IMPLICATIONS FOR USE OF CREDITS APPLIED TO PREFERRED KNOCK-OUT CRITERIA

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Executive Summary *The debit/credit system for assessing risk is a cornerstone of individual life insurance underwriting. This article explores the ramifications of knock-out criteria preferred risk underwriting intertwined with a debit/credit model. Debits and credits should remain a foundation for risk assessment, especially when assessing the merits of substandard risks. But this approach is problematic when used to move risks between preferred risk classes initially developed in a knock-out environment. By using Framingham risk of coronary artery disease as a proxy for mortality, it can be demonstrated that preferred knock-out rules describe the worst risk allowed into the preferred class, and that credits applied to the preferred risk classes erode the overall results. This is because the average risk associated with a preferred class is very different than the preferred rules. Credits are awarded to anyone qualifying for the credit, whereas knock-out rules move a risk out when only one adverse factor is present.*

Debits and Credits

For over a century the cornerstone of individual life insurance underwriting has been the stratification of risk using a debit/credit approach.[1] Generally, one debit equals a 1% increase in mortality while one credit equals a 1% reduction in mortality. The industry generally groups the mortality increases into 25 debit buckets and refers to them as risk classes or tables. A fundamental of underwriting is to apply favorable (credits) as well as unfavorable (debits) factors toward assessing an individual's mortality risk.

Knock-out Criteria

Many companies employ preferred knock-out criteria to stratify risks into preferred risk classes. This is not an underwriting fundamental, but the process works as long as the implications are understood. By definition, a knock-out rule means a person not qualifying for a given preferred criteria is "knocked-out" of that risk class. In general, a series of preferred rules is established to determine into which risk class an applicant belongs.

Exploration

To explore the interplay between knock-out rules and debit/credit approaches this article applies established techniques vetted, accepted and publicly reported. Underwriters stratify risk based on the aggregation of debits and credits. This is very similar to techniques employed by the Framingham Study, whose goal is to apply a score of positive and negative points to an individual to determine his unique risk of coronary artery disease (CAD) over a specified time period. The point score works like underwriting in that positive points increase risk while negative points decrease risk. Positive points act like debits and negative points act like credits. The difference being the Framingham point system is used to predict the risk of CAD, whereas the debit and credit structure used by life underwriters is used to predict mortality.

Because of its wide acceptance, the Framingham point system will be used to define risk. There is a direct correlation between a heart attack and mortality. That correlation is attenuated because not everyone who has a heart attack dies of his heart attack. In 2008, Dr. Randall Zusman of Mass General stated that 33% of the time the first manifestation of coronary artery disease, i.e., a heart attack, results in death.[2] Results can be thought of as degrees of CAD risk which works as a proxy for mortality.

Framingham Point Score

The Framingham Heart Study (FHS) was launched in 1948 when 5,209 residents of the town of Framingham, MA, volunteered to be medically examined and followed for development of coronary artery disease.[3] Through use of data gathered at time of exam, risk factors for heart disease were discovered. The Framingham Study is ongoing. In 1971 the offspring of the original cohort volunteered.[4] Then in 2002 children of the offspring cohort came forward as new volunteers.[5]

Over the years Framingham produced scoring systems, i.e., simple lookup tables that can be used by physicians to help predict which patients may be more likely to develop CAD. Because heart disease risk is multifactorial, the Framingham researchers used a multivariate model that quantifies risk associated with multiple factors taken into consideration simultaneously through the use of multiple variable regression equations. The results from these equations have been converted into simple point score tables that are easy to use and explain. This article will use the 2008 version of the equation/tables published in *Circulation* by D'Agostino et al.[6]

The tables of point scores and 10-year heart disease risk produced by these equations are as follows:[7]

An individual's risk can be easily calculated from these tables. For example, a 45-year-old male with characteristics described in Table 2 produces a point total of 5:

Table 2

Risk Factor	Points
Male 45	6
SBP 124	0
HDL 64	-2
Chol 188	1
Non - Smoker	0
Non - Diabetic	0
Total	5

This 5-point total translates to a 3.9% risk of heart disease over the next 10 years. This is determined by looking up the translation of 5 points into a 10-year heart disease risk also found in Table 1.

Relative Risk

What does a 3.9% risk mean? Is it high or low? How does it compare to the average person? Underwriting describes risk relative to a referent population. For life insurance underwriting, the referent population

Table 1

Estimate of 10-Year Risk for Men			Estimate of 10-Year Risk for Women	
Age	Points		Age	Points
30-34	0		30-34	0
35-39	2		35-39	2
40-44	5		40-44	4
45-49	6		45-49	5
50-54	8		50-54	7
55-59	10		55-59	8
60-64	11		60-64	9
65-69	12		65-69	10
70-74	14		70-74	11
75-79	15		75-79	12

Total Cholesterol	Men		Total Cholesterol	Women
mg/dl	Points		mg/dl	Points
<160	0		<160	0
160-199	1		160-199	1
200-239	2		200-239	3
240-279	3		240-279	4
≥ 280	4		≥ 280	5

Table 1 (cont.)

