WHITE PAPER

IDENTIFYING THE OPTIMAL DTI DEFINITION THROUGH ANALYTICS

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1 EXECUTIVE SUMMARY

The following white paper will explore the main characteristics of three alternative ways the commonly used Debt to Income (DTI) measure can be calculated. The different versions are first described in terms of main characteristics and then analyzed in terms of risk prediction using portfolio data. The main goal is to benchmark each version compared to the others in order to provide financial institutions with meaningful insights.

1.1 THE TEAM

CRIF operates as a global company specializing in the development and management of credit information, business information and credit management solutions worldwide. CRIF Lending Solutions is a part of CRIF and serves the most successful U.S. financial institutions, including large banks, credit unions, finance companies and credit card processors. The Achieve Analytics & Business Consulting team, part of the global consulting network, provides analytics, consulting services, and reporting aimed at maximizing returns for every phase of the lending/credit process. Within the CRIF group, The Achieve Team represents the competence center for analytics and consulting services for the North American and Latin American markets.

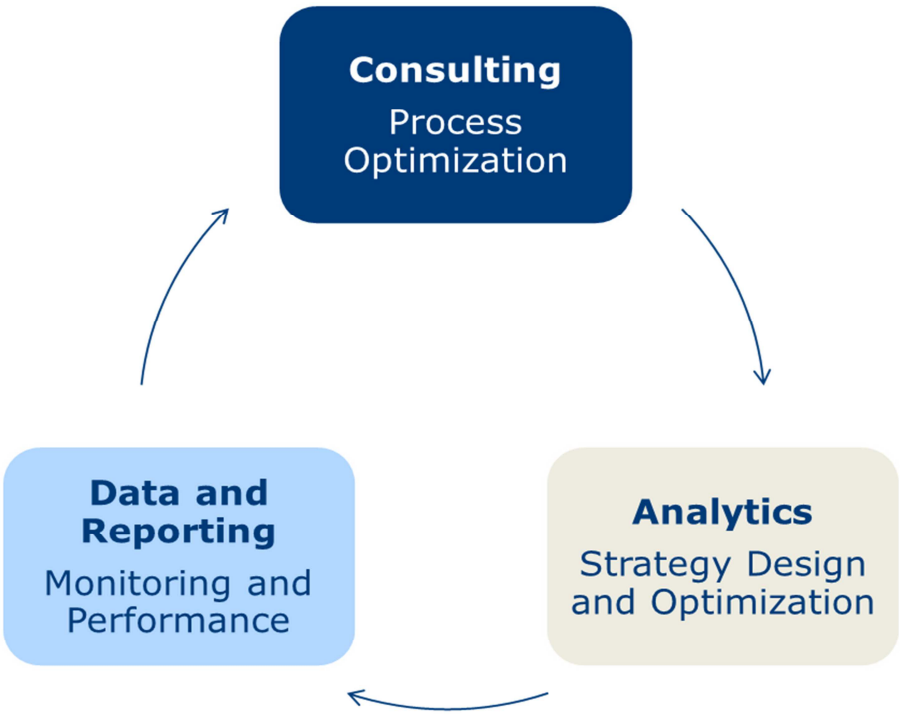
1.2 OUR MISSION AND OUR APPROACH

Our mission is to maximize customer satisfaction by providing products and services of the utmost quality to serve our clients' needs.

We strongly believe that every financial organization should be driven by the concept of the *continuous improvement approach.* We organized our teams and our offerings around this concept:

- the **Consulting Practice** will help you design and optimize your credit process
- the **Analytics Practice** will allow you to design and optimize your decisioning strategies
- the **Data and Reporting** practice will help you monitor your performance and fine-tune your results

A unique proposition for a challenging environment



2 WHAT IS THE DTI?

2.1 DEBT TO INCOME (DTI) AND DISPOSABLE INCOME (DI)

DTI is one of the most common measures used in the financial industry to determine the ability of a borrower to absorb additional debt. The Debt to Income Ratio (DTI) represents the ratio between an applicant's[1] monthly debt obligations and the monthly income. Financial institutions use DTI to identify potentially risky situations before extending credit to an applicant. It is calculated as follows:

Debt to Income Ratio = Total monthly debt payments/ Total monthly income

A higher debt ratio should represent a riskier situation for an Institution. This is why Banks and Credit Unions set a maximum DTI in their credit policies. The upper limit, above which an application is declined, can differ between institutions. This is because the DTI is linked to the risk propensity (or risk appetite) of each financial institution.

