

DETERMINING THE CASH DISCOUNT IN THE FIRM'S CREDIT POLICY: AN EVALUATION¹

Stephen F. Borde* and Daniel E. McCarty**

Abstract

The purpose of this study is to test the most general form of the maximum cash discount model developed by Hill and Riener [1979]. This study is an extension of their work. The model is dynamically tested using computer simulations. Under these dynamic tests, the model provides a stable output (maximum cash discount) which peaks in the 2 percent to 3 percent range. This model appears to have the potential to be a very useful management tool in the process of setting value-maximizing company policy on how much discount should be offered for early payment.

INTRODUCTION

Ramirez, Walderman, and Lasser [1991] report that practitioners believe additional research is needed in new techniques of asset-liability management. Gentry [1988] argues that there is need for research in many areas of short-term financial management. For example, several studies of small firms including Brunell, Jessell, and McCarty [1990], Walker [1985], Anvari and Gopal [1983] and Grablowsky [1978] have reported that managers understate the cost of missing a trade discount. Furthermore, managers are not likely to borrow in order to take advantage of trade discounts. However, Smith and Belt [1989] contend that managers in large firms are becoming more sophisticated in their evaluation of terms of sale. Likewise, Hill, Wood, and Sorenson [1981] and Hill, Sartoris, and Ferguson [1984] suggest that firms do not change terms of sales with the economic cycle. This paper examines the issue of trade credit from the viewpoint of the provider of trade credit.

Terms of sale models have been developed by Sartoris and Hill [1981], Alexander and Gahlon² [1980], Hill and Riener [1979], Weston and Tau [1980], Christie [1969], Celec and Icerman [1980] and Wrightsman [1969]. Because data needed to test these models is not readily available and is not likely to become available, empirical tests of these theories is not possible. Thus, this study uses an alternative to traditional empirical tests.

The Hill and Riener [1979] cash discount model is designed to help managers find their firms' maximum level of cash discount, given the tradeoffs between benefits and costs. However, Hill and Riener [1979] do not test their model to determine its degree of sensitivity to the various input variables, and they make no attempt to examine the distribution of outputs for a given set of stochastic inputs. Thus, the purpose of this study is to test the most general form of the maximum cash discount model developed by Hill and Riener [1979], thereby effectively extending their work.

TRADE CREDIT OVERVIEW

Trade credit, accrued wages and taxes, commercial bank loans, and commercial paper fall under the broad heading of short-term financing. Accounts payable or trade credit typically is the largest single category of short-term financing, representing about 40 percent of current liabilities of the average non-financial firm. This percentage may be higher for smaller firms because smaller firms often do not qualify for financing from other sources; they rely heavily on trade credit [Weston and Brigham, 1982; Walker, 1985].

If a firm's accounts payable exceeds its accounts receivable, it is receiving trade credit financing. Ward and Chapman [1987] support this notion by suggesting that trade credit can be regarded as a general source of funds. However, to the

*University of Central Florida

**Florida Atlantic University

buyer, the cost of trade credit financing can be very high; for example, trade credit terms such as “2/10, net 30” translates into a financing cost of over 37 percent on an annualized basis. With such high cost, reasons why buyers accept trade credit and sellers offer it are unclear. Several explanations have been offered for this enigma which fall under four broad categories: financing [Emery, 1984], pricing Nadiri [1969], macroeconomic conditions [Schwartz, 1974], and information [Smith, 1987].

In inventory management, economic order quantities may be affected as a result of the payment delays associated with trade credit [Rachamadugu, 1989; Chung, 1989; Haley and Higgins, 1973], which implies that interactions may occur between trade credit and other operational considerations. From a buyer’s viewpoint, not accepting the discount and paying later may be advantageous in the presence of rapid inflation, as future funds would be worth less in real terms [Ben-Horim and Levy, 1982]. The amount of trade credit implicitly extended may be affected by a firm’s ability to collect accounts receivable. Firms in the United States generally collect trade debts about 3 weeks quicker than firms in the United Kingdom, perhaps because of more widely available credit information in the United States. The typical credit period in the United States is 30 days whereas 45 days is the norm in the United Kingdom [Kirkman, 1979].