Men	Points		Women	Points
NonSmoker	0		NonSmoker	0
Smoker	4		Smoker	3

HDL	Men		HDL	Women
mg/dl	Points		mg/dl	Points
≥ 60	-2		≥ 60	-2
50-59	-1		50-59	-1
45-49	0		45-49	0
34-44	1		34-44	1
<35	2		<35	2

Systolic BP Men	Points			Systolic BP Women	Points	
mm Hg	Untreated	Treated		mm Hg	Untreated	Treated
<120	-2	0		<120	-3	-1
120-129	0	2		120-129	0	2
130-139	1	3		130-139	1	3
140-159	2	4		140-149	2	5
≥ 160	3	5		150-159	4	6
				≥ 160	5	7

Point Total Men	10-year Risk %		Point Total Women	10-year Risk %
≤ -3	<1		≤ -2	<1
-2	1.1		-1	1.0
-1	1.4		0	1.2
0	1.6		1	1.5
1	1.9		2	1.7
2	2.3		3	2.0
3	2.8		4	2.4
4	3.3		5	2.8
5	3.9		6	3.3
6	4.7		7	3.9
7	5.6		8	4.5
8	6.7		9	5.3
9	7.9		10	6.3
10	9.4		11	7.3
11	11.2		12	8.6
12	13.2		13	10.0
13	15.6		14	11.7
14	18.4		15	13.7
15	21.6		16	15.9
16	25.3		17	18.5
17	29.4		18	21.5
18+	>30		19	24.8
			20	28.5
			21+	>30

is composed of applicants classified as standard risks. In general, a standard risk for life insurance means a risk that has not been ascribed a debit rating after accounting for credits. There is a point at which the sum of the debits and credits exceeds that allowed for standard classification. Such policies are considered rated and the rating is based on the translation of the debit sum into a premium surcharge.

The concept of relative risk can be applied to the FHS risk of heart disease as well. If, for example, the average risk for all 45-year-old males suffering a heart attack in the next 10 years is 4.9%, then having a 3.9% risk is lower than average. Simply put, risk is 3.9% / 4.9% = 80% of average, or 20% lower than average 100% - 80% = 20% which translates to 20 credits. If the person's risk of a heart attack was 6.8% in the next 10 years, then his relative risk would be 6.8% / 4.9% = 175% of average, or 75% higher than average 175% - 100% = 75% and that translates to 75 debits.

The concept of average risk will be applied to the Framingham point score. The average characteristics for all the individuals in a risk class can be described once the rules for inclusion have been established.

NHANES III

To continue with the theme of publicly available data, this article uses a statistical sample of the US population gathered in 1988 – 1994 by the National Center for Health Statistics as part of the Centers for Disease Control and Prevention (CDC) referred to as the National Health and Nutrition Examination Survey (NHANES) dataset.[8] Over the years there have been several such collections of data. This is the third study in this series and is referred to as NHANES III.

Each individual in the NHANES III dataset who underwent an exam and blood draw is potentially eligible for risk stratification based on the Framingham point score. Dataset information for gender, age, tobacco use, cholesterol, HDL and systolic blood pressure allows heart disease risk to be assigned to those members of the dataset.

The following arbitrary rules are used to identify the characteristics of a standard risk. This allows for the identification of the average risk that falls within the standard class (Table 3).

This means that an individual has to have characteristics less than or equal to all these factors to be included in the standard class. When these rules are applied, the averages produced for these characteristics are as follows (Table 4):

Table 3

Characteristic	Value
Systolic BP (mmHg)	≤150
Diastolic BP (mmHg)	≤94
Cholesterol (mg/dl)	≤275
Chol/HDL Ratio	≤7.8
BMI (kg/m^2)	≤34

Table 4

Characteristic	Value	Avg
Systolic BP (mmHg)	≤150	121
Diastolic BP (mmHg)	≤94	74
Cholesterol (mg/dl)	≤275	201
Chol/HDL Ratio	≤7.8	4.2
BMI (kg/m^2)	≤34	26

The rule states that systolic blood pressure (SBP) must be less than or equal to 150. There will not be very many people who have an SBP of 150. In fact, most people will have SBP that is much lower than 150. A simple average of all the SBPs produces an average reading of 121. The other factors are calculated similarly.

Now that a baseline has been identified, risk for each individual in the dataset can be calculated relative to this referent. The individuals selected from the NHANES III dataset are between the ages of 30 and 79, and have readings for all characteristics (BMI, SBP, DBP, cholesterol, HDL) present in their record. This produces a dataset of 11,131 individuals. The Framingham Cox multivariate risk equation published by D'Agostino in 2008[9] is used to identify an individual's risk of developing CAD. Each person's risk is compared to average to produce an individual relative risk of heart disease. Graph 1 (next page) shows the range and number of individuals associated with each relative risk range.

The X-axis shows the distribution of relative risk and the Y-axis describes the number of people within a given range. Each range label describes the midpoint of risk, plus or minus 5%. For example the bar assigned 0.80 includes members whose risk is >75% to <85% of average. Risk continues out into the tail but is cut off at 200% of average.

This distribution describes risk of CAD and not all cause mortality.