Another measure commonly used to assess risk is the disposable income. Disposable income (DI) is the amount of income that is available for spending and saving after income taxes and payments for existing monthly debt obligations have been accounted for. Disposable income is considered to be one of the key economic indicators as it is used to monitor overall economic conditions and trends. It is calculated as follows:

Disposable Income = Total monthly income – Total monthly debt payments

The goal of the disposable income is to measure whether the borrowers will have sufficient income available after they have paid for their existing debt. The remaining "free" income has to be sufficient for the repayment of the loan object of the application.

DTI and DI are the two important measures institutions consider during the process of credit analysis. Both metrics' aims are toward determining the ability of the borrower to repay. They are often used in combination with one another in order to better cluster the population.

Although we recognize the importance of using both measures in a combined way, this document only focuses on the DTI measure.

2.2 IMPORTANCE OF DTI

The DTI is one of the most critical ratios that financial institutions consider when determining the approval or rejection of loans. Generally, DTI is part of an institution's approval policy, and when it is not part of the policy, there are limits included as part of the underwriting guidelines.

Maximum thresholds for DTI are usually set between 40% and 50% depending on product type and the institution's policies. A typical threshold for mortgages is usually set to 43% (to account for qualified mortgage requirements), and a vehicle loan might be set to 45%. In some cases, a maximum DTI of 60% can be allowed for applications that contain strong compensating factors. Applications which go beyond these values are often declined.

Given the importance for financial institutions of developing effective risk policies and sound risk management strategies, we chose to leverage the experience the Achieve Team has in the industry in order to support our partners in configuring their DTIs. We decided to summarize the main characteristics of the most common versions of DTI calculations used in the industry. We also decided to go one step further and test the actual performance of the three different versions in predicting risk. In doing this, we used the indirect vehicle credit portfolio data.

[1] DTI often refers to multiple applicants, for example it can be calculated at a household level.

3 STATISTICAL ANALYSIS

3.1 STATISTICAL ANALYSIS

Considering that the DTI ratio is frequently used as a measure to predict the risk associated with repayment, we performed a statistical exercise to determine whether or not the measure is actually an effective predictor of defaults.

In order to measure the performance of the three DTI versions, we took a portfolio of indirect vehicle products at the moment of the origination and kept record of the level of DTI in each application. The portfolio is characterized by an average Through the Door (TTD) credit bureau score (CBS) of 679 and an average booked CBS of 709 with a default rate of 0.81%. We decided not to take into consideration any other variables, solely the DTI. We created different buckets of DTI thresholds which reflect the standard in the industry credit policies. We measured the performance of the different DTI versions 12 months after the application was booked.

The logical expectation of the exercise was to have higher default ratios associated with higher DTI classes.

The Team summarized the results using a highly valuable metric, which is known in statistics as Information Value (IV)[2]. The primary goal of IV is to help determine the ability of each DTI version to distinguish the bad accounts (the accounts which defaulted after a year) from the good accounts. As such, the higher the IV, the more effective that particular DTI version is in assessing the risk.

Figure 1 – Interpretation of Information Value ranges

Information Value	Interpretation
>0.5	Very strong predictor
0.3 to 0.5	Strong predictor
0.1 to 0.3	Medium predictor
0.02 to 0.1	Weak predictor
<0.02	Not predictive

3.2 DTI VERSIONS

As mentioned, the DTI is the ratio between debt and income. The denominator is usually straightforward, being the monthly or yearly income. However, it is very important to have in place procedures in order to avoid collecting misleading data (for example, gross values vs. net values).

The numerator, from a theoretical standpoint, should consider each form of debt the borrower has. This would include the debt reported in the credit bureau file, such as loan history, credit card history, mortgage, auto, and personal loans. Additionally, the theoretical DTI would also consider other recurring expenses that are typically not included in the credit file data. These expenses may include rental obligations, monthly expenses (e.g. utilities and telecommunications), and loans that are not captured by the credit file (e.g. subprime loans and payday loans).

