STREAMLINING TRADE CREDIT DECISIONS

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Abstract

Investigating the trade credit-worthiness of new customers can involve time-consuming and expensive tasks which may impair customer goodwill and result in lost sales. This article examines the role that PC based decision support systems and expert systems can play in streamlining trade credit decisions.

Introduction

In this article we examine a problem faced by many businesses providing goods or services to other businesses. When a new customer places an order, companies typically conduct a credit investigation prior to advancing trade credit. This can often be an expensive and time consuming task. We will explore the potential for using computerized decision support systems and expert systems technology to expedite the process.

The XYZ Company's current credit checking system (Figure 1) was causing a problem. Prospective new customers were required to submit documentation in support of their request for trade credit. Relevant data were entered into a credit scoring model to determine the company's "credit score". (See Mehta for a fuller discussion of the mechanics of credit scoring models.) Each credit application was also routinely submitted to an external credit agency for investigation. A credit status report was returned usually within ten days. The high volume of new business was placing a financial and manpower strain on the Credit Department. Moreover management believed that processing delays were resulting in lost sales and a significant loss of goodwill.

We will explore two ways of tackling this problem. First, the Credit Manager could cut costs and obtain

more timely information by adopting a sequential approach to the trade credit decision. Specifically the manager would use the credit scoring model initially to investigate the prospective customer. The more expensive external credit agency would only be used if the credit scoring model proved inconclusive. Second, the Credit Department's workload could be reduced by enabling the Sales Department to accept some new customers without initiating a formal credit investigation.

In this paper we describe a prototype decision support system (DSS) based on a decision tree model of the problem facing the Credit Manager. The DSS was developed on a personal computer using LOTUS 1-2-3. The DSS will help a manager decide on the best strategy for investigating a new customer. We will also describe how the DSS helped in the development of an expert system which will enable sales staff to identify new customers that can be accepted without a formal credit investigation. A summary of the proposed system is given in figure 2.

Approaching the Trade Credit Problem in Stages

In situations where the cost of obtaining information is large compared to the potential profit on a credit sale, the credit manager of the XYZ Com-

FIGURE 1. EXISTING SYSTEM

FIGURE 2 PROPOSED SYSTEM

pany can achieve greater effectiveness by approaching the trade credit decision in stages. Following this approach, the credit manager obtains information regarding the credit-worthiness of a potential customer starting with the lowest cost information source. If this information proves inconclusive, the credit manager trades-off the benefits versus the costs of additional information. Only if the benefits exceed the costs is the higher cost information source employed.

For example assume that the credit manager has just received an application for trade credit from a new customer. The manager's decision problem can be broken down into three stages. At the first stage, there is no information specific to the credit customer. The manager has three options: accept, reject or investigate further by incurring the cost of a credit-scoring model. If the third option is chosen the manager proceeds to the second stage.

At the second stage, there are again three options: accept, reject or investigate further by incurring the cost of having the customer analyzed by an external credit agency. If the third option is chosen, the manager proceeds to the third stage. At the third stage there are only two options: accept or reject the customer. The option of investigating further is not available at this third and last stage. At each stage the credit manager can calculate the expected cost of acceptance and rejection using the formulas in table 1. These costs will vary for each stage as they reflect different estimates of probabilities of bad debt, average collection periods and average collection costs.

Stage 1 - Deciding Whether an Investigation is Necessary

A new customer initiates a purchase request of 40 units, priced at \$100 less a discount of 2%. Each unit

has a variable cost of \$60. The company's requires an annual rate of return of 15%. There are three options available to the credit manager: Accept the sale on credit, reject the sale, or investigate the customer further using a credit scoring model. The expected costs of accepting, rejecting or investigating further are based on the formulas in table 1, together with the manager's subjective estimates of the average collection period (35 days), the average collection cost (\$3.75) and the probability of a bad debt loss (10%). In the absence of any more specific information on the customer, the credit manager will use these averages to decide whether the customer should be accepted or rejected. If the results from this first test are inconclusive then a formal investigation is justified.

Stage 2 - Using the Credit Scoring Model

The incremental cost of investigating further using a credit scoring model is assessed to be \$4.75 per customer. The credit scoring model classifies the customer as either: Good (G), Indeterminate (Ind), or Poor (P). Accordingly, the credit manager will revise estimates of the average collection period, average collection cost, and the probability of a bad debt for Good, Poor, and Indeterminate customers respectively. (Table 2.)