Graph 1

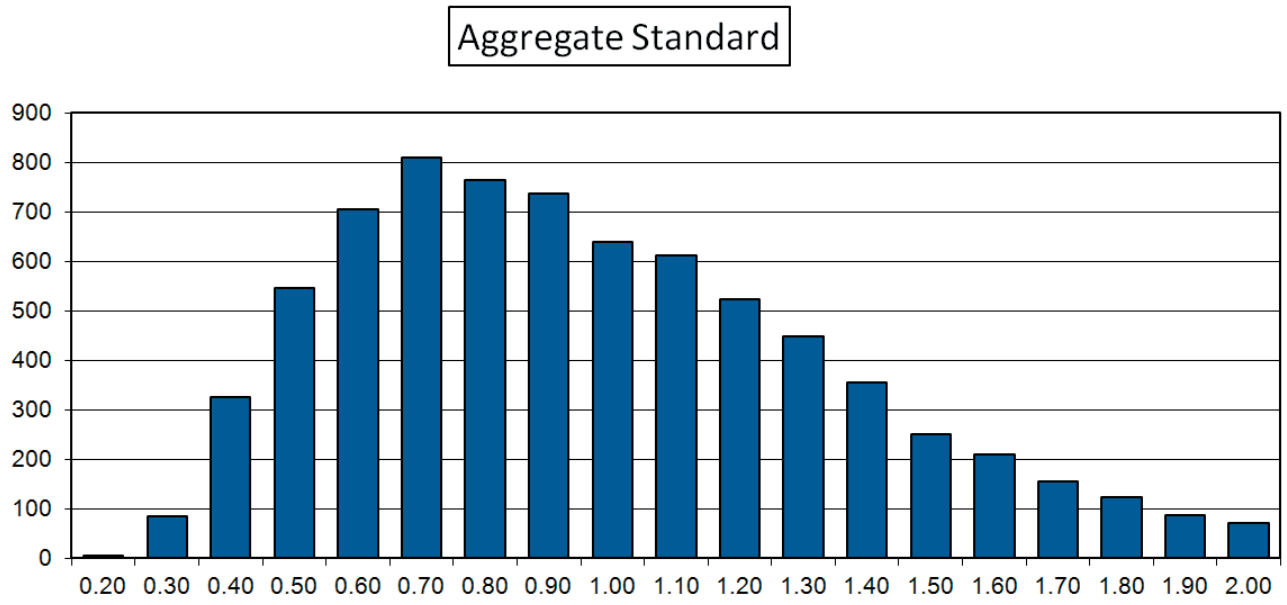


Table 5

Criteria	Super Preferred	Preferred	Residual Standard
Chol	≤ 240	≤ 260	≤ 275
Ratio	≤ 4.5	≤ 5.5	≤ 7.8
SBP	≤135	≤140	≤150
DBP	≤ 85	≤ 90	≤ 94
BMI kg/m^2	≤ 30	≤ 32	≤ 34

Preferred Knock-out Criteria

Table 5 describes some arbitrary preferred criteria for illustrative purposes.

These preferred rules are applied to the dataset. Individuals will be placed into their appropriate risk bucket, then the average criteria values are calculated for each risk class. Tables 6 through 8 show the results.

The preferred rules describe the worst risk that could possibly qualify for the risk class. This could be thought of as the edge. On the other hand, the average risk could be thought of as the middle of the risk class and describes the average risk contained within the class. Note that even the Residual Standard class, on average, qualifies for Super Preferred on all factors other than Chol/HDL ratio.

Actuaries price based on the average mortality associated with a risk class. This article will show each risk class contains a range of risks. If the distribution

Table 6

Criteria	Super Preferred	Avg
SBP	≤135	114
DBP	≤ 85	71
Chol	≤240	184
Ratio	≤ 4.5	3.3
BMI kg/m^2	≤ 30	23.8

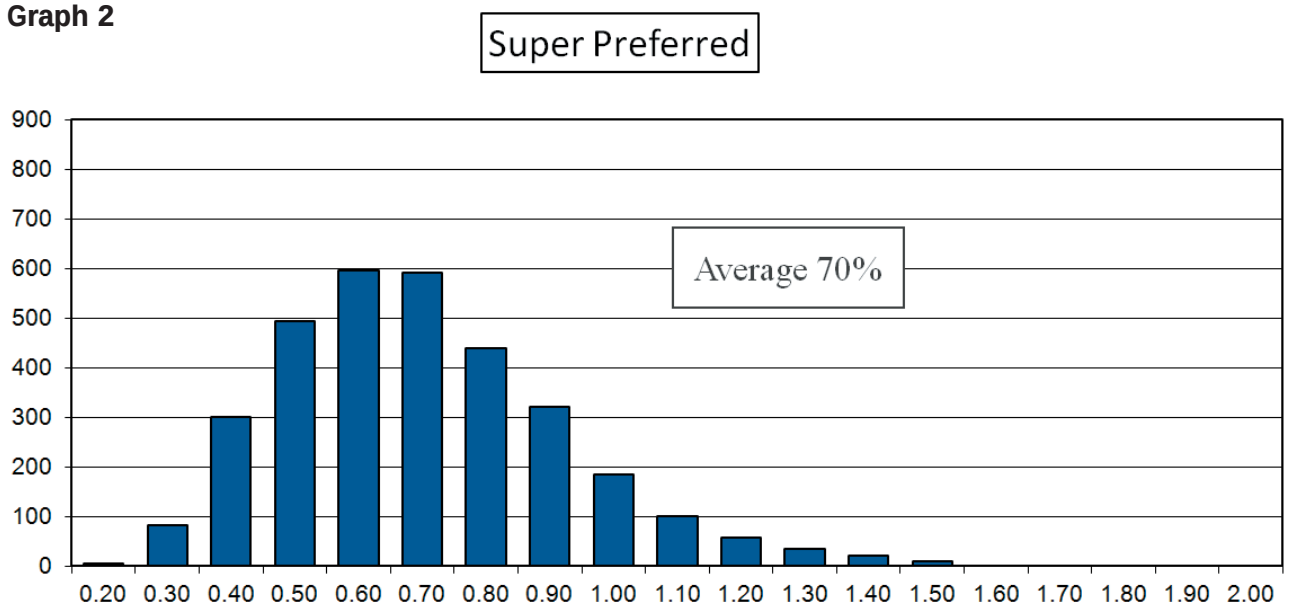
Table 7

Criteria	Preferred	Avg
SBP	≤140	123
DBP	≤ 90	75
Chol	≤260	207
Ratio	≤5.5	4.4
BMI kg/m^2	≤ 32	26.8

