads Captured	Default Rate		Percent Bads Captured
Group	Interval	Cumulative		Interval	Cumulative	
1	0.17%	0.17%	0.24%	0.13%	0.13%	0.12%
2	0.30%	0.24%	0.42%	0.27%	0.20%	0.25%
3	0.73%	0.40%	1.02%	0.47%	0.29%	0.43%
4	1.36%	0.64%	1.89%	0.90%	0.44%	0.83%
5	2.29%	0.97%	3.18%	1.98%	0.75%	1.81%
6	4.12%	1.50%	5.72%	3.83%	1.26%	3.50%
7	6.58%	2.22%	9.12%	7.22%	2.11%	6.61%
8	9.67%	3.15%	13.42%	13.86%	3.58%	12.67%
9	16.31%	4.62%	22.63%	27.16%	6.20%	24.84%
10	30.54%	7.21%	42.37%	53.50%	10.93%	48.94%

Universe Expansion — Validation

The VantageScore 4.0 model provides a predictive credit score to approximately 40 million more adults than conventional scoring models.

- VantageScore models score consumers that may not be scored by conventional models that require a minimum of six months of credit history on the credit file or an update to the credit file at least once every six months
- Consumers incrementally scored by VantageScore 4.0 are those with:
  - Less than six months history on their credit file
  - No updates to their credit file within the last six months
  - No scoreable trades but have public records and/or unpaid collections
- The following consumers are not scored, and receive exclusion codes:
  - 001 – Deceased
  - 004 – Credit report has no information or only inquiries
- VantageScore 4.0 was validated on the aforementioned populations. Results are:
  - Gini = 52.1
  - This compares with a VantageScore 3.0 Gini of 49.7
- Gains chart for "New Scoring" populations:

Figure 27

Decile	Default Rate		Percent Bads Captured
	Interval	Cumulative	
1	2.6%	2.6%	1.3%
2	4.9%	3.8%	2.4%
3	7.3%	5.0%	3.6%
4	9.9%	6.2%	4.8%
5	14.2%	7.8%	6.9%
6	21.7%	10.1%	10.5%
7	26.1%	12.4%	12.7%
8	31.6%	14.8%	15.3%
9	37.5%	17.3%	18.2%
10	50.0%	20.6%	24.3%

VantageScore 4.0 Statistical Bias: New scoring (universe expansion) vs. Mainstream scoreable consumers

The statistical bias test is applied on the universe expansion vs. mainstream consumer population segments for the score ranges that had a sufficient sample for a robust statistical chi-square test. Using the same statistical bias methodology, there were no discernible differences in the probability of default within each score band between consumers that are traditionally scored by credit score models (mainstream consumers) and consumers who are not traditionally scored in the credit industry (e.g., universe expansion consumers) — Figures 28 and 29 below. Note that there was insufficient sample size for score bands above 660.

Statistical Bias: Default profiles Universe Expansion vs. Mainstream with confidence intervals

Figure 28

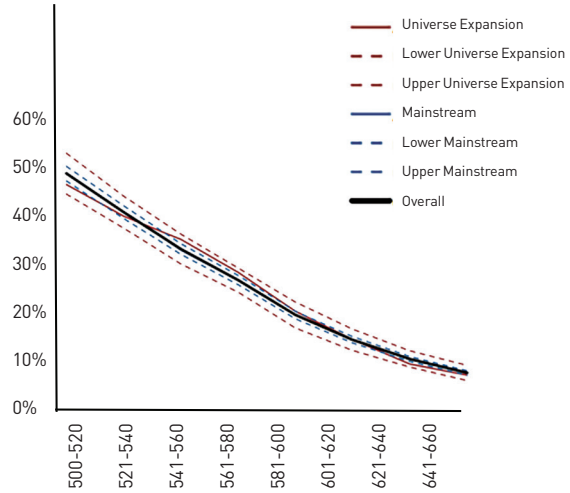


Figure 29

Mainstream Population

Vantage Score 4.0 Range	Start Point	641	621	601	581	561	541	521	500
	End Point	660	640	620	600	580	560	540	520
Test Chi-Square		0.507	2.546	0.003	0.584	2.969	3.039	0.431	2.066
Critical Value		7.477	7.477	7.477	7.477	7.477	7.477	7.477	7.477
Is Test → Critical Value {If "Yes" then Statistical Bias}		No	No	No	No	No	No	No	No