Stage 3 - Using the External Credit Agency

If the results of the credit scoring model are inconclusive, there is a second, more expensive, information source which can be tapped. The manager may ask an external credit agency to investigate the customer. It costs \$17 to have this analysis performed. The credit agency will classify the customer as either: Favorable (F) or Unfavorable (U). The credit manager further modifies the estimates of collection period, collection cost and the

$$C_1 = (B.V+r.V.T/365+Z).N$$

$$C_2 = (1-B).(U_g-D.U_p).N$$

where	C_1	=	Cost of Acceptance
	C_2	=	Cost of Rejection
	B	=	Probability of bad debt
	N	=	Number of Units Requested
	U_p	=	Price per Unit
	U_g	=	Gross Profit per Unit
	D	=	Discount per unit
	r	=	Required Rate of Return
	T	=	Average Collection Period
	V	=	Variable Cost per Unit
	Z	=	Average Collection Cost per Unit

TABLE 1. EXPECTED COST OF ACCEPTING OR REJECTING NEW CUSTOMER ORDER

Credit Scoring Model Classification	Probability of Credit Model Classification	Average Collection Period	Average Collection Costs	Probability of bad Debt
G	0.3	20 days	\$ 1	0.02
I	0.4	50 days	\$ 4	0.1
P	0.3	180 days	\$15	0.7

TABLE 2. STAGE 2 ESTIMATES (CUSTOMERS SUBJECTED ONLY TO CREDIT SCORING MODEL)

Prior Credit Scoring Model Classification	Subsequent Credit Agency Classification	Probability of Credit Agency Classification	Average Collection Period	Average Collection Costs	Probability of bad Debt
G	F	0.9	20 days	\$0.40	0.01
G	U	0.1	60 days	\$3.50	0.2
I	F	0.6	25 days	\$0.70	0.1
I	U	0.4	100 days	\$7.00	0.3
P	F	0.2	30 days	\$6.00	0.2
P	U	0.8	180 days	\$13.00	0.8

TABLE 3. STAGE 3 ESTIMATES (CUSTOMERS SUBJECTED TO CREDIT SCORING MODEL AND CREDIT AGENCY CHECK)

probability of bad debt. (Table 3.)

At first, the above estimates will be based on the informed guesses of the Credit Manager. As the system matures, however, the estimates should be refined with objective data derived from the company's experience with its three mutually exclusive groups of customers - customers accepted or rejected (1) without any investigation, (2) subjected only to credit scoring model, and (3) subjected to both the credit scoring model and the external credit agency check.

Solving the Credit Manager's Problem

The credit manager's decision problem is solved using the "average out and fold back" procedure for analyzing decision tree problems. (See Magee.) A description of the tabular output from the decision tree is given in Table 4.

As might be expected, the alternative to reject the new customer at this early stage is inferior. The optimum decision is to investigate the customer further. This is intuitively appealing as the invoice amount and the profit margin are not particularly high. In other words the potential profit is not large enough in relation to the potential loss

CREDIT ANALYSIS ASSUMPTIONS

PROBABILITY OF BAD CREDIT LOSS	10.00 %
NUMBER OF ITEMS FINANCED	40
UNIT PRICE OF ITEM(S) FINANCED	\$100.00
UNIT VARIABLE COST	\$60.00
REQUIRED ANNUAL RATE OF RETURN -	15.00 %
EXPECTED COLLECTION PERIOD -	35.00 days
AVERAGE COLLECTION COST -	\$3.75
DISCOUNT RATE ON CREDIT -	2.00 %
INVESTIGATION COST - STAGE 2 -	\$4.75 CREDIT SCORING MODEL
INVESTIGATION COST - STAGE 3 -	\$17.00 EXTERNAL CREDIT CHECK

CREDIT ANALYSIS OUTPUT

PROFIT MARGIN ON ORDER	40%
GROSS CONTRIBUTION	\$1,600.00
TRADE CREDIT DECISION	COST
ACCEPT WITHOUT INVESTIGATION	\$278.27
INVESTIGATE FURTHER	\$251.69
REJECT WITHOUT INVESTIGATION	\$1,368.00
% SAVING WITH INVESTIGATION	9.55%

**TABLE 4. TABULAR OUTPUT FROM DECISION SUPPORT SYSTEM
(HIGH INVOICE, LOW MARGIN)**

if the customer defaults on the transaction to warrant selling the goods without a credit investigation.

A detailed analysis of the courses of action recommended to the credit manager is given in the decision tree in figure 3. Probabilities are denoted by numbers in parentheses. Payoffs at each stage incorporate optimal decisions in succeeding stages. Optimum paths through the network are indicated with heavy lines. For example, assuming the results of the credit scoring model are indeterminate, the decision tree recommends that the customer should be accepted (\$293.32) without further investigation using the external credit agency (\$506.47).

Reducing Investigation Backlog with an Expert System

The previous sections have documented how the cost and time involved in checking credit-worthiness of new customers can be reduced using a decision support system in the Finance Department. We now suggest a way in which the volume of cases to check can also be reduced through the design of a simple expert system for use in the order entry process.

Davis defines an expert system as a computer application that guides the performance of ill-structured tasks which usually require experience and specialized knowledge. Nau claims that by using an expert system, a non-expert can achieve performance comparable to an expert in a specific problem domain. An expert system is characterized by a knowledge base comprising the data and rules which represent the manager's expertise.

In the trade credit problem the expert is the Credit Manager and the non-expert is the salesperson who takes the order from the new customer. Our challenge is to design an expert system that would capture the credit manager's expertise.

Specifically we need to learn in what circumstances a credit manager would accept a new customer without a formal investigation. If these rules could be programmed, the salesperson could decide when it was necessary to forward a new customer to the credit department for investigation. The Credit Manager's workload would be reduced and the throughput of new customer orders would be increased without significantly increasing the risk of bad debt losses.