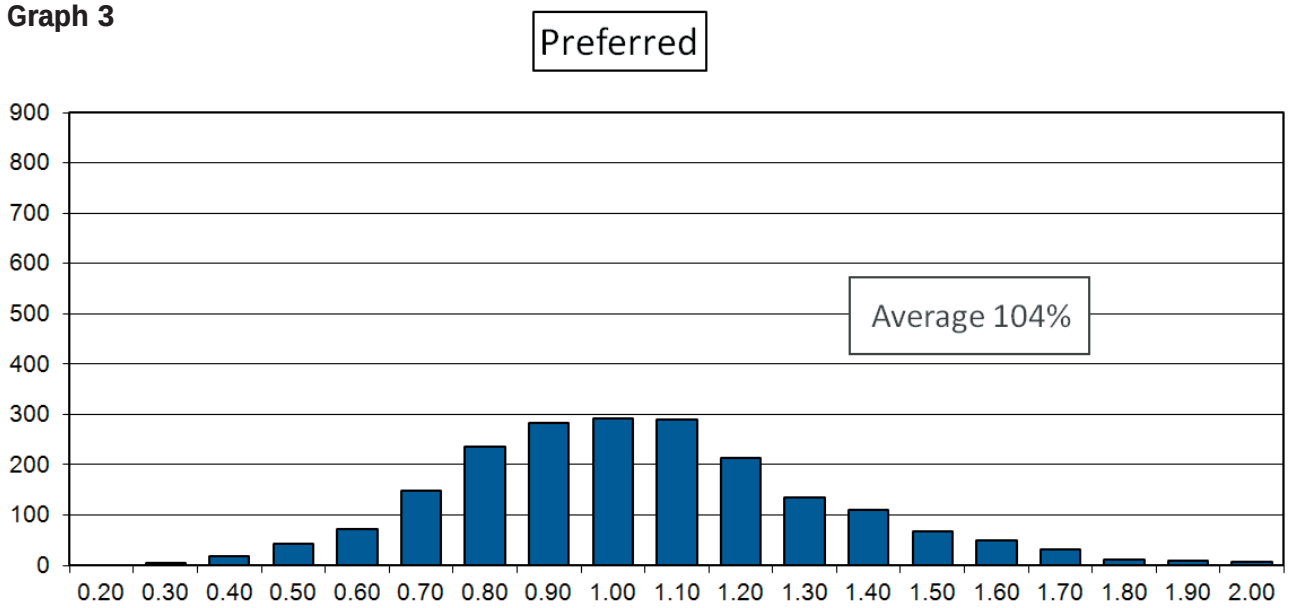
Table 8

Criteria	Residual Standard	Avg
SBP	≤150	129
DBP	≤ 94	77
Chol	≤275	220
Ratio	≤7.8	5.2
BMI kg/m^2	≤ 34	27.9

Graph 2



Graph 3



is altered where the average changes, pricing will no longer be accurate.

The range of risks associated with the Super Preferred risk class can be graphically displayed showing where individuals fall on the relative risk continuum. In this example, the average risk of CAD for the Super Preferred class is 70%. For the Preferred class the average risk of CAD is 104%, and for Residual Standard risk is 138% of average (Graphs 2, 3 above and 4, page 48).

Graph 5 (page 48) provides a summarized view of the distribution of relative risk score by knock-out preferred criteria. Dark blue represents individuals who qualify for Super Preferred, light blue qualify for Preferred, and gray are individuals that qualify for Residual Standard.

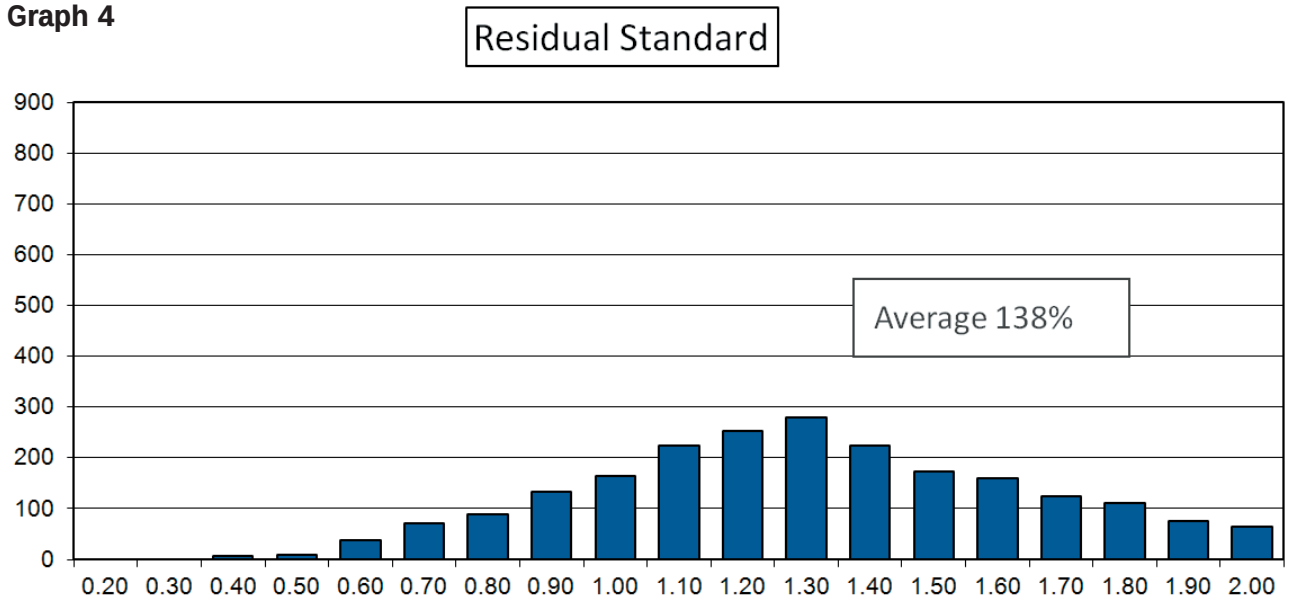
A Super Preferred Risk who just barely qualifies on all factors (the edge) would receive a score of 9 points; 9 points translates to a 7.9% risk of CAD in 10 years (Table 9, page 49).