Universe Expansion Population

Vantage Score 4.0 Range	Start Point	641	621	601	581	561	541	521	500
	End Point	660	640	620	600	580	560	540	520
Test Chi-Square		0.477	0.111	0.953	0.445	0.085	0.081	0.512	0.151
Critical Value		7.477	7.477	7.477	7.477	7.477	7.477	7.477	7.477
Is Test → Critical Value {If "Yes" then Statistical Bias}		No	No	No	No	No	No	No	No

Additional Considerations

Collections Accounts

- Paid vs. Unpaid collection accounts
  - All PAID collection accounts, medical and non-medical, are ignored in VantageScore 4.0
- Medical vs. Non-medical Unpaid Collections
  - Unpaid medical collection accounts are penalized less significantly than unpaid non-medical collection accounts
  - Medical collection accounts that are less than 180 days old are not considered

Handling of Inquiries

- Multiple major credit inquiries within a 14-day window are considered one inquiry regardless of the type of account (e.g., mortgage, auto, installment, bankcard). Retail, collection and utility inquiries are not de-duped.

Natural Disasters

- If the lender or servicer places a natural disaster notification on the account, delinquencies are temporarily excluded from the calculation of the consumer's score.

Handling of Student Loans

- Government and private student loan information are considered in combination. The following account condition information is considered: deferred, active and pay-down status.

Authorized User

- The impact of score-boosting through rental of authorized user trades is minimized.

Figure 30: Score Shifts

Score shifts by score bands from VantageScore 3.0 to VantageScore 4.0:

Score Range	VantageScore 4.0								
VantageScore 3.0	300-450	451-500	501-550	551-600	601-650	651-700	701-750	751-800	801-850
300-450	51.5%	38.4%	8.9%	1.1%	0.1%	0.0%	0.0%	0.0%	0.0%
451-500	7.5%	41.1%	41.8%	8.8%	0.7%	0.0%	0.0%	0.0%	0.0%
501-550	0.7%	11.7%	45.6%	36.0%	5.7%	0.3%	0.0%	0.0%	0.0%
551-600	0.0%	1.1%	14.6%	48.0%	32.1%	4.1%	0.1%	0.0%	0.0%
601-650	0.0%	0.0%	0.9%	13.6%	48.4%	31.5%	5.3%	0.2%	0.0%
651-700	0.0%	0.0%	0.1%	1.7%	16.2%	47.1%	30.7%	4.0%	0.1%
701-750	0.0%	0.0%	0.0%	0.0%	1.0%	16.6%	52.4%	26.3%	3.7%
751-800	0.0%	0.0%	0.0%	0.0%	0.0%	1.0%	15.5%	51.5%	32.0%
801-850	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.3%	23.1%	76.6%

Forbearance and Deferred Payment Plans

Lenders/Servicers may choose to report an account to be in a forbearance or deferred payment plan by using a special comment code or other indicator. In such cases, all of the credit file information associated with that account will continue to be included in the score calculation. In other words, the presence of the forbearance or deferred payment related code will not lead to any change in how that account is included in the score calculation.* The forbearance and deferred payment codes are not directly tied to delinquency status or other fields used to calculate the score.

Score Scaling

The score range for VantageScore 4.0 is 300 to 850. The base score, 725, was established at the 50th percentile of the U.S. population. This represents a good:bad odds of 41:1. Halving and doubling of odds of default occur every 40 points.