There would naturally be a limit to the extent of transferring the credit manager's expertise to the salesperson. For example it would be inappropriate to expect the salesperson to continue beyond the first stage of the trade credit decision making process as this would require specialized knowledge in interpreting the results of the credit scoring model.

The key to deciding whether an expert system is feasible hinges on the ability to capture the rules the credit manager uses to decide whether or not a credit examination is necessary. To test whether this is possible, the decision support system developed earlier in this paper is used to simulate the credit manager's decision process in a variety of situations. The object is to identify situations where the manager always arrives at the decision to accept a new customer without further investigation.

An example of one of the simulation runs is described in table 5 and figure 4. In this run, it is assumed that the simulated sale involved fewer items than previously assumed (10 items) at a higher profit margin (48%). The optimum decision is now to accept the customer without an investigation.

The primary criterion used by the manager in making this decision is assumed to be cost minimization based on expected cost of accepting the order compared to the expected cost of

investigating further. Accordingly the difference between these two costs (representing the percentage saving from investigating the new customer further) is plotted for varying sizes of invoice and profit margin, while holding all

other parameters constant. The resulting graph is shown in figure 5.

As the profit margin on a particular invoice increases, it is apparent that a larger invoice amount is required

FIGURE 3 LOTUS DECISION TREE ANALYSIS OF TRADE CREDIT PROBLEM
(TABLE 4 DATA)

to justify a credit investigation. This trade-off between profit margin and size of invoice is intuitively appealing as one would expect the profits from the high margin invoices that are paid to offset the losses in variable costs on invoices that are not paid.

ship between invoice amount, profit margin, and expected savings resulting from a credit investigation into a set of rules that could conceivably form the basis of an expert system for use during order entry a break-even chart was constructed in figure 6.

To translate the apparent relation -

The chart describes combinations

KEY:

A ACCEPT
I INVESTIGATE FURTHER
R REJECT
G GOOD
Ind INDETERMINATE
P POOR
F FAVORABLE
U UNFAVORABLE

CREDIT SCORING MODEL
(STAGE 2)

EXTERNAL CREDIT CHECK
(STAGE 3)

DECISION POINT

CHANCE EVENT

OPTIMUM PATH

FIGURE 4 LOTUS DECISION TREE ANALYSIS OF TRADE CREDIT PROBLEM
(TABLE 5 DATA)

of invoice amount and profit margin that would result in a zero saving from a credit investigation. It is apparent that, for the set of parameters used in this simulation run, new customers ordering goods carrying a profit margin in excess of 48% would have to place an exceptionally large order before a credit investigation is justified. Similarly, customers ordering less than \$500 would not need to be investigated unless the goods ordered carried a margin of less than 36%.

Developers of such an expert system should incorporate a system for automatically redefining the break-even curve as parameters change, for ex-

ample, as new products are introduced and new market segments are exploited. A computerized expert system is envisioned, however in cases where product pricing structures are simple and profit margins are known by sales staff, a manual version of the expert system would be possible.

Conclusions

Traditional approaches to investigating trade credit-worthiness of new customers can involve time-consuming and expensive tasks which can impair customer goodwill and result in lost sales. This paper suggests two ways in which the process can be streamlined.

CREDIT ANALYSIS ASSUMPTIONS

PROBABILITY OF BAD CREDIT LOSS	10.00 %
NUMBER OF ITEMS FINANCED	10
UNIT PRICE OF ITEM(S) FINANCED	\$100.00
UNIT VARIABLE COST	\$52.00
REQUIRED ANNUAL RATE OF RETURN	15.00 %
EXPECTED COLLECTION PERIOD	35.00 days
AVERAGE COLLECTION COST	\$3.75
DISCOUNT RATE ON CREDIT	2.00 %
INVESTIGATION COST - STAGE 2	\$4.75 CREDIT SCORING MODEL
INVESTIGATION COST - STAGE 3	\$17.00 EXTERNAL CREDIT CHECK

CREDIT ANALYSIS OUTPUT

PROFIT MARGIN ON ORDER	48.00%
GROSS CONTRIBUTION	\$480.00
TRADE CREDIT DECISION	EXPECTED COST
ACCEPT WITHOUT INVESTIGATION	\$63.23
INVESTIGATE FURTHER	\$70.29

**TABLE 5. TABULAR OUTPUT FROM DECISION SUPPORT SYSTEM
(LOW INVOICE, HIGH MARGIN)**

**FIGURE 5 EXPECTED SAVINGS RESULTING FROM
CREDIT INVESTIGATION**

**FIGURE 6 DECISION RULE FOR NEW CUSTOMER
ORDER ENTRY**

First, a decision support system based on decision theory is developed to assist the credit manager decide on the most cost effective sequencing of credit investigations using first a credit scoring model and then if deemed necessary an external credit agency to investigate the new customer.

Second, an expert system is design-

ed to identify and filter new customers that require credit investigation at the time of order entry. Instead of routinely routing all new customers through the credit investigation process, the salesperson can tap the expertise of the credit manager to decide on who needs to be investigated. Hence only critical customers are forwarded to the credit manager for investigation.

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