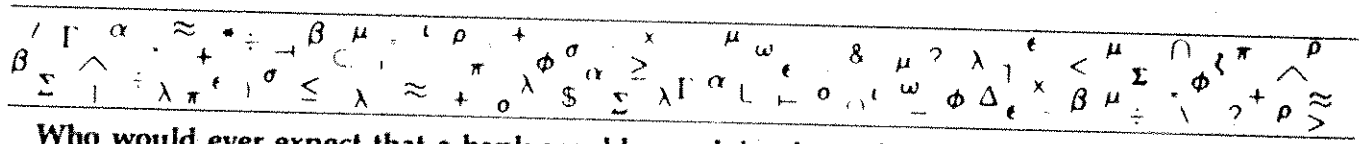
20/30 Hindsight: Cash Management in Local Banks

RON A. PEFFER

Department of Applied Mathematics
Rabobank Nederland
Utrecht, The Netherlands

JAN TELGEN

Department of Applied Mathematics
Rabobank Nederland
Utrecht, The Netherlands



Who would ever expect that a bank would complain about the number of calculations required to do anything, let alone cut down costs? Mr. Peffer and Dr. Telgen describe their experiences in implementing a cash management system for use by independent local banks; when they got that response — perhaps because a square root calculation was required? — they made the system even easier to use. It seems that the savings in this case should be obvious to the prospective users. Why is it so hard to get people to save money especially if they are bank employees? Peffer and Telgen offer some suggestions.

Robert G. Chamberlain

The Rabobank organization is a cooperative of close to 1,000 independent local banks, with a total of nearly 3,000 branches. With total assets equaling Dfl 116 billion (a Dutch florin is worth about 30 US cents), it is among the 50 largest banks in the world, although most of Rabobank's business is conducted within The Netherlands.

The amount of cash money handled in the branches varies greatly; it may range anywhere from Dfl 10,000 to over Dfl 1 million a day. To meet the demands resulting from cash transactions, the branches need a certain stock of cash money. Since this stock does not earn interest, it should be kept as small as commercially acceptable. Excess cash can be shipped to De Nederlandse Bank (DNB; comparable to the Federal Reserve) and shortages can be replenished. These shipments involve relatively high costs, which are virtually independent of the amount shipped. Shipments both to and from the local banks have to be requested at least one day in advance.

The theoretical problem is not very difficult and has been addressed in the literature quite extensively (Bell and Noori 1984; Girgis 1968; Hausman and

0091-2102/86/1605/0072$01.25

FINANCIAL INSTITUTIONS — BANKS
PROFESSIONAL — MS/OR IMPLEMENTATION

Sanchez-Bell 1975; and Heyman 1973). Embedded in the organizational structure of Rabobank, however, are extra difficulties that add a dimension to the problem; all local banks are completely independent and local management is responsible for cash management. In fact, the central organization (Rabobank Nederland) is the daughter of almost 1,000 mothers; the reverse situation (physically less unlikely) is more common, at least in banking.

Because of this structure, Rabobank Nederland can only advise the local banks. Implementation of this advice depends on the degree to which the local bank managers think the advice is sound, self-evident, and similar to their gut feelings. This organizational structure is likely to slow down the implementation of all kinds of support and services offered by Rabobank, including the use of a systematic cash management procedure.

Several years ago, the problem of cash management became a hot topic because of soaring interest rates, which increased the costs of holding stocks of cash. At that time, the annual costs of cash at Rabobank were estimated at Dfl 5 million for shipment and Dfl 40 million for inventory (opportunity costs due to lost interest). In response to these costs, the management of Rabobank Nederland initiated a study that was intended to result in a cash management system for use by the local banks.

Unsuccessful Attempts (by Others)

Because other major Dutch banks faced similarly rising costs for their cash transactions, around 1978 Rabobank and a number of other banks made a joint effort to develop a cash management system. A multitude of factors, including competition among the participants, prevented this working group from coming up with a workable system. As a result, most banks went further toward developing a system on their own.

One bank started by trying to model the demand for and supply of cash at the branches. With these models, it would be possible to forecast the flow of cash in the branches and to use these forecasts as a basis for a cash management system.

Fairly soon it turned out that to get useful predictions, weekly, monthly, and yearly patterns should be distinguished, interspersed with effects due to special days (such as Easter and local fairs); all such patterns are different for different locations.

Even after accounting for these patterns, the remaining error in the model was relatively large; we suspect it was mostly due to the effects of weather conditions.