The average risk in the Super Preferred Risk class produces a score of 4 points; 4 points translates to a 3.3% risk of CAD in 10 years. This shows there are different degrees of individual risk within a given risk class and significant difference between the average and the edge (Table 10, page 49).

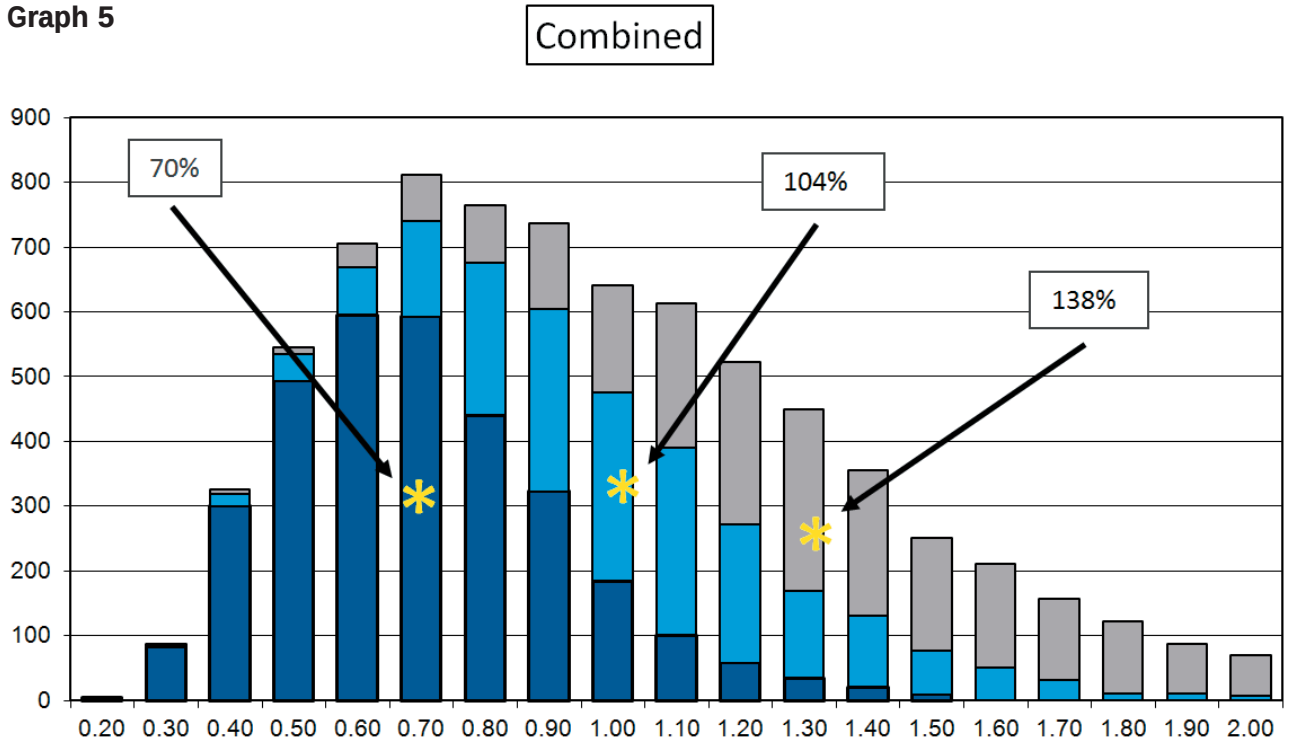
Credits

Credits are favorable mortality risk factors and are applied to reduce mortality assessments. What happens when these crediting program factors are applied to

Graph 4



Graph 5



knock-out preferred criteria? Arbitrary rules have been created that follow the themes in play today. The primary theme being the risk factor value is set at a threshold lower than the preferred rule itself. For some instances the credits are set at the preferred rule threshold as well. The following credit program (Tables 11 and 12, page 49), while fictitious, attempts to capture the essence.

For each credit threshold the following percent of all applicants qualify (Table 13, page 49).

An individual's risk of CAD was fixed at the outset of the article. Applying the above crediting rules moves people into the Super Preferred risk class. The gray portion of the bar identifies individuals moved into the Super Preferred Risk class and their location along the relative risk axis (Graph 6, page 50).

The increase comes from the movement of individuals from the other risk classes into the Super Preferred risk class. Graph 7 (page 50) shows the relative risk for individuals who moved up from the Preferred class. The gray color identifies individuals who move.