However, from a practical standpoint, financial institutions typically consider DTI that includes debt obligations reported in the credit bureau file (e.g. loan and credit card history, mortgage, auto, personal loans) and some application data, which typically only includes data such as rental obligations. The other recurring expenses are generally not captured.

During the process of conducting on-site assessments at various financial institutions, the CRIF team realized that institutions have different credit policies and guidelines that can impact how DTI is measured, calculated and capable of assessing credit risk. As such, the team identified three possible versions of the DTI. The debt components taken into consideration for each DTI version are the only distinguishing factors.

DTI Version 1: This calculation methodology allows for a more complete view of the applicant's debts and assumes accountability for debts that have not been repaid. This version:

[2] The Information Value (IV) is based on entropy theory, and measures the distance between two distributions (i.e. good population versus bad population)

- Considers mortgage payment information from the credit bureau file and not from the application data.
- Estimates 1% of the balance for foreclosures.
- Takes into account the entire outstanding debt balance for collections, repossessions, and charge-offs in the monthly debt calculation. Example: if an applicant has trade amount of $5,000 in collections then $5,000 will be included in the monthly debt calculation.
- For delinquent accounts, the estimated monthly payment amount is weighted by the number of payments the account is delinquent; severe delinquent and bankrupt trades are estimated at 5 times the estimated monthly payment amount.
- Omits deferred student loans.
- For open actively paying accounts, the estimated monthly payment is calculated based on the monthly payment information available from the credit bureau. When the monthly payment information is not available from the bureau, it is estimated using the original terms and total loan amount or takes 5% of the balance for revolving debts.

DTI Version 2: is considered to represent the industry's best practice that is most commonly used in loan origination systems. This version:

- Considers mortgage payment information only from the application data.
- Debts in bankruptcy are excluded because the applicant is not obligated to repay those debts since bankruptcy was declared.
- Estimates the monthly payment amount as 5% of the balance for all collection and charge-off debts; this is a conservative estimate considering that the customer may choose not to repay these debt obligations.
- Delinquent and non-delinquent accounts are estimated at 3% of the debt balance.
- Omits deferred student loans.
- Excludes installment accounts if there are less than 10 payments remaining on the loan.

