# CASH AND LIQUIDITY MANAGEMENT

Most often, when news breaks about a firm's cash position, it's because the company is running low. That wasn't the case for many companies in 2006. For example, insurance company Cigna had a cash balance of $2.15 billion. Cigna had a market capitalization of $14.77 billion, so cash made up about 15 percent of the company's value. Other companies with large cash balances included IBM with $10.5 billion in cash, Pfizer with about $27.5 billion, and ExxonMobil with about $36 billion. Of course, no company came close to Microsoft, which at one point had $64 billion in cash on hand. Why would firms such as these hold such large quantities of cash? We examine cash management in this chapter to find out.

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**This chapter is about** how firms manage cash. The basic objective in cash management is to keep the investment in cash as low as possible while still keeping the firm operating efficiently and effectively. This goal usually reduces to the dictum "Collect early and pay late." Accordingly, we discuss ways of accelerating collections and managing disbursements.

In addition, firms must invest temporarily idle cash in short-term marketable securities. As we discuss in various places, these securities can be bought and sold in the financial markets. As a group, they have very little default risk, and most are highly marketable. There are different types of these so-called money market securities, and we discuss a few of the most important ones.

## 20.1 Reasons for Holding Cash

John Maynard Keynes, in his classic work *The General Theory of Employment, Interest, and Money,* identified three motives for liquidity: the speculative motive, the precautionary motive, and the transaction motive. We discuss these next.

### THE SPECULATIVE AND PRECAUTIONARY MOTIVES

**speculative motive**
The need to hold cash to take advantage of additional investment opportunities, such as bargain purchases.

The **speculative motive** is the need to hold cash in order to be able to take advantage of, for example, bargain purchases that might arise, attractive interest rates, and (in the case of international firms) favorable exchange rate fluctuations.

For most firms, reserve borrowing ability and marketable securities can be used to satisfy speculative motives. Thus, there might be a speculative motive for maintaining liquidity, but not necessarily for holding cash per se. Think of it this way: If you have a credit card with a very large credit limit, then you can probably take advantage of any unusual bargains that come along without carrying any cash.

**precautionary motive**
The need to hold cash as a safety margin to act as a financial reserve.

This is also true, to a lesser extent, for precautionary motives. The **precautionary motive** is the need for a safety supply to act as a financial reserve. Once again, there probably is a precautionary motive for maintaining liquidity. However, given that the value of money market instruments is relatively certain and that instruments such as T-bills are extremely liquid, there is no real need to hold substantial amounts of cash for precautionary purposes.

### THE TRANSACTION MOTIVE

Cash is needed to satisfy the **transaction motive**: the need to have cash on hand to pay bills. Transaction-related needs come from the normal disbursement and collection activities of the firm. The disbursement of cash includes the payment of wages and salaries, trade debts, taxes, and dividends.

Cash is collected from product sales, the selling of assets, and new financing. The cash inflows (collections) and outflows (disbursements) are not perfectly synchronized, and some level of cash holdings is necessary to serve as a buffer.

As electronic funds transfers and other high-speed, "paperless" payment mechanisms continue to develop, even the transaction demand for cash may all but disappear. Even if it does, however, there will still be a demand for liquidity and a need to manage it efficiently.

**transaction motive**
The need to hold cash to satisfy normal disbursement and collection activities associated with a firm's ongoing operations.

### COMPENSATING BALANCES

Compensating balances are another reason to hold cash. As we discussed in the previous chapter, cash balances are kept at commercial banks to compensate for banking services the firm receives. A minimum compensating balance requirement may impose a lower limit on the level of cash a firm holds.

### COSTS OF HOLDING CASH

When a firm holds cash in excess of some necessary minimum, it incurs an opportunity cost. The opportunity cost of excess cash (held in currency or bank deposits) is the interest income that could be earned in the next best use, such as investment in marketable securities.

Given the opportunity cost of holding cash, why would a firm hold cash in excess of its compensating balance requirements? The answer is that a cash balance must be maintained to provide the liquidity necessary for transaction needs—paying bills. If the firm maintains too small a cash balance, it may run out of cash. If this happens, the firm may have to raise cash on a short-term basis. This could involve, for example, selling marketable securities or borrowing.