Table 9

Super Preferred Rules		Points
Systolic BP	135	1
Cholesterol	240	3
Ratio	4.5 [53]	-1
Male 45		6
Total Points		9

Table 10

Super Preferred Avg		Points
Systolic BP	114	-2
Cholesterol	184	1
Ratio	3.3 [56]	-1
Male 45		6
Total Points		4

Table 11

Variable		Credits
BP	≤ 125/80	-15
	≤ 130/85	-10
Ratio	≤ 4.0	-10
	≤ 5.0	-5
BMI	≤ 30	-20
	≤ 32	-10

After removing the individuals who move up, the Preferred class is left with those who remain. (Graph 8, page 50).

But the Preferred class will be repopulated with individuals who move up from Residual Standard and beyond. Those individuals (in gray) who move into the Preferred class are distributed along the X-axis as described in Graph 9 (page 51).

Using average risk of heart disease as the benchmark, the original average risk is compared to the new risk after applying the credit program. For the Super Preferred class, the average risk was 70%. After credits are applied, the average risk increases to 78%. For the Preferred class, the original average risk was 104% and risk increases to 126% after the application of the crediting program.

The Rationale

The reason for this can be found in the definition of a credit compared to knock-out criteria. In general, there are perhaps 10 criteria that must be met to qualify for a Preferred risk class. If one of those factors is missed, the person is knocked-out of the Preferred class to a risk class whose mortality assumption is higher. That is despite the fact that the person may have qualified for most of the preferred criteria.

On the other hand, a credit is awarded when present. It does not depend on the other factors. Assume there were 10 criteria to be met to be placed in the Super Preferred class. Also say that all the Super Preferred criteria factors are also credit factors. If only 9 of the 10 criteria are met, the person is knocked out of the Preferred class. For the 9 favorable factors, probably most have credits associated with them, which, when added together, would probably move the person back into the Super Preferred risk class.

Debits and Credits

As can be seen by the graphs, knock-out criteria does not completely efficiently stratify risk. There is overlap of risk as evidenced by the multiple colors associated with many of the individual graph bars. Despite this, knock-out criteria does work. On average, the relative risk associated with each class grades as expected. If this average risk is priced for, results should work.

On the other hand, a more robust risk class strategy applies preferred criteria using a point system or debit credit structure. This would eliminate complaints about just missing one criterion when all the other criteria were favorably achieved. A debit/credit structure would better align with clinical literature such as the Framingham Study. A debit/credit structure would align with the century-old industry underwriting debit/credit model in place today. The Framingham point system shown here could be recast to produce more homogenous risk classes producing similar size risk buckets, but better aligned risk across the spectrum. This example (Graph 10, page 51) places

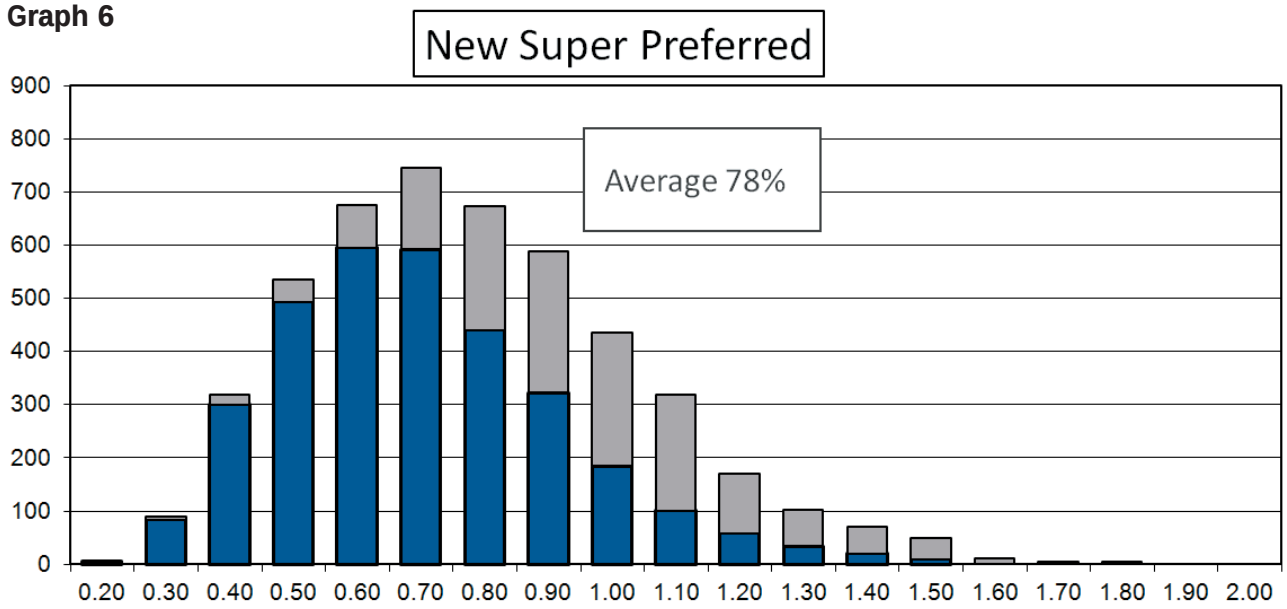
Table 12

Guidelines	
40 or More Credits	Allow Move 2 Preferred Classes
30 or More Credits	Allow Move 1 Preferred Class
20 or More Credits	Qualifies for Residual Standard