BENEFITS AND COSTS OF A CASH DISCOUNT

From the seller’s perspective, Hill and Riener [1979] identify several benefits and costs associated with cash discounts. Cash discounts typically induce some customers to pay early in exchange for a pre-specified discount. To the seller, cash is received sooner, thereby reducing the need to borrow. An early payment discount is in effect a price reduction. If buyers are price elastic, cash discounts may generate greater demand for the firm’s products. Thus, cash discounts can be used as a tool in the process of fine tuning product price. Earlier payment may reduce the possibility of bad debt losses as less time would be available for buyers to develop payment problems. This argument is supported by Besley and Osteryoung [1985] who find in a 1982 survey that most firms impose subjective trade credit limits as a way of controlling bad debt risk exposure.

On the negative side, a cash discount may directly reduce total sales revenue if unit sales volume does not increase sufficiently to offset the unit revenue loss. This may occur if buyers are price inelastic and therefore are not induced to buy proportionally more units of product in response to a price reduction. Bockhorn and Harris [1989] find that over half of the 33 farm supply firms surveyed in their study had unprofitable cash discounts. Frantz and Viscione [1976] support the notion that the cost of a cash discount has a negative impact on sellers’ profits. They say that a 2 percent cash discount can reduce profits by as much as 28 percent. However, this relationship would depend on customers’ price elasticity and the firm’s degree of leverage.

DISCOUNT DECISION

Hill and Riener [1979] address the issue of discount size by developing a maximum cash discount model. Their decision criterion is the present values of two sets of cash flows: the cash flows associated with the old policy and the cash flows associated with the new policy³. The Hill and Riener decision objective is to find a present value break-even policy by computing the maximum cash discount the firm can or should offer, given a set of assumptions about cash flow timing, change in sales volume, fraction of credit sales expected to be paid with the discount, and changes in bad debt losses that would arise from having offered the discount.

For firms that do not currently offer a cash discount, introduction of a cash discount would probably induce some portion of existing customers to pay early and take advantage of the discount. The remaining customers would pay later without the discount. This may have the effect of changing the firm’s distribution of cash receipts from a unimodal distribution to a bimodal distribution. One mode for early payers, and the other for later payers who chose not to take advantage of the cash discount.

Since the present value of the respective cash flows is the basis upon which the maximum cash discount is determined, then choice of an appropriate discount rate for present value calculations is an important issue. Choice of an opportunity cost of capital figure to use as a present value discount rate has been a controversial issue. Some firms adjust the discount rate by a factor that represents the ratio of variable costs to sales, but Oh [1976] suggests that such an adjustment understates the true opportunity cost of capital. Atkins and Kim [1977] respond to Oh’s argument by saying that the net present value (NPV) approach is the only correct one.

From the buyer’s perspective, Brick and Fung [1984] suggest that comparing the cost of trade credit with other financing alternatives without considering taxes is inappropriate. However, taxation is an issue not addressed by Hill and Riener [1979] and therefore not included in their model. This paper makes no attempt to further develop their model by including the effects of taxation. The primary purpose of this study is to test the model in its existing form.⁴

MAXIMUM CASH DISCOUNT MODEL

The most general form of the maximum cash discount model developed by Hill and Riener [1979] includes an array of input variables and is represented by the following equation:

Equation 1

$$\delta_{\max} = I - (I + i)^{M-N'} \left[I - \frac{I}{P} + \frac{(I-b)(I+i)^{N'-N} + vg(I+i)^{N'-Q}}{p(I+g)(I-b+k)} \right]$$

where:

- δ = cash discount for early payment, new policy,
- i = opportunity cost of capital, discount rate,
- N = mean collection period for all payers under current policy,
- N' = mean collection period for later payers under new policy,
- M = mean collection period for earlier payers under new policy,
- Q = average payment day of variable costs,
- p = fraction of sales derived from earlier payers,
- $(I-p)$ = fraction of sales derived from later payers,
- b = fraction of sales never collected or bad debts,
- k = fractional bad debt reduction from early payment,
- g = fractional change in sales volume or growth rate,
- v = variable costs as a fraction of sales.