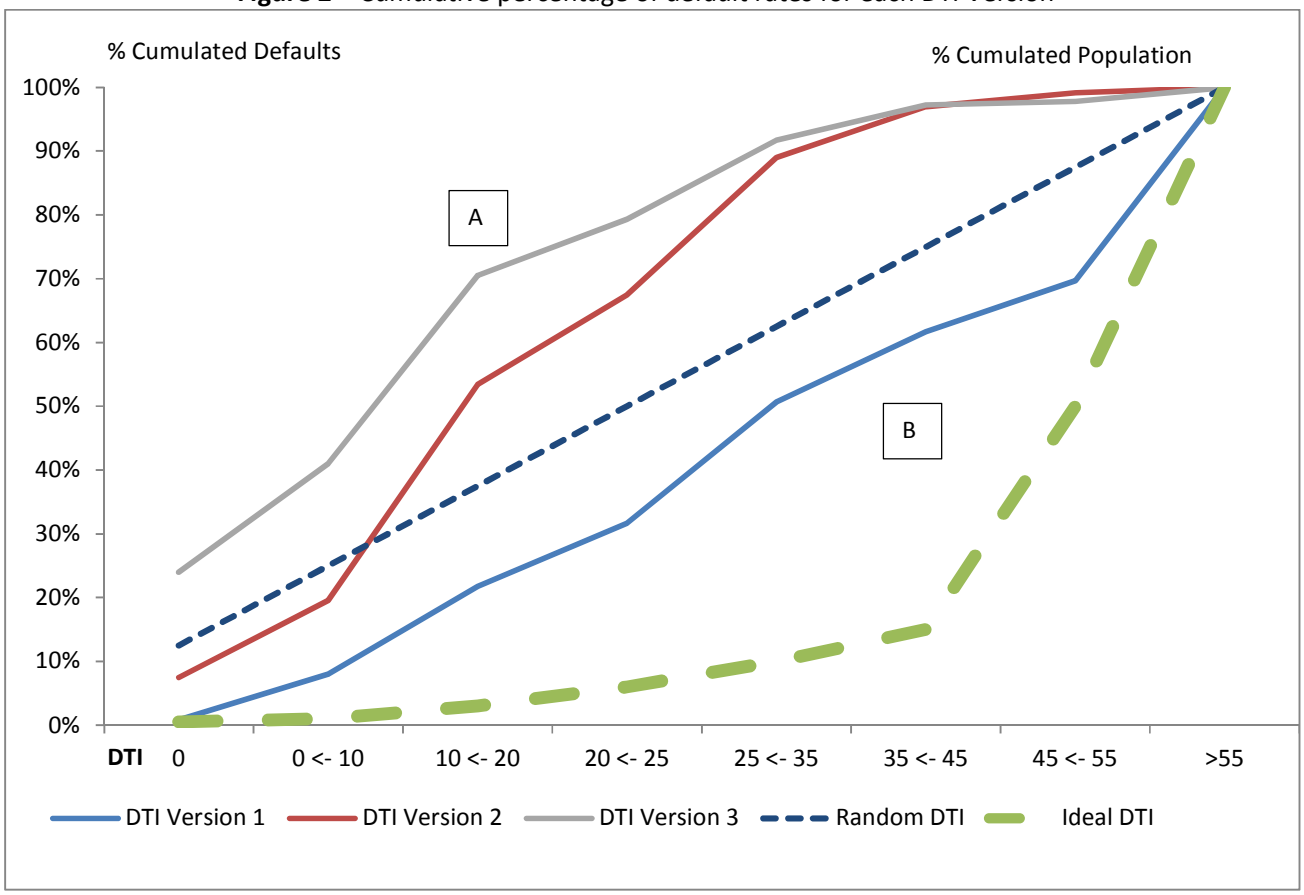
DTI Version 3: This version represents the least conservative estimate of the customers' outstanding monthly debt obligations. This version:

- Considers mortgage payment information from both credit bureau file and application data. If the difference between the bureau and the application is less than $100, the DTI calculation will consider the higher of the two values. If the difference is greater than $100, the calculation will consider the sum of both values.
- Excludes trades in collections, foreclosures, and charge-off status based on the assumption that the applicant is no longer making monthly payments on these accounts.
- Delinquent and non-delinquent accounts are estimated at 3% of the debt balance.
- Trades with a balance of $100 are omitted with the assumption that the applicant will no longer be making payments on the accounts in the near future.
- Excludes installment accounts if there are less than 3 payments remaining on the loan.

3.3 RESULTS OF THE ANALYSIS

The team performed a statistical analysis to assess the implications of the three DTI Versions. Credit portfolios with different characteristics in terms of FICO were used to conduct the analysis. We observed the performance of these portfolios after one year. The default accounts were defined as "60 Days Past Due." The overall results have been captured in the following figures:

Figure 2 – Cumulative percentage of default rates for each DTI Version[3]



Attributes with strong predictive power should be capable of separating the "goods" from the "bads". Consequentially, we expect the lower classes of DTI to be associated with lower defaults.

The above graph summarizes the results of the analysis. On the left vertical axis we can see the cumulated sum of % defaults, while the horizontal axis represents the different classes of DTI. The logical expectation is to see a higher concentration of defaults for higher levels of DTI.

To simplify the understanding of the graph, we added two variables to the three DTI versions: "Random DTI" and "Ideal DTI". Random DTI represents a random distribution of the defaults among all DTI buckets. Because the defaults are random, it is not capable of differentiating risk. Hence, this variable is simply a straight line. The other variable is the Ideal DTI which represents a theoretical, very well performing DTI variable capable of totally isolating the bad accounts. Since such behavior is nearly impossible to obtain with just one variable, multivariate models are built.

Let's put it in this way: the goal of each DTI version is to always be below the Random DTI and as close as possible to the Ideal DTI.