Activities such as selling marketable securities and borrowing involve various costs. As we've discussed, holding cash has an opportunity cost. To determine the appropriate cash balance, the firm must weigh the benefits of holding cash against these costs. We discuss this subject in more detail in the sections that follow.

### CASH MANAGEMENT VERSUS LIQUIDITY MANAGEMENT

Before we move on, we should note that it is important to distinguish between true cash management and a more general subject, liquidity management. The distinction is a source of confusion because the word *cash* is used in practice in two different ways. First of all, it has its literal meaning: actual cash on hand. However, financial managers frequently use the word to describe a firm's holdings of cash along with its marketable securities, and marketable securities are sometimes called *cash equivalents* or *near-cash*. In our discussion of Microsoft's and Cigna's cash positions at the beginning of the chapter, for example, what was actually being described was their total cash and cash equivalents.

The distinction between liquidity management and cash management is straightforward. Liquidity management concerns the optimal quantity of liquid assets a firm should have on hand, and it is one particular aspect of the current asset management policies we discussed in our previous chapter. Cash management is much more closely related to optimizing mechanisms for collecting and disbursing cash, and it is this subject that we primarily focus on in this chapter.

> **Concept Questions**
>
> **20.1a** What is the transaction motive, and how does it lead firms to hold cash?
> **20.1b** What is the cost to the firm of holding excess cash?

## Understanding Float

**20.2**

As you no doubt know, the amount of money you have according to your checkbook can be very different from the amount of money that your bank thinks you have. The reason is that some of the checks you have written haven't yet been presented to the bank for payment. The same thing is true for a business. The cash balance that a firm shows on its books is called the firm's *book,* or *ledger, balance*. The balance shown in its bank account as available to spend is called its *available,* or *collected, balance*. The difference between the available balance and the ledger balance, called the **float**, represents the net effect of checks in the process of *clearing* (moving through the banking system).

### DISBURSEMENT FLOAT

Checks written by a firm generate *disbursement float,* causing a decrease in the firm's book balance but no change in its available balance. For example, suppose General Mechanics, Inc. (GMI), currently has $100,000 on deposit with its bank. On June 8, it buys some raw materials and pays with a check for $100,000. The company's book balance is immediately reduced by $100,000 as a result.

GMI's bank, however, will not find out about this check until it is presented to GMI's bank for payment on, say, June 14. Until the check is presented, the firm's available balance is greater than its book balance by $100,000. In other words, before June 8, GMI has

**float**
The difference between book cash and bank cash, representing the net effect of checks in the process of clearing.

a zero float:

$$\text{Float} = \text{Firm's available balance} - \text{Firm's book balance}$$
$$= \$100{,}000 - 100{,}000$$
$$= \$0$$

GMI's position from June 8 to June 14 is:

$$\text{Disbursement float} = \text{Firm's available balance} - \text{Firm's book balance}$$
$$= \$100{,}000 - 0$$
$$= \$100{,}000$$

While the check is clearing, GMI has a balance with the bank of $100,000. It can obtain the benefit of this cash during this period. For example, the available balance could be temporarily invested in marketable securities and thus earn some interest. We will return to this subject a little later.

## COLLECTION FLOAT AND NET FLOAT

Checks received by the firm create *collection float.* Collection float increases book balances but does not immediately change available balances. For example, suppose GMI receives a check from a customer for $100,000 on October 8. Assume, as before, that the company has $100,000 deposited at its bank and a zero float. It deposits the check and increases its book balance by $100,000 to $200,000. However, the additional cash is not available to GMI until its bank has presented the check to the customer's bank and received $100,000. This will occur on, say, October 14. In the meantime, the cash position at GMI will reflect a collection float of $100,000. We can summarize these events. Before October 8, GMI's position is:

$$\text{Float} = \text{Firm's available balance} - \text{Firm's book balance}$$
$$= \$100{,}000 - 100{,}000$$
$$= \$0$$

GMI's position from October 8 to October 14 is:

$$\text{Collection float} = \text{Firm's available balance} - \text{Firm's book balance}$$
$$= \$100{,}000 - 200{,}000$$
$$= -\$100{,}000$$

In general, a firm's payment (disbursement) activities generate disbursement float, and its collection activities generate collection float. The net effect—that is, the sum of the total collection and disbursement floats—is the net float. The net float at a point in time is simply the overall difference between the firm's available balance and its book balance. If the net float is positive, then the firm's disbursement float exceeds its collection float, and its available balance exceeds its book balance. If the available balance is less than the book balance, then the firm has a net collection float.