For the U.S. population, the following credit tiers are identified by these score ranges:

Figure 31: Mainstream Population

Credit Tiers	VS 4.0
Superprime	781-850
Prime	661-780
Near Prime	601-660
Subprime	300-600

Validation

To confirm the model's predictive capability, the developers validated the scorecards with a hold-out sample from the actual model development population and from an out-of-time sample. This process provides a quality check to verify the scorecards are performing as expected and not tuned specifically to the data used in the development sample. VantageScore models are validated annually and the performance results are published on VantageScore.com. Detailed supporting statistics are available from any of the three national credit reporting companies or by emailing info@vantagescore.com .

Exclusion Codes

- 001 – Deceased
- 004 – Credit report has no information or only inquiries

*An adjustment to the model algorithm was implemented on June 2020 related to the treatment of either a forbearance or deferred payment-related code on an account. This adjustment was put in place to minimize any potential negative impact associated uniquely with the usage of these codes.

Adverse Action Codes

VantageScore provides up to four adverse action reason codes (also known as factor codes) that indicate which predictive attributes had the most negative influence on the score (i.e., caused the score to be lower). These codes are used in adverse action notifications to customers and are displayed in order of their contribution to the score.

To comply with FACTA, an additional fifth reason code will be returned when the consumer file has inquiries that affected the consumer's score and inquiries are not in the top four key reason codes.

For full file consumers, the adverse action reason codes are derived by considering three scorecards – the derogatory scorecards, the default scorecard and the final scorecard that the consumer is assigned. The number of reason codes was determined from each of the aforementioned scorecards based on their respective relative maximum achievable score and the absolute maximum of 850. The points lost based on the highest ranked attributes within each scorecard are identified and presented to the consumer from highest to lowest impact.

For Segments 1, 2 and 3, the reason codes were selected and prioritized only from the individual scorecard.

The adverse action reason codes are assigned a 2-byte numeric reason code (there are 89 possible reason codes). Reason codes were assigned to indicate the type of attributes they represent.

A complete list of adverse action reason codes is available in English and Spanish from any of the three national credit reporting companies that offer VantageScore 4.0, or by emailing info@vantagescore.com .

Positive action codes

VantageScore also can provide up to four positive reason codes that indicate which predictive attributes had the most positive influence on the score (i.e., caused the score to be higher).

The positive action codes are assigned a 3-byte reason code (there are 93 possible reason codes). Reason codes were assigned to indicate the type of attributes they represent.

A complete list of positive action reason codes is available in English and Spanish from any of the three national credit reporting companies that offer VantageScore 4.0, or by emailing info@vantagescore.com .

Performance Charts

VantageScore generates detailed performance charts as part of the annual model assessment. Current and historical charts are available from any of the three national credit reporting companies that offer VantageScore 4.0, or by emailing info@vantagescore.com .

Charts provide proportion of consumers that fall into the following categories by score range:

Good = Current To 30 Days Past Due
60+ = 60 Or More Days Past Due, Charge Off, Or Bankruptcy
90+ = 90 Or More Days Past Due, Charge Off, Or Bankruptcy
Co+ = Charge Off Or Bankruptcy
Bk = Bankruptcy

Breakdowns available include:

Geography: U.S.-wide and regional (Northeast, South, Midwest, West)
Account Type: Originations and Account Management
Industry: Overall, Credit Union, Bankcard, Revolving, Installment, Auto, Retail, Real Estate, Department Store and Student Loan
Score Ranges : 20-point breaks, 5% volume breaks

VantageScore Licensees

The VantageScore credit score models are sold and marketed only through individual licensing arrangements with the three major credit reporting companies (CRCs): Equifax, Experian and TransUnion.

Lenders and other commercial entities interested in learning more about the VantageScore credit score models, including the VantageScore 4.0 credit score model, may contact one of the following CRCs listed for additional assistance:

Call 1-888-202-4025
www.equifax.com/vantagescore

Call 1-888-414-4025
www.experian.com/vantagescoreforlenders

Call 1-866-922-2100
www.transunion.com/product/vantagescore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