This clearly does not happen for DTI versions 2 and 3. In fact, pay attention to box A, which corresponds to a DTI up to 20%. At this point, DTI versions 2 and 3 are well above the Random DTI: this tells us that even a randomized variable is capable of assessing risk in a better way. Cleary, these versions are not good predictors of the default event. In fact, the opposite is true because the majority of defaults are in the lower classes of DTI.

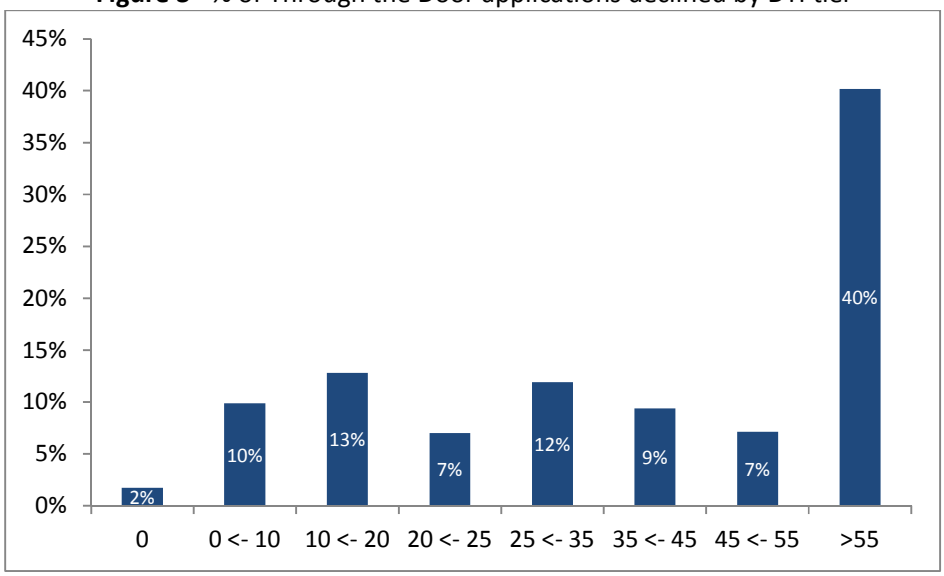
Conversely, we clearly see that DTI version 1 is a strong predictor of the default event. In fact, in the last three DTI buckets (above 35% DTI or box B and beyond), we have almost 50% of the defaults and only 26% of the population (for simplicity, the total population distribution in each DTI bucket is not shown). This explicitly indicates that DTI Version 1

[3] The population is cumulated based on the DTI version 1

is an effective predictor of risk. It shows a strong positive correlation between the DTI level and the default rate of the accounts.

One aspect we must consider is that the analysis is based on the booked population. This means that the population has been pre-selected and filtered by underwriters who certainly have selected the "good" high DTI applicants among all high DTI applicants. This phenomenon can clearly be seen on the graph below, which distributes the declined application by DTI bucket.

Figure 3– % of Through the Door applications declined by DTI tier



Pre-selection of the population means that the sample is biased. This is likely the reason why DTI version 2 and DTI version 3 are performing worse than the DTI random variable. Nevertheless, we clearly see that DTI version 1 can significantly boosta financial institution's ability to accurately assess credit risk.

The predictive capacity of each DTI version can also be seen when we look at how the different DTI versions will rank the population by FICO score. The table below shows the average FICO score in each DTI bin for the different DTI versions.

Figure 4 – Information Values for each DTI Version

Average Fico TTD by DTI version			
DTI Bins	**DTI Version 1**	**DTI Version 2**	**DTI Version 3**
0 <- 0.1	731	610	672
0 <- 10	715	718	673
10.01 <- 20	705	697	667
20.01 <- 25	699	677	675
25.01 <- 35	692	667	687
35.01 <- 45	679	663	693
45.01 <- 55	662	652	695
>55	603	640	691

We can clearly see that DTI version 1 has very strong ranking capabilities. The dependent variable (FICO) increases as long as the DTI increases. This is not happening at all for DTI version 3. In fact, the last DTI bin (>55) has an average DTI

which is even higher than the typical "safest" DTI Bin (0-10). DTI version 2 is capable of collating the risk but not as strongly as version 1.