Ideally, a manager could determine an appropriate level for each of the input variables applicable to the particular firm and apply them to the above equation to arrive at the maximum cash discount that should be offered. However, this ideal approach may not be possible in reality. The necessary data may not be readily available, and measurement problems may arise. Thus, trial and error may be the only feasible approach, but use of trial and error techniques may have undesirable side effects. For example, in trying to determine the degree of customer price elasticity, a firm could vary its prices and observe the effect of such changes on product demand. However, frequent and/or significant price changes may adversely affect customer relations with consequent loss of patronage. Likewise, the introduction of a cash discount would likely induce some customers to pay early. But the proportion of customers likely to take the discount and the consequent aggregate shift in payment timing is difficult to predict.

METHODOLOGY AND RESULTS

The sensitivity of the model's output to its inputs could be determined by taking partial derivatives, but this approach would not account for interactions among variables. Similarly, sensitivity of the maximum cash discount to a change in the values of each of the respective variables over a pre-specified range of values may provide useful information⁵ but also would not account for interactions. With this type of static analysis, interactions among variables are not assessed because the value of only one variable is changed while all others are held constant. One way of alleviating this problem is to apply a dynamic analysis, which would allow for simultaneous interaction of all variables at varying input levels.

Firm-specific input variable data is not readily available as firms are not typically willing to share proprietary information, or firms may not have adequately developed information systems to provide the necessary data. Because of data availability problems, measurement problems, input variable interactions, and stochastic influences on input variables, point estimates of input variable values may be inappropriate. Thus, computer simulation using a range of values for each input variable may be more appropriate.

Researchers have used simulation as a way of dealing with uncertainty, risk, and stochastic input variables. Hertz [1964] uses simulation to develop a "new method" of approaching capital investment. His method generates density and cumulative probability distributions of returns, as outputs, for a variety of stochastic inputs. This provides managers a better alternative to using single point estimates or three scenario estimates. These probability distributions provide a more comprehensive overview of the potential returns and risks, which would likely promote better managerial

decisions. Gentry and Pyhrr [1973] use simulation in a similar manner. They use a variety of inputs such as desired growth rate, planned investment, debt ratio, and other variables to estimate probability distributions of required rates of return. Gup [1980] uses Monte Carlo simulation to assess the relationship between certain financial variables on economic concentration. Popp and Vogt [1979] use a simulation model to explore the effects of alternatives to a public school property tax. Bey and Singleton [1978] use simulation to examine the assumption of intertemporal independence of cash flows in the capital budgeting decision. Simulation is used in the development of bond portfolio strategies [Bierwag, 1978] and in gaining a better understanding of the implications of various investment strategies [Zeikel, 1978; Ibbotson and Sinquefeld, 1976]. Cooper [1977] uses simulation to estimate the effects of changes in the shape of the term structure of interest rates. Silhan and McKeown [1985] suggest that simulated mergers produce similar results to those of actual mergers, implying that simulation is a valid analytical tool in forecasting the results of mergers. Hoppenhaver [1984] simulates a financial futures trading strategy for banks. Taussig [1983] uses simulation to analyze the effects of certain accounting standards on the repatriation of cash by multinational firms.

