tions researcher skilled in the implementation of conversational, mathematical-programming-based, decision-support models.

REFERENCES

1. Calman, Robert F. *Linear Programming and Cash Management/CASH ALPHA.* Cambridge, Massachusetts, MIT Press, 1968.
2. Ferguson, Daniel M., and Maier, Steven F. "Disbursement System Design for the 1980s." *Journal of Cash Management,* 2 (November 1982), 56–72.
3. Fielitz, Bruce D., and White, Daniel L. "Two Stage Solution Procedure for the Lockbox Location Problem." *Management Science,* 27 (August 1981), 881–886.
4. Nauss, Robert M, and Markland, Robert E. "Optimizing Procedure for Lock Box Location Analysis," *Management Science,* 27 (August 1981), 855–865.
5. Pogue, Gerald A., Faucet, Russell B., and Bussard, Ralph N. "Cash Management: A Systems Approach." *Industrial Management Review,* Vol. 11, (Winter 1970), 55–74.
6. Stone, Bernell K. "Cash Planning and Credit-Line Determination with a Financial Statement Simulator: A Case Report on Short-Term Financial Planning." *Journal of Financial and Quantitative Analysis,* 7 (December 1973), 711–729.
7. Stone, Bernell K. "Allocating Credit Lines, Planned Borrowing, and Tangible Services over a Company's Banking System." *Financial Management,* 2 (Summer 1975), 65–78.
8. Stone, Bernell K., Downes, David H., and Magee, Robert P. "Computer-Assisted Financial Planning: The User-Planner Interface." *The Journal of Business Research,* 5 (September 1977), pp. 215–233.

DISCUSSION

J. G. KALLBERG*: The paper of Sartoris and Hill (S&H) builds upon their own and upon other academic research in trade credit policy. They view trade credit decisions within a more complete context of firm value maximization and while they present a net present value framework that is flexible enough to incorporate a variety of other working capital problems, they focus upon determination of credit period and discount. This question is particularly timely in view of the July 1981 passage of the Cash Discount Act which greatly extends the ability of vendors to (differentially) offer discounts for cash payment, and in view of the widespread usage of credit as a powerful marketing tool. The following analysis considers a number of ways to extend the S&H formulation, raises further pragmatic issues, and cites some additional relevant literature.

The basic qustion is: why should an optimal trade credit policy exist? In the Lewellen, McConnell, and Scott [4] study cited by S&H, in a perfectly competitive product and capital market with value-maximizing vendors and buyers, there is no optimal trade credit policy; all "feasible" credit terms are perfect substitutes. This type of irrelevance argument was previously presented in Schwartz and Whitcomb [6]. They develop three motives for a trade credit offer

> "The transactions motive reflects the fact that buyers' transactions costs are reduced if invoices are allowed to accumulate for periodic payment . . . The financing motive exists if firms can profitably link financial intermediation to the sale of a product due to capital market imperfections. The pricing motive exists if product market imperfections make trade credit an effective means of disguised price reductions or discriminatory pricing." [6; p. 259]

* New York University.

These two papers suggest that the focus should be on the types of market imperfections that allow trade credit decisions to become important. As will be discussed further, this aspect of the problem deserves more attention than S&H have accorded it.

The model of S&H assumes that a payment will qualify for a discount (payment time t_d), will not qualify (payment time t_c), or will become uncollectible. This framework is less general than that developed earlier in Lieber and Orgler [5]. Here overdue payments are charged a penalty rate (K per unit time); a collection rate ($f(K, y(t), t)$) is controlled by a collection expense rate ($y(t)$); receivables remaining (at time t_v) are sold for a fixed proportion (μ) of face value. With minor changes, if we append the following expression

$$b(1-q)S_t\left\{\int_{t_c}^{t_v} \exp(-rt)\{(1+Kt)f(K, y(t), t)\}\,dt + \mu\{1-\int_{t_c}^{t_v} f(K, y(t), t)\,dt\}\exp(-rt_v)\right\}$$

to S&H's equation (1) we have Lieber and Orgler's equation (6). It would be interesting to continue the S&H analysis with this addition.