The results are further supported from a statistical standpoint. One of the most powerful statistical measures, known as Information Value, was calculated in order to derive the data analysis. This particular value is able to indicate the strength of each DTI version in terms of risk predictability. A high IV indicates stronger predictability. Consequently, the table in Figure 5 shows that DTI Version 1 has the highest IV of 39.37% compared to the other versions.

Figure 5 – Information Values for each DTI Version

DTI	IV
DTI Version 1	0.3937
DTI Version 2	0.2311
DTI Version 3	0.1248

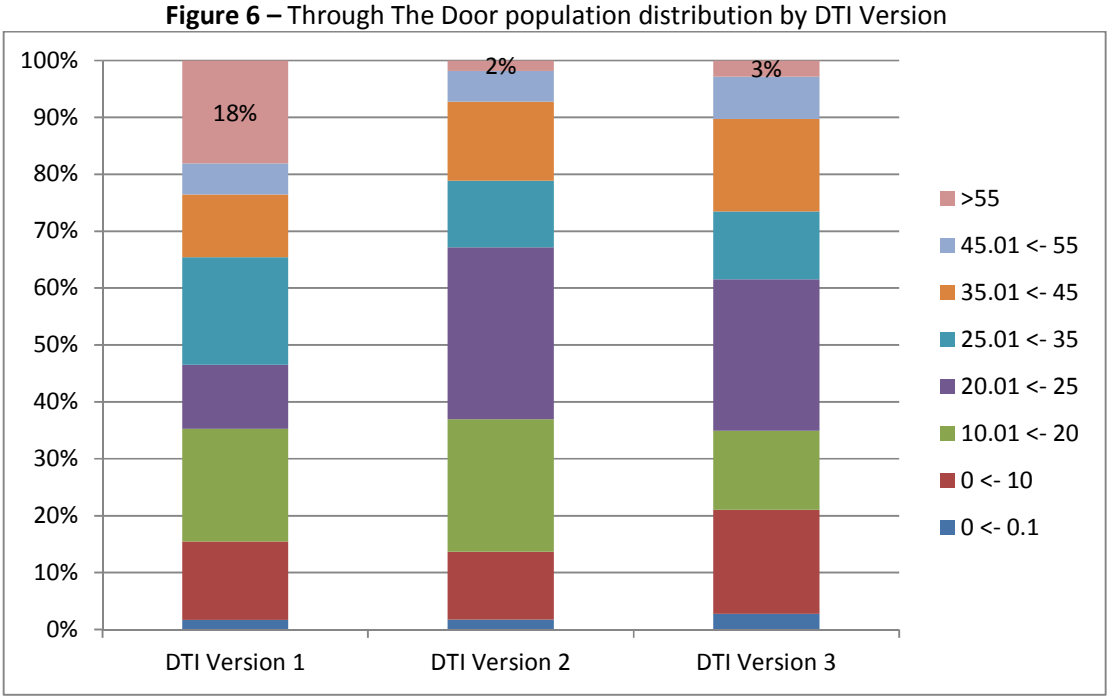
4 MAIN CONCLUSIONS

The analysis conducted provides clear suggestions: certain versions of the DTI measure are much more accurate than others in predicting the credit default event. We clearly see that DTI version 1 is a good assessor of risk, while DTI version 2 and 3 are much weaker in isolating the bad applications.

It is very important to calculate the DTI in the proper way, which includes the most effective way to handle the credit bureau data and the related attributes. Moreover, the analysis demonstrates that the credit bureau seems to be a more reliable source of data in terms of assessing risk (DTI version 1 only accounts for bureau information for financial debts).

Financial institutions might think that they have to strengthen their risk appetites if DTI Version 1 is used since it allows for a more conservative approach by considering all debt components into the calculation. However, as shown, this is not true. They must re-calibrate their strategy to accommodate a different way to calculate the DTI. We clearly see this effect in Figure 6, where we see how the highest DTI bin (>55) accounts for a much higher portion of the population for DTI version 1 (18% vs. 2% and 3%).

Figure 6 – Through The Door population distribution by DTI Version



We believe that the effort necessary to redesign institutions' strategies and policies will be justified by the benefits realized through a more accurate selection of the population, leading to less risk and higher value generation.