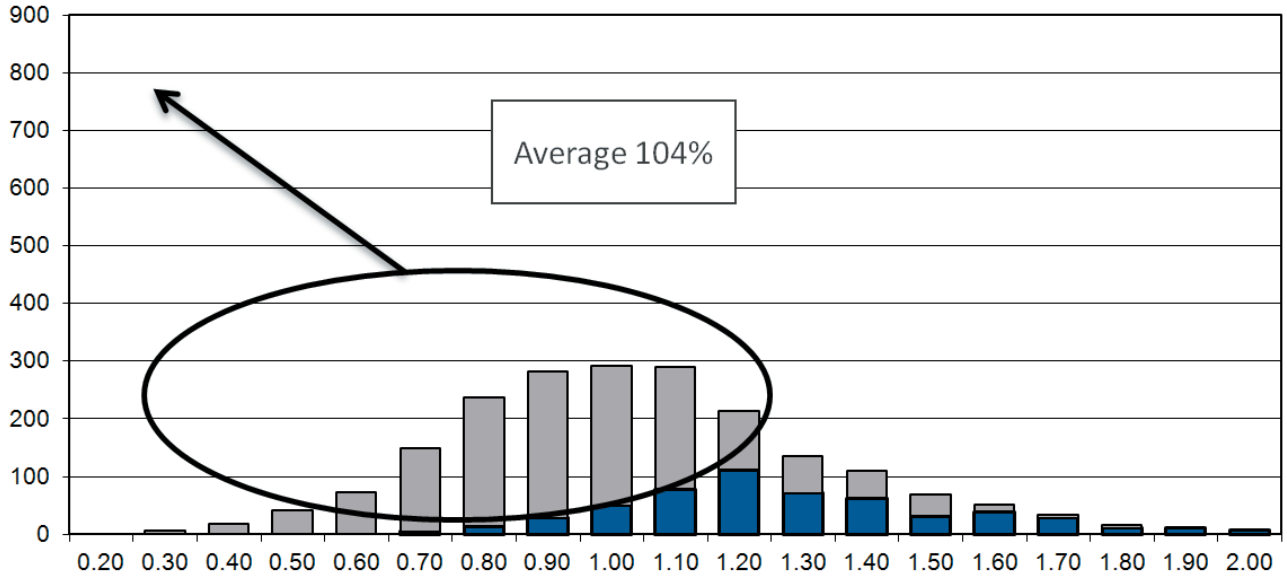
Table 13

Percent Eligible	
40 or More Credits	40%
30 or More Credits	65%
20 or More Credits	87%