Simulation tests are performed on the maximum cash discount model developed by Hill and Riener [1979]. The model is tested with 5000 trials, each trial using a different value within boundaries, for each of the 10 input variables. The high and low boundaries for each input variable are shown in the first and tenth columns of Table 1, respectively. For example, the input values for (i), the discount rates, are limited to a minimum value of 7 percent and a maximum value of 16 percent. The other 9 inputs are similarly bounded, as shown in Table 1.

The results of the first simulation test, which is the distribution of maximum cash discount values, is shown as the solid graphic line in Figure 1. A second simulation test is performed using a more restricted range of input values. The high and low input values are restricted to the values shown in the third and eighth columns of Table 1, respectively. The distribution of outputs, under these restricted conditions, is shown as the dotted graphic line in Figure 1. Both of these simulations are replicated 5 times each in an attempt to establish the degree of output distribution stability. Output distributions are virtually identical across replications. Figure 2 shows cumulative probability distributions that reflect the probability density functions shown in Figure 1.

The results of these simulation tests indicate that with a relatively wide range of input values for each variable, the most likely output is in the 2 percent to 3 percent range. Dispersion of the output distribution narrows very quickly when the range of input variable values is slightly reduced. However, a portion of the output distribution lies to the left of zero (negative discounts). A negative "discount" implies that the firm should not accept the proposed change since it would have to raise prices just to break even [Hill and Riener, 1979].

SUMMARY AND CONCLUSION

This study tests the maximum cash discount model developed by Hill and Riener [1979], which is designed to help managers find the maximum cash discount that they should offer. The model is tested dynamically using computer simulations and a range of input variable values. The model provides a stable output which peaks in the 2 percent to 3 percent range.

A major implication of these results is that managers who are unable to obtain precise or accurate input variable values for the model could apply this simulation technique with available estimates of input variable values and obtain a reasonably accurate approximation of their firm's maximum cash discount. Alternatively, managers may arbitrarily use a cash discount value in the 2 percent to 3 percent range and be reasonably assured that their choice is not very likely to be grossly inaccurate. This may account for why firms seldom change their terms of sale. In conclusion, this model appears to have the potential to be a very useful management tool in the process of setting value-maximizing company policy on how much discount should be offered for early payment.

ENDNOTES

1. Some confusion exists in the literature and in practice between the terms cash discount and early payment discount. Cash discount is used frequently to mean early payment discount. In this paper, the terms cash discount and using early payment discount are used interchangeably.
2. Alexander and Gahlon give credit to Seymour Friedland, *The Economics of Corporate Finance*, (Englewood Cliffs: Prentice-Hall, Inc.), 1966, for being the first to apply value maximization principles to the terms of sale decision.
3. Weston and Tuan (1980) show that an alternative binomial expansion approach produces essentially the same results and therefore may be considered equivalent for most purposes.

TABLE 1
Input Data Values and Numerical Approximations of a
Variant of the Partial Derivatives (Elasticities)