A firm should be concerned with its net float and available balance more than with its book balance. If a financial manager knows that a check written by the company will not clear for several days, that manager will be able to keep a lower cash balance at the bank than might be possible otherwise. This can generate a great deal of money.

For example, take the case of ExxonMobil. The average daily sales of ExxonMobil are about $1 billion. If ExxonMobil's collections could be sped up by a single day, then ExxonMobil could free up $1 billion for investing. At a relatively modest .01 percent daily rate, the interest earned would be on the order of $100,000 *per day.*

| **Staying Afloat** | **EXAMPLE  20.1** |
|---|---|

Suppose you have $5,000 on deposit. One day, you write a check for $1,000 to pay for books, and you deposit $2,000. What are your disbursement, collection, and net floats?

After you write the $1,000 check, you show a balance of $4,000 on your books, but the bank shows $5,000 while the check is clearing. The difference is a disbursement float of $1,000.

After you deposit the $2,000 check, you show a balance of $6,000. Your available balance doesn't rise until the check clears. This results in a collection float of −$2,000. Your net float is the sum of the collection and disbursement floats, or −$1,000.

Overall, you show $6,000 on your books. The bank shows a $7,000 balance, but only $5,000 is available because your deposit has not been cleared. The discrepancy between your available balance and your book balance is the net float (−$1,000), and it is bad for you. If you write another check for $5,500, there may not be sufficient available funds to cover it, and it might bounce. This is why financial managers have to be more concerned with available balances than book balances.

## FLOAT MANAGEMENT

Float management involves controlling the collection and disbursement of cash. The objective in cash collection is to speed up collections and reduce the lag between the time customers pay their bills and the time the cash becomes available. The objective in cash disbursement is to control payments and minimize the firm's costs associated with making payments.

*For a real-world example of float management services, visit* www.carreker.com.

Total collection or disbursement times can be broken down into three parts: mailing time, processing delay, and availability delay:

1. *Mailing time* is the part of the collection and disbursement process during which checks are trapped in the postal system.
2. *Processing delay* is the time it takes the receiver of a check to process the payment and deposit it in a bank for collection.
3. *Availability delay* refers to the time required to clear a check through the banking system.

Speeding up collections involves reducing one or more of these components. Slowing up disbursements involves increasing one of them. We will describe some procedures for managing collection and disbursement times later. First, we need to discuss how float is measured.

**Measuring Float**   The size of the float depends on both the dollars and the time delay involved. For example, suppose you mail a check for $500 to another state each month. It takes five days in the mail for the check to reach its destination (the mailing time) and one day for the recipient to get over to the bank (the processing delay). The recipient's bank holds out-of-state checks for three days (availability delay). The total delay is $5 + 1 + 3 = 9$ days.

In this case, what is your average daily disbursement float? There are two equivalent ways of calculating the answer. First, you have a $500 float for nine days, so we say that the total float is $9 \times \$500 = \$4,500$. Assuming 30 days in the month, the average daily float is $\$4,500/30 = \$150$.

Alternatively, your disbursement float is $500 for 9 days out of the month and zero the other 21 days (again assuming 30 days in a month). Your average daily float is thus:

$$
\begin{aligned}
\text{Average daily float} &= (9 \times \$500 + 21 \times 0)/30 \\
&= 9/30 \times \$500 + 21/30 \times 0 \\
&= \$4,500/30 \\
&= \$150
\end{aligned}
$$

This means that, on an average day, your book balance is $150 less than your available balance, representing a $150 average disbursement float.

Things are only a little more complicated when there are multiple disbursements or receipts. To illustrate, suppose Concepts, Inc., receives two items each month as follows:

| Amount | Processing and availability delay | Total float |
|---|---|---|
| Item 1: $5,000,000 | × 9 | = $45,000,000 |
| Item 2: $3,000,000 | × 5 | = $15,000,000 |
| Total $8,000,000 | | $60,000,000 |

The average daily float is equal to:

$$\text{Average daily float} = \frac{\text{Total float}}{\text{Total days}} \qquad [20.1]$$

$$= \frac{\$60 \text{ million}}{30} = \$2 \text{ million}$$

So, on an average day, there is $2 million that is uncollected and not available.