Apart from the obvious difficulty in using such a model for forecasts, the task of calibrating and updating these models (3,000 models would be required for Rabobank) and handling the massive amount of data involved would be enormous. The bank following this approach never escaped the modeling stage and finally abandoned all efforts.

Another bank followed a more traditional approach and imposed one pair of upper and lower limits on the amounts of cash in each of its 35 branches. For Rabobank such a solution is simply infeasible: all member banks are completely independent and there is no way (formal or informal) that Rabobank can impose

limits on the cash holdings.

If Rabobank were to advise its member banks on upper and lower limits, the member banks would argue (rightly) that local conditions are of predominant importance for determining these limits and that they want these conditions to be incorporated in their determination. In fact, the bank that imposed limits had to relax them for the majority of its branches within one year, because of "exceptional" local conditions.

These two approaches did not explicitly try to minimize costs. A third bank tried to incorporate cost considerations by determining a "general weekly pattern" for each branch: a sort of average of observed demand for cash over the week, thus ignoring monthly and yearly patterns. Given this general pattern, threshold values can be derived for each day of the week; cash holdings above the upper threshold for that day trigger a cash transport from the branch to DNB and cash holdings below the lower threshold for that day trigger a shipment from DNB to that branch.

The problem of cash management became a hot topic because of soaring interest rates.

The bank involved, which has a relatively small number of branches, seems to have persuaded most of its branches to use this system, although they complain about the number of calculations required. Observing these complaints and realizing that convincing its member banks of right values for the thresholds would be difficult, Rabobank has not followed this approach.

Our Approach

Even so, Rabobank first tried a method based on the general weekly pattern. Given this pattern, all possible combinations of shipments from DNB were considered and the associated costs were determined in a straightforward way. This resulted in fixed days for the shipments to take place. At first the implementation (in a small number of branches) seemed successful, but when changes in the general weekly pattern had to be dealt with, the branches found determination of new days for shipment too complicated, and Rabobank abandoned the system.

Then, we were called in to develop a computerized system for determining the shipment days. Although this was a very limited task, we succeeded in convincing our clients that their approach contained some flaws. (We called them "points at which the approach might be extended.") First, there was no opportunity for shipments on different days throughout the week; second, the amount of available cash was not considered; and third, special events (such as holidays) were ignored. Therefore, the overall optimality of the system was questionable (at best).

Our client agreed upon an extension of their approach at these points. So we started to develop a completely new and different system!

In developing our system, an important consideration was implementation in the local banks. Therefore we decided to use estimates by local cashiers and managers as the basis for our system: their

knowledge of demand and supply of cash at the branches seemed to be unmatched.

We distinguished two cases: (1) ultimately a shipment of money from DNB to the local bank must take place; (2) ultimately a shipment of money from the local bank to DNB must take place. Aside from the distribution of various denominations of bills, local banks almost always know into which category they fall.

In case 1, the question is not when to order (at the last possible time before the cashier runs out of cash), but how much to order. Denote the demand for money on day i as $M(i)$ (negative for an occasional net supply by customers) then the order quantity Q should be

$$Q = \sum_{i=1}^{t} M(i),$$

where t is the day of the next order. Then the total cost per day for the next t days is

$$TCPD(t) = \left[B + R \sum_{i=1}^{t} (i-1) * M(i) / t \right],$$

where B is the order cost and R is the holding cost per day (which is the interest rate/360). (Interest calculations generally use either 365 or 360; we used 360 because physical storage costs and insurance costs are not explicitly included in the formula.) Now t^*, such that $TCPD(t^*) = \min(TCPD(t))$, gives the number of days for which one shipment of money should be optimal.

Presenting this formula to the local banks would have been impossible, therefore we gave them a form on which they were guided through the calculations for $TCPD(t)$ for each value of t from one to 20.

In case 2, similar reasoning was followed. Here the problem is not how much to ship to DNB (almost all of the cash available), but how long to wait for the next shipment. A form similar to that for case 1 was developed.

These forms do not use an analytical formula to minimize $TCPD(t)$. Because $M(i)$ is not constant, $TCPD(t)$ may have several local minima. Since t must be integer and fairly small (usually < 10) it is simpler to calculate $TCPD$ for all reasonable values of t and pick the minimum.