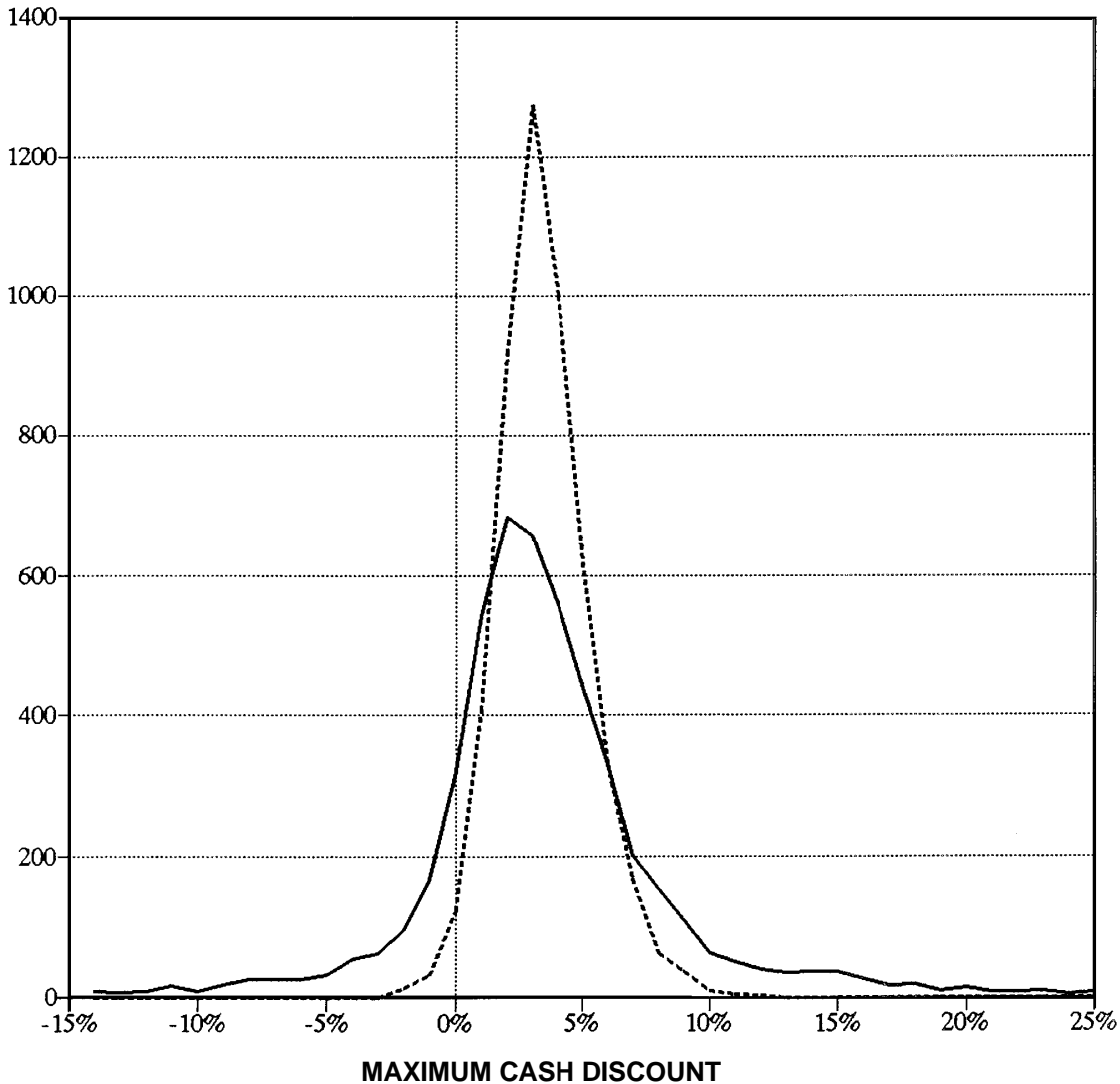
COLUMN NUMBER:	1	2	3	4	5	6	7	8	9	10
INPUT VARIABLE	Input Variable Values and Corresponding Sensitivity (Elasticity) Measures									
Opportunity Cost of Capital										
I value (%):	7%	8%	9%	10%	11%	12%	13%	14%	15%	16%
Sensitivity:		0.13	0.14	0.15	0.17	0.18	0.19	0.20	0.22	0.23
Average collection period, all payers, current policy										
N value (days):	30	40	50	60	70	80	90	100	110	120
Sensitivity:		0.47	0.53	0.58	0.62	0.65	0.67	0.70	0.71	0.73
Average collection period, later payers, new policy										
N' value (days):	50	60	70	80	90	100	110	120	130	140
Sensitivity:		-0.26	-0.32	-0.39	-0.46	-0.55	-0.64	-0.75	-0.86	-1.00
Average collection period, earlier payers, new policy										
M value (days):	7	8	9	10	11	12	13	14	15	16
Sensitivity:		-0.04	-0.04	-0.05	-0.05	-0.06	-0.06	-0.07	-0.07	-0.08
Fraction of sales derived from earlier payers										
p value (%):	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