Another way to see this is to calculate the average daily receipts and multiply by the weighted average delay. Average daily receipts are:

$$\text{Average daily receipts} = \frac{\text{Total receipts}}{\text{Total days}} = \frac{\$8 \text{ million}}{30} = \$266,666.67$$

Of the $8 million total receipts, $5 million, or 5/8 of the total, is delayed for nine days. The other 3/8 is delayed for five days. The weighted average delay is thus:

$$\text{Weighted average delay} = (5/8) \times 9 \text{ days} + (3/8) \times 5 \text{ days}$$
$$= 5.625 + 1.875 = 7.50 \text{ days}$$

The average daily float is thus:

$$\text{Average daily float} = \text{Average daily receipts} \times \text{Weighted average delay} \qquad [20.2]$$
$$= \$266,666.67 \times 7.50 \text{ days} = \$2 \text{ million}$$

**Some Details**   In measuring float, there is an important difference to note between collection and disbursement float. We defined *float* as the difference between the firm's available cash balance and its book balance. With a disbursement, the firm's book balance goes down when the check is *mailed,* so the mailing time is an important component in disbursement float. However, with a collection, the firm's book balance isn't increased until the check is *received,* so mailing time is not a component of collection float.

This doesn't mean that mailing time is not important. The point is that when collection *float* is calculated, mailing time should not be considered. As we will discuss, when total collection *time* is considered, the mailing time is a crucial component.

Also, when we talk about availability delay, how long it actually takes a check to clear isn't really crucial. What matters is how long we must wait before the bank grants availability—that is, use of the funds. Banks actually use availability schedules to determine how long a check is held based on time of deposit and other factors. Beyond this, availability delay can be a matter of negotiation between the bank and a customer. In a similar vein, for outgoing checks, what matters is the date our account is debited, not when the recipient is granted availability.

**Cost of the Float**   The basic cost of collection float to the firm is simply the opportunity cost of not being able to use the cash. At a minimum, the firm could earn interest on the cash if it were available for investing.

| | | | Day | | | |
|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | . . . |
| Beginning float | $    0 | $1,000 | $2,000 | $3,000 | $3,000 | . . . |
| Checks received | 1,000 | 1,000 | 1,000 | 1,000 | 1,000 | . . . |
| Checks cleared (cash available) | −    0 | −    0 | −    0 | − 1,000 | − 1,000 | . . . |
| Ending float | $1,000 | $2,000 | $3,000 | $3,000 | $3,000 | . . . |

| | | Day | | |
|---|---|---|---|---|
| | $t$ | $t + 1$ | $t + 2$ | . . . |
| Beginning float | $3,000 | $    0 | $    0 | . . . |
| Checks received | 1,000 | 1,000 | 1,000 | . . . |
| Checks cleared (cash available) | − 4,000 | − 1,000 | − 1,000 | . . . |
| Ending float | $    0 | $    0 | $    0 | . . . |

Suppose the Lambo Corporation has average daily receipts of $1,000 and a weighted average delay of three days. The average daily float is thus 3 × $1,000 = $3,000. This means that, on a typical day, there is $3,000 that is not earning interest. Suppose Lambo could eliminate the float entirely. What would be the benefit? If it costs $2,000 to eliminate the float, what is the NPV of doing so?

Figure 20.1 illustrates the situation for Lambo. Suppose Lambo starts with a zero float. On a given day, Day 1, Lambo receives and deposits a check for $1,000. The cash will become available three days later on Day 4. At the end of the day on Day 1, the book balance is $1,000 more than the available balance, so the float is $1,000. On Day 2, the firm receives and deposits another check. It will collect three days later on Day 5. At the end of Day 2, there are two uncollected checks, and the books show a $2,000 balance. The bank, however, still shows a zero available balance; so the float is $2,000. The same sequence occurs on Day 3, and the float rises to a total of $3,000.