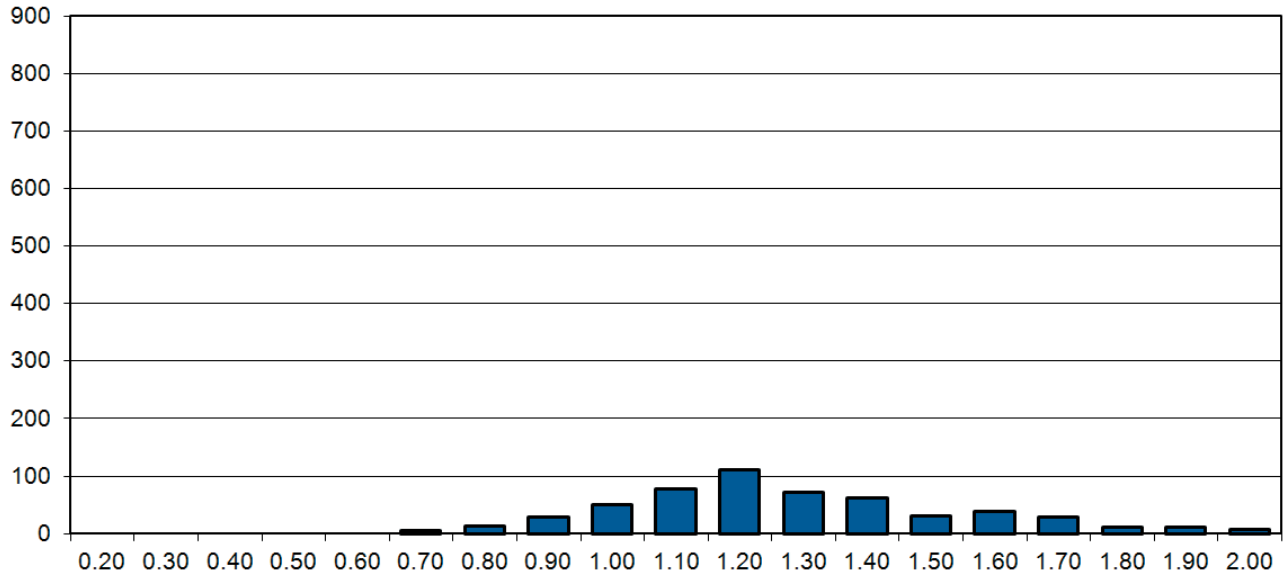
Graph 6



Graph 7



Graph 8



Graph 9

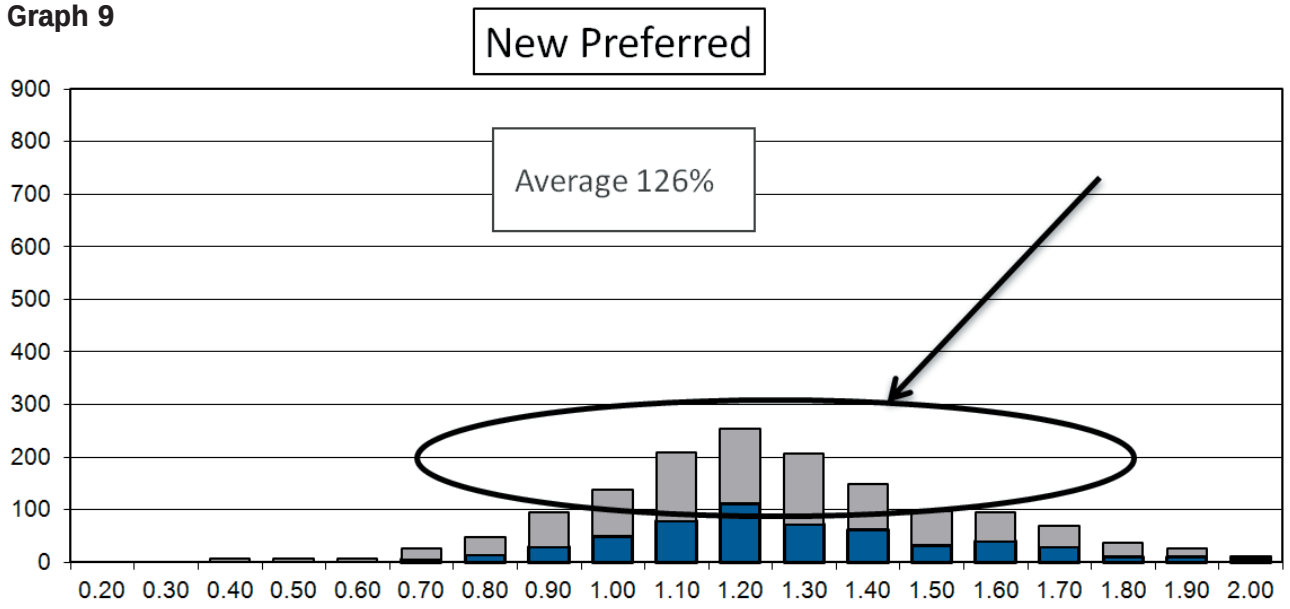
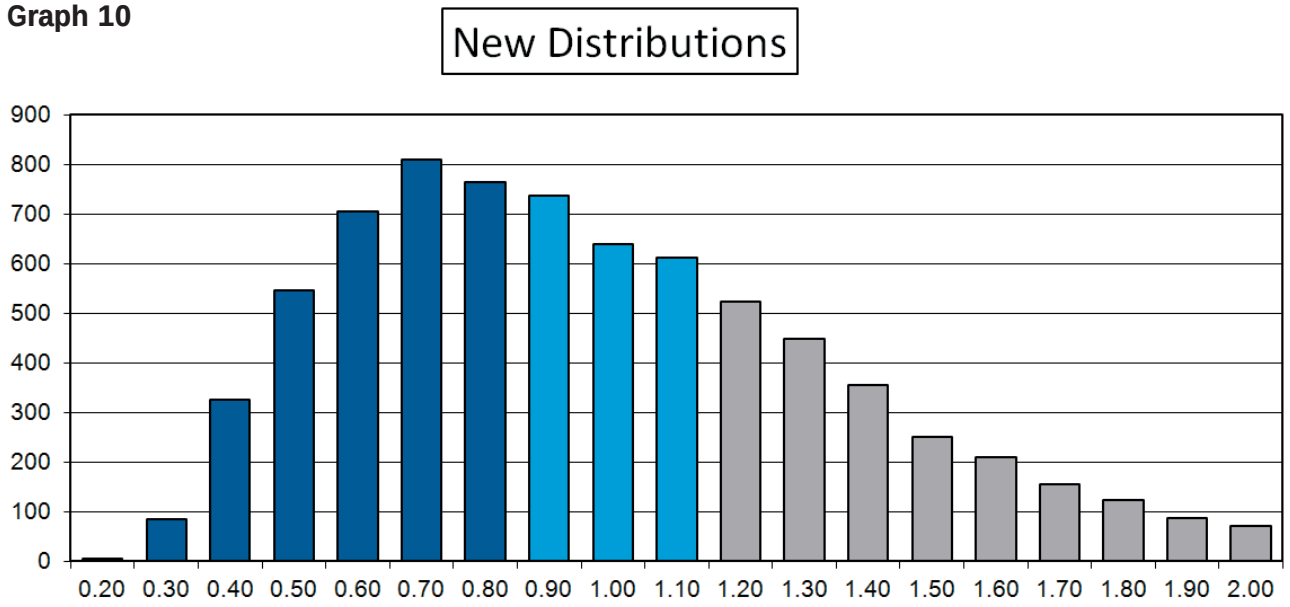


Table 14

Risk Class	New Relative Risk of CAD	New Qualifying %	Original Relative Risk of CAD	Original Qualifying %
Super Preferred	63%	42%	70%	42%
Preferred	99%	26%	104%	26%
Res Std	151%	31%	138%	31%

Graph 10



CAD risk at 85% or lower in the Super Preferred class, 86% to 115% qualify for Preferred and 116% or higher would be Residual Standard. Using this model, average risk and qualifying percentages would be (Table 14, page 51).

In reality, no system can truly be this perfect. There are too many variables still unaccounted for. Yet, a debit/credit model would get closer to this look (Graph 10, page 51) than knock-out criteria.

Summary

Debit/credit or knock-out preferred criteria both work to stratify risk. Debit/credit is a superior approach to knock-out criteria. Pricing and underwriting issues must be addressed when credits are applied in a knock-out environment.

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