Sensitivity:		-0.88	-0.80	-0.74	-0.69	-0.64	-0.60	0.56	-0.53	-0.50
Fractional change in sales volume or growth rate										
g value (%):	-2%	-1%	0%	1%	2%	3%	4%	5%	6%	7%
Sensitivity:		1.63	-7.12	0.46	0.71	0.79	0.83	0.84	0.85	0.86
Variable costs as a fraction of sales										
v value (%):	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
Sensitivity:		-0.17	-0.32	-0.51	-0.76	-1.12	-1.67	-2.59	-4.48	-10.59
Fraction of sales never collected or bad debts										
b value (%):	0.0%	0.3%	0.6%	0.9%	1.2%	1.5%	1.8%	2.1%	2.4%	2.7%
Sensitivity:		-0.00	-0.00	-0.01	-0.01	-0.01	-0.02	-0.02	-0.02	-0.03
Fractional bad debt reduction resulting from early payment										
k value (%):	0.0%	-0.1%	-0.1%	-0.2%	-0.2%	-0.3%	-0.3%	-0.4%	-0.4%	-0.5%
Sensitivity:		-0.01	-0.03	-0.05	-0.07	-0.09	-0.11	-0.13	-0.15	-0.18
Average payment day of variable costs										
Q value (days):	5	6	7	8	9	10	11	12	13	14
Sensitivity:		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

4. Alexander and Gahlon [1980] extend the Hill and Riener approach by first arguing that the discount period and discount rate are a firm specific decision. They develop a model that requires the fraction of sales taking the discount and the change in sales to be a function of the discount period and rate. Second, they introduce taxes and find that taxes and sales growth rate have a significant impact on the optimal decision. This conclusion is based on a simple numerical example.
5. See the Appendix for a numerical approximation of a variant of the partial derivatives.
6. In calculating the percentage changes, the "midway" formula approach is used. This technique uses the average of the high and low values in the denominator, rather than a single high or low value.

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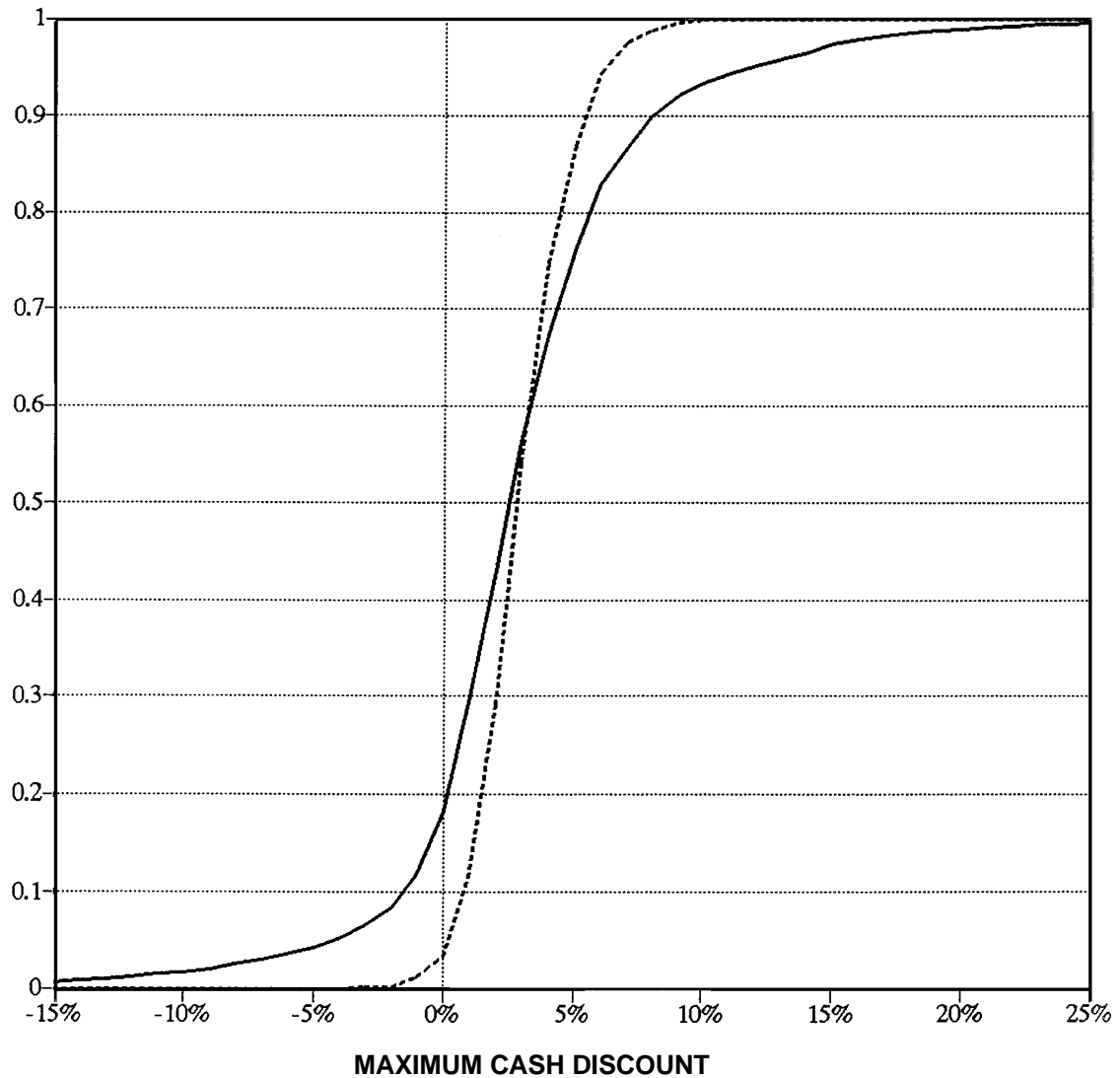
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FIGURE 1
Simulation Test 5000 Trials



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FIGURE 2
Cumulative Probability Distribution



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APPENDIX

Numerical Approximation of a Variant of the Partial Derivatives

In order to measure the degree of sensitivity the output of the model displays toward each respective input variable, sensitivity measurements are conducted, which are analogous to elasticity measurements. In essence, the percentage change⁶ in each input variable is compared to the resulting percentage change in the output (the maximum cash discount), while holding all other input variables constant. This process is replicated until a sensitivity measurement is obtained for each of the ten input variables over a range of input values.

The results of these measurements are reported in Table 1. For example, consider Columns 9 and 10 and the growth rate in sales (g). As the growth rate in sales increases from 6 percent to 7 percent (more than a 15 percent change), the maximum cash discount increases by about 13 percent. Consequently, the value of the elasticity measure ("Sensitivity" in Table 1) is less than one (0.86), which implies that the maximum cash discount is relatively insensitive to a change in the sales growth rate. Conversely, a value greater than one would suggest that the maximum cash discount is sensitive to such a change. A negative sign associated with a sensitivity measure denotes an inverse relationship.

From the results shown in Table 1, the output of the model displays a greater degree of sensitivity to some input variables than to others. Some input variables have a direct influence on the output while others have an inverse influence. Many input variables display some change in sensitivity, at varying rates, depending on the absolute level or value of input. Furthermore, some sensitivities display non-stationary sensitivities, with sign reversals.

Most of the input variables do not generate significant instability in the model. However, the sales growth rate variable (g) does show some evidence of instability at the zero growth point, as suggested by its abnormally high sensitivity value and sign change. Also noteworthy is the rapid and significant change in sensitivity of the variable cost factor (v).