On Day 4, Lambo again receives and deposits a check for $1,000. However, it also collects $1,000 from the Day 1 check. The change in book balance and the change in available balance are identical, +$1,000; so the float stays at $3,000. The same thing happens every day after Day 4; the float therefore stays at $3,000 forever.[1]

Figure 20.2 illustrates what happens if the float is eliminated entirely on some day $t$ in the future. After the float is eliminated, daily receipts are still $1,000. The firm collects the same day because the float is eliminated, so daily collections are also still $1,000. As Figure 20.2 illustrates, the only change occurs the first day. On that day, as usual, Lambo collects $1,000 from the sale made three days before. Because the float is gone, it also collects on the sales made two days before, one day before, and that same day, for an additional $3,000. Total collections on Day $t$ are thus $4,000 instead of $1,000.

What we see is that Lambo generates an extra $3,000 on Day $t$ by eliminating the float. On every subsequent day, Lambo receives $1,000 in cash just as it did before the float was eliminated. Thus, the only change in the firm's cash flows from eliminating the float is this extra $3,000 that comes in immediately. No other cash flows are affected, so Lambo is $3,000 richer.

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[1]This permanent float is sometimes called the *steady-state float.*

In other words, the PV of eliminating the float is simply equal to the total float. Lambo could pay this amount out as a dividend, invest it in interest-bearing assets, or do anything else with it. If it costs $2,000 to eliminate the float, then the NPV is $3,000 − 2,000 = $1,000; so Lambo should do it.

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**EXAMPLE 20.2**    **Reducing the Float: Part I**

Instead of eliminating the float, suppose Lambo can reduce it to one day. What is the maximum Lambo should be willing to pay for this?

If Lambo can reduce the float from three days to one day, then the amount of the float will fall from $3,000 to $1,000. From our discussion immediately preceding, we see right away that the PV of doing this is just equal to the $2,000 float reduction. Lambo should thus be willing to pay up to $2,000.

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**EXAMPLE 20.3**    **Reducing the Float: Part II**

Look back at Example 20.2. A large bank is willing to provide the float reduction service for $175 per year, payable at the end of each year. The relevant discount rate is 8 percent. Should Lambo hire the bank? What is the NPV of the investment? How do you interpret this discount rate? What is the most per year that Lambo should be willing to pay?

The PV to Lambo is still $2,000. The $175 would have to be paid out every year forever to maintain the float reduction; so the cost is perpetual, and its PV is $175/.08 = $2,187.50. The NPV is $2,000 − 2,187.50 = −$187.50; therefore, the service is not a good deal.

Ignoring the possibility of bounced checks, the discount rate here corresponds most closely to the cost of short-term borrowing. The reason is that Lambo could borrow $1,000 from the bank every time a check was deposited and pay it back three days later. The cost would be the interest that Lambo would have to pay.

The most Lambo would be willing to pay is whatever charge results in an NPV of zero. This zero NPV occurs when the $2,000 benefit exactly equals the PV of the costs—that is, when $2,000 = C/.08, where C is the annual cost. Solving for C, we find that C = .08 × $2,000 = $160 per year.

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**Ethical and Legal Questions**    The cash manager must work with collected bank cash balances and not the firm's book balance (which reflects checks that have been deposited but not collected). If this is not done, a cash manager could be drawing on uncollected cash as a source of funds for short-term investing. Most banks charge a penalty rate for the use of uncollected funds. However, banks may not have good enough accounting and control procedures to be fully aware of the use of uncollected funds. This raises some ethical and legal questions for the firm.

For example, in May 1985, Robert Fomon, chairman of E.F. Hutton (a large investment bank), pleaded guilty to 2,000 charges of mail and wire fraud in connection with a scheme the firm had operated from 1980 to 1982. E.F. Hutton employees had written checks totaling hundreds of millions of dollars against uncollected cash. The proceeds had then been invested in short-term money market assets. This type of systematic overdrafting of accounts (or check *kiting,* as it is sometimes called) is neither legal nor ethical and is apparently not a widespread practice among corporations. Also, the particular inefficiencies in the banking system that Hutton was exploiting have been largely eliminated.

For its part, E.F. Hutton paid a $2 million fine, reimbursed the government (the U.S. Department of Justice) $750,000, and reserved an additional $8 million for restitution to defrauded banks. We should note that the key issue in the case against Hutton was not its float management per se, but, rather, its practice of writing checks for no economic reason other than to exploit float.