One can reformulate S&H's example 2 (timing uncertainty) in more generality to clarify a number of points. Rather than consider only two possible payment dates, let $P(s)$ represent the proportion of day t_1 sales that are collected on day s. The net present value of day t_1 sales is thus

$$S_{t_1}\int_{t_1}^{\infty} P(s)\phi(s)\exp(-rs)\,ds$$

where $\phi(s)$ is a "penalty factor." S&H set $\phi(s) = \exp(rs)$ so that the adjustment for late payment is merely the appropriate discount factor. The vendor is now indifferent to time of payment. (Example 1 can also be treated in this manner; the only difference is in that case the net present value is $(1-d)S_{t_1}$.) In the language of [4], this means that, independent of payment date, the vendor always receives the "equilibrium cash price." Hence we are back to the perfect market case where "... credit price and credit period are de facto perfect substitutes ..." [4; p. 107]. (These types of interest penalties on late payments are practiced in Scandinavia; see, for example, Gianotti and Smith [2; p. 29].) Of course it would be more interesting to allow $\phi(s)$ to vary so as to generate an "appropriate" risk-return tradeoff. The S&H treatment considers only the zero risk strategy. The relevant literature includes Cyert and Thompson [1] who use a mean-variance approach to determine the optimal accounts receivable portfolio assuming a Markov chain process for receivables, and Schwartz and Whitcomb [6] who discuss using the CAPM to determine the risk-adjusted rate of return on accounts receivable investment.

Research in this area of corporate finance is made difficult by the lack of empirical evidence surrounding many of the decisions relevant to trade credit policy. (One recent exception is the theoretical and empirical study of cash

discounts versus credit card usage by Ingene and Levy [3].) Furthermore, as S&H point out, it is awkward to apply many of the concepts of modern financial theory. And, as previously mentioned, the economic theory suggests that the relevance of the trade credit decision arises largely from market imperfections. In addition to the imperfections cited above, some of the arguments usually employed in evaluating factoring or bulk financing agreements are pertinent here. There are tax considerations, not only in the financing of receivables, but also, for example, with respect to retailers' very significant tax deferrals on revolving credit sales. There are numerous balance sheet effects that must be considered. Finally, casual empiricism suggests that trade credit policies are rather uniform across product classes, often relating to the perishability or obsolescence characteristics of the product. Evaluating changes in credit policies must consider these pragmatic issues (including "marketing" effects) as well as the relevant net present values.

REFERENCES

1. Robert M. Cyert and Gerald L. Thompson, "Selecting a Portfolio of Credit Risks by Markov Chains," *Journal of Business*, Volume 41 (1968), pp. 39–46.
2. John B. Gianotti and Richard W. Smith, *Treasury Management: A Practitioner's Handbook*, Ronald Press, New York (1981).
3. Charles A. Ingene and Michael Levy, "Cash Discounts to Retail Customers: An Alternative to Credit Card Sales," *Journal of Marketing*, Volume 46 (Spring 1982), pp. 92–103.
4. Wilbur G. Lewellen, John J. McConnell, and Jonathan A. Scott, "Capital Market Influences on Trade Credit Policies," *Journal of Financial Research*, Volume 3, Number 2 (Fall 1980), pp. 105–113.
5. Zvi Lieber and Yair E. Orgler, "An Integrated Model for Accounts Receivable Management," *Management Science*, Volume 22, Number 2 (October 1975), pp. 212–219.
6. Robert A. Schwartz and David K. Whitcomb, "The Trade Credit Decision," in James L. Bicksler (Editor), *Handbook of Financial Economics*, North-Holland, Amsterdam (1979), pp.257–273.

DISCUSSION

GARY W. EMERY*: Professor Stone's paper represents the newest member of a family of models that may be used to assign credit and tangible service activities to banks and to determine the least cost method of payment. He makes a convincing case for the necessity of revising existing models to more accurately reflect present banking practice and he clearly describes the required changes to the objective function and constraints. Because of the communality among these models, my discussion primarily addresses some issues that apply to banking system design models in general.

First, a banking system design model should recognize the interactions between the use of tangible services and the availability and cost of credit. Professor Stone's model does incorporate some of the interactions since the fees paid and balances maintained are payments for both types of services. Furthermore, planned borrowing and therefore credit line size are based on the company's

* Indiana University.