Fairly soon, the local banks made it clear that they were not comfortable giving point-estimates of the volume of cash transactions. They started to build extra safety stocks to avoid the danger of running out of cash. Clearly, we needed to extend our system. So we allowed interval estimates for the volume of cash transactions at the local banks, mentioning that the estimated interval should contain the realization nine out of 10 times.

This, we assumed, resulted in a 90 percent confidence interval. Furthermore, we assumed that the distribution would be normal with its mean in the middle of the interval. From these assumptions and the supplied data, the variance can be calculated.

With these assumptions, it is a matter of straightforward calculus to derive the cumulative distribution of the volume of cash on each of the days considered. Then, the specification of an acceptable level of cash stockouts (for example, once a year) results in an acceptable level for the safety stock.

To calculate the safety stock, we developed an additional form to be used in

conjunction with the original form. With these forms, we supplied the local banks with a seven-page manual that described the terms used, the forms, their interaction, and their use.

Although the system works and we thought it was not too difficult, it is considered to be too cumbersome and laborious by most banks. Hence many banks do not use it.

It was a logical step to incorporate the forms into a computer program, which eliminates the need for local banks to monitor correspondence between the forms and do the calculations. The computer program does not do more than could be done using the forms, although it does so in a somewhat different manner. Its original coding consisted of 221 lines of FORTRAN, but it was reprogrammed for the microcomputers available (primarily for accounting purposes) at the local banks.

This program can be called up on an internal videotex system that gives access to the mainframes of Rabobank Nederland. Now the local banks only have to call the program and type the input. Then the computer responds with advice on the timing and amount of the first shipment of cash to take place.

What Happened

As a test, the original form and its extension to include the safety stock were supplied to six local banks with a total of 17 branches. From a mathematical point of view, the results were quite positive: in certain branches, savings of up to 50 percent were achieved, with an average savings of 15-20 percent of the original costs.

However, from an implementation point of view these forms were not successful. Usually, the first form was greeted with enthusiasm ("at last we have something"), which faded when the safety stock form appeared ("too complicated") and completely vanished after two or three uses ("too time-consuming").

Much more successfully implemented was the computerized version of the form. An initial test with six (other) local banks confirmed our feeling that this was the way to proceed. Fairly soon, the system was made available to 20 banks; nine months after inception, all local banks could use it.

> If Rabobank were to advise its member banks on upper and lower limits, the member banks would argue (rightly) that local conditions are of predominant importance . . .

One year later, we checked the use of the system and found that only 200 calls were made to it through the videotex system each month. Considering that 200 local banks have this system, that we advised using it every other day, and that there was much higher initial use, we found this low number quite surprising. We have come up with three probable explanations.

The first is that consultation via the videotex system costs money (for use of the telephone lines), whereas consultation on the accounting micros is free. Therefore, banks that have both tend to use the latter.

The second explanation is that savings of 15-20 percent are not considered

interesting enough by some local banks. They just don't want to take the trouble to use the system, since it saves them "only" a few thousand florins a year. Of course, over the entire Rabobank organization, these few thousand florins would add up to several million florins a year. But Rabobank Nederland has no way to force the local banks to take its advice.

A third explanation was observed frequently: after using the system several times, local banks with fairly stable streams of cash realized that the system always gave approximately the same advice. Having seen this, they started following this "general advice" without consulting the system (except maybe for special events or holidays). This way, they achieved some savings by using the system and still obtain those savings without using it any further.

Based on our tests, we estimate that overall savings of 15-20 percent of original costs (Dfl 45 million per year) are possible. Because of the small number of banks using the system, we estimate the total savings at Dfl 5 million a year, mainly due to a decrease in the average cash balance in the branches.

Acknowledgment

We gratefully acknowledge contributions by Mr. Guus Maas and Mr. Mat Knaapen in implementing the system.

References

Bell, P. C. and Noori, Hamed A. 1984, "Foreign currency inventory management in a branch bank," *Journal of the Operational Research Society*, Vol. 35, No. 6, pp. 513–525.

Girgis, N. M. 1968, "Optimal cash balance levels," *Management Science*, Vol. 15, No. 3, pp. 130–140.

Hausman, W. H. and Sanchez-Bell, A. 1975, "The stochastic cash balance problem with average compensating balance requirements," *Management Science*, Vol. 21, No. 8, pp. 849–857.

Heyman, D. P. 1973, "A model for cash balance management," *Management Science*, Vol. 19, No. 12, pp. 1407–1413.

An Inteview with the Authors

Chamberlain: *With all the calculations that must be made in a bank every day, what do you suppose causes one more set to be too many or too complicated?*

Peffer and Telgen: Although many calculations are made in a bank every day, very few of them are done manually. Most of those done manually are absolutely necessary for the daily process: for example, foreign currency calculations must be done immediately because a client is waiting. Cash management calculations are done by hand, but they are not essential; they can be postponed and are soon forgotten.

Another reason might be that the cash management problem seems so simple (everybody understands the problem). People think the solution must be simple too. They may feel that their ability to make judgment is questioned when they are asked to apply a set of calculation rules to obtain that solution.

C: *While use of the videotex system obviously costs money because it uses the telephone line, I do not agree that the use of the accounting micros is free: Did you assess the cost of the clerks' time needed to use your system? Might that cost exceed the savings in at least some cases?*

P and T: We agree that both systems cost money. The big difference is that every month there is a bill to be paid

for the videotex system (telephone lines), while there is no bill for the accounting micro. It makes a tremendous difference emotionally if (variable) costs are visible. A clerk is required by both systems, but usually cash management is something like a spare-time activity. This means that clerk's costs can be ignored. Also, it indicates the perceived importance of cash management.

C: *In the computerized versions of your system, do the clerks have to enter data that already exists elsewhere in the system? Or is it extracted more or less automatically from existing files? How many numbers are involved?*

P and T: Some information available in the micros is entered (current cash holdings); other available information is extracted (interest rates, order costs). For every run, three numbers of a general nature have to be entered, plus two numbers specific to the day considered (the estimated mean and the estimated margin of cash transactions). In the future, it might be possible to do some automatic forecasting of cash transactions based on information residing in the computer. However, we are very skeptical about the value of such an approach and certainly do not want to advocate it.

C: *Changing the subject — Does it feel like an implementation failure when you observe that the banks with stable cash-flow patterns only use the system once in a while? On reflection, do you think that is a failure?*

P and T: On the contrary, we believe our efforts are successful if the goal of the study is achieved. Since the goal was to save money with better cash management and not to implement a system, we were successful. It doesn't matter that the system is not implemented, it does matter that cash awareness has improved.

C: *Hear! Hear!*

C: *What have you learned from your experience? If you were to start over, what would you do differently?*

P and T: To start with, we learned from our experiences, but also from others' experiences.

The main lesson is that huge savings company-wide may be very small for a single local bank. We should have realized that no awareness of cash management exists in many banks, nor could it easily be evoked by savings of a "mere" Dfl 1,000 per year for the bank.

If we were to start over again, we would put even more emphasis on ease of use; instead of being an objective, it would be an indispensable condition. This would have prevented us from coming up with a seven-page manual. Also, we would have investigated the available technical possibilities sooner.

C: *In our correspondence, you told me the following anecdote about cash management in a Scottish bank:*

> After several unsuccessful attempts and years of struggling against high cash stocks in the branches, they found a means to cut the costs of stock at the branches that was both simple and effective: As part of the accounting process, branches report the amount of cash transactions and the overnight cash holdings to

the head office. Also at the head office, shipments of cash to and from the branches are recorded. As a result, the head office can calculate *ex post* the actual costs of cash management and the "optimal" cash management policy for every branch and the associated cost. Of course, in the "optimal" policy, uncertainty is ignored, but this is believed to affect all branches similarly.

Now, a measure of performance in cash management is given to each branch by dividing the actual costs by the "optimal" costs. This measure is calculated on a monthly basis for every branch and published in the internal magazine of the bank, where the branches are ranked according to their cash management measure!

The moral pressure exerted by this monthly publication has dramatically increased senior management involvement and reduced cash management costs at the expense of some tension in the branches.

C: *How do you think that approach to the problem of cash management awareness compares to the one taken by your sponsor? Could such a tactic be used by Rabobank Nederland? Do you think it would cause an increase in the use of your model?*

P and T: As stated before, awareness of cash management is much more important than the particular model used. The approach we described was certainly instrumental in increasing cash awareness. But generally banks are conservative organizations that are unlikely to adopt such novel management principles as internal competition. On top of that, Rabobank Nederland would have trouble convincing its member banks (or the branches) to take part in the competition and provide the necessary data. There is no way Rabobank Nederland can force its member banks to take part.

If, however, a competition were to come into existence, banks and branches would use all available means (including our model) to prevent being ranked at the bottom of the list.