Despite the stiff penalties for check kiting, the practice apparently continues. For example, in June 2006, Baltimore County Savings Bank revealed losses totaling $6.9 million as the result of check kiting.

### ELECTRONIC DATA INTERCHANGE AND CHECK 21: THE END OF FLOAT?

*Electronic data interchange (EDI)* is a general term that refers to the growing practice of direct, electronic information exchange between all types of businesses. One important use of EDI, often called *financial EDI* or *FEDI,* is to electronically transfer financial information and funds between parties, thereby eliminating paper invoices, paper checks, mailing, and handling. For example, it is now possible to arrange to have your checking account directly debited each month to pay many types of bills, and corporations now routinely directly deposit paychecks into employee accounts. More generally, EDI allows a seller to send a bill electronically to a buyer, thereby avoiding the mail. The seller can then authorize payment, which also occurs electronically. Its bank then transfers the funds to the seller's account at a different bank. The net effect is that the length of time required to initiate and complete a business transaction is shortened considerably, and much of what we normally think of as float is sharply reduced or eliminated. As the use of FEDI increases (which it will), float management will evolve to focus much more on issues surrounding computerized information exchange and funds transfers.

One of the drawbacks of EDI (and FEDI) is that it is expensive and complex to set up. However, with the growth of the Internet, a new form of EDI has emerged: Internet e-commerce. For example, networking giant Cisco Systems books about $13 million in orders each day on its Web site from resellers around the world. Cisco estimates that it saved $2.1 billion in technical support, marketing, distribution, and working capital management costs in 2003 by exploiting the Web. Firms are also linking to critical suppliers and customers via "extranets," which are business networks that extend a company's internal network. Because of security concerns and lack of standardization, don't look for e-commerce and extranets to eliminate the need for EDI anytime soon. In fact, these are complementary systems that will most likely be used in tandem as the future unfolds.

On October 29, 2004, the Check Clearing Act for the 21st Century, also known as Check 21, took effect. Before Check 21, a bank receiving a check was required to send the physical check to the customer's bank before payment could be made. Now a bank can transmit an electronic image of the check to the customer's bank and receive payment immediately. Previously, an out-of-state check might take three days to clear. But with Check 21, the clearing time is typically one day; and often a check can clear the same day it is written. Thus, Check 21 promises to significantly reduce float.

### Concept Questions

**20.2a** Which would a firm be most interested in reducing, collection or disbursement float? Why?

**20.2b** How is daily average float calculated?

**20.2c** What is the benefit from reducing or eliminating float?

## 20.3 Cash Collection and Concentration

From our previous discussion, we know that collection delays work against the firm. All other things being the same, then, a firm will adopt procedures to speed up collections and thereby decrease collection times. In addition, even after cash is collected, firms need procedures to funnel, or concentrate, that cash where it can be best used. We discuss some common collection and concentration procedures next.

### COMPONENTS OF COLLECTION TIME

Based on our previous discussion, we can depict the basic parts of the cash collection process as follows. The total time in this process is made up of mailing time, check-processing delay, and the bank's availability delay.
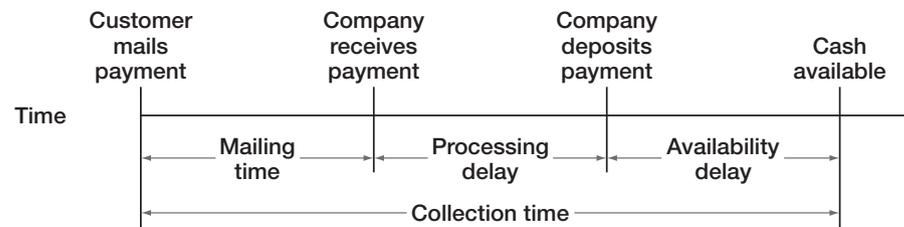


The amount of time that cash spends in each part of the cash collection process depends on where the firm's customers and banks are located and how efficient the firm is in collecting cash.

### CASH COLLECTION

How a firm collects from its customers depends in large part on the nature of the business. The simplest case would be a business such as a restaurant chain. Most of its customers will pay with cash, check, or credit card at the point of sale (this is called *over-the-counter collection*), so there is no problem with mailing delay. Normally, the funds will be deposited in a local bank, and the firm will have some means (discussed later) of gaining access to the funds.

When some or all of the payments a company receives are checks that arrive through the mail, all three components of collection time become relevant. The firm may choose to have all the checks mailed to one location; more commonly, the firm might have a number of different mail collection points to reduce mailing times. Also, the firm may run its collection operation itself or might hire an outside firm that specializes in cash collection. We discuss these issues in more detail in the following pages.

Other approaches to cash collection exist. One that is becoming more common is the preauthorized payment arrangement. With this arrangement, the payment amounts and payment dates are fixed in advance. When the agreed-upon date arrives, the amount is automatically transferred from the customer's bank account to the firm's bank account, which sharply reduces or even eliminates collection delays. The same approach is used by firms that have online terminals, meaning that when a sale is rung up, the money is immediately transferred to the firm's accounts.

### LOCKBOXES

**lockboxes**
Special post office boxes set up to intercept and speed up accounts receivable payments.

When a firm receives its payments by mail, it must decide where the checks will be mailed and how the checks will be picked up and deposited. Careful selection of the number and locations of collection points can greatly reduce collection times. Many firms use special post office boxes called **lockboxes** to intercept payments and speed cash collection.

The flow starts when a corporate customer mails remittances to a post office box
instead of to the corporation. Several times a day the bank collects the lockbox
receipts from the post office. The checks are then put into the company bank
accounts.

Figure 20.3 illustrates a lockbox system. The collection process is started by customers'
mailing their checks to a post office box instead of sending them to the firm. The lock-
box is maintained by a local bank. A large corporation may actually maintain more than
20 lockboxes around the country.

In the typical lockbox system, the local bank collects the lockbox checks several times
a day. The bank deposits the checks directly to the firm's account. Details of the operation
are recorded (in some computer-usable form) and sent to the firm.

A lockbox system reduces mailing time because checks are received at a nearby
post office instead of at corporate headquarters. Lockboxes also reduce the processing
time because the corporation doesn't have to open the envelopes and deposit checks for
collection. In all, a bank lockbox system should enable a firm to get its receipts processed,
deposited, and cleared faster than if it were to receive checks at its headquarters and deliver
them itself to the bank for deposit and clearing.

Some firms have turned to what are called "electronic lockboxes" as an alternative to
traditional lockboxes. In one version of an electronic lockbox, customers use the telephone
or the Internet to access their account—say, their credit card account at a bank—review
their bill, and authorize payment without paper ever having changed hands on either end of
the transaction. Clearly, an electronic lockbox system is far superior to traditional bill pay-
ment methods, at least from the biller's perspective. Look for systems like this to continue
to grow in popularity.

## CASH CONCENTRATION

**cash concentration**
The practice of and procedures for moving cash from multiple banks into the firm's main accounts.

As we discussed earlier, a firm will typically have a number of cash collection points; as a result, cash collections may end up in many different banks and bank accounts. From here, the firm needs procedures to move the cash into its main accounts. This is called **cash concentration**. By routinely pooling its cash, the firm greatly simplifies its cash management by reducing the number of accounts that must be tracked. Also, by having a larger pool of funds available, a firm may be able to negotiate or otherwise obtain a better rate on any short-term investments.

In setting up a concentration system, firms will typically use one or more *concentration banks*. A concentration bank pools the funds obtained from local banks contained within some geographic region. Concentration systems are often used in conjunction with lockbox systems. Figure 20.4 illustrates how an integrated cash collection and cash concentration system might look. As Figure 20.4 illustrates, a key part of the cash collection and concentration process is the transfer of funds to the concentration bank. There are several options available for accomplishing this transfer. The cheapest is a *depository transfer check (DTC),* which is a preprinted check that usually needs no signature and is valid only for transferring funds between specific accounts within the *same* firm. The money becomes available one to two days later. *Automated clearinghouse (ACH)* transfers are basically electronic versions of paper checks. These may be more expensive, depending

**FIGURE 20.4**

Lockboxes and Concentration Banks in a Cash Management System
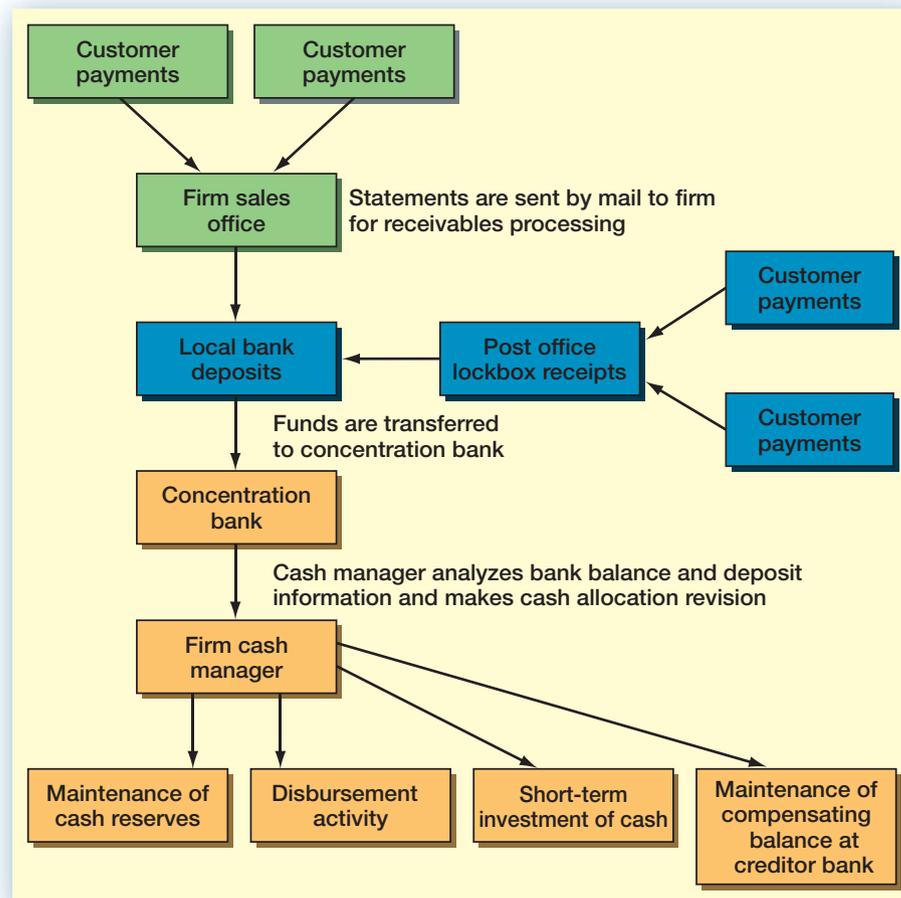
on the circumstances, but the funds are available the next day. The most expensive means of transfer are *wire transfers,* which provide same-day availability. Which approach a firm will choose depends on the number and size of payments. For example, a typical ACH transfer might be $200, whereas a typical wire transfer would be several million dollars. Firms with a large number of collection points and relatively small payments will choose the cheaper route, whereas firms that receive smaller numbers of relatively large payments may choose more expensive procedures.

*Global Treasury News has current info about cash management, especially for international issues.* (www.gtnews.com)

## ACCELERATING COLLECTIONS: AN EXAMPLE

The decision of whether or not to use a bank cash management service incorporating lockboxes and concentration banks depends on where a firm's customers are located and the speed of the U.S. postal system. Suppose Atlantic Corporation, located in Philadelphia, is considering a lockbox system. Its collection delay is currently eight days.

Atlantic does business in the southwestern part of the country (New Mexico, Arizona, and California). The proposed lockbox system would be located in Los Angeles and operated by Pacific Bank. Pacific Bank has analyzed Atlantic's cash-gathering system and has concluded that it can decrease collection time by two days. Specifically, the bank has come up with the following information on the proposed lockbox system:

Reduction in mailing time          = 1.0 day
Reduction in clearing time         =  .5 day
Reduction in firm processing time  =  .5 day
                          Total = 2.0 days

The following is also known:

Daily interest on Treasury bills                   = .025%
Average number of daily payments to lockboxes = 2,000
Average size of payment                            = $600

The cash flows for the current collection operation are shown in the following cash flow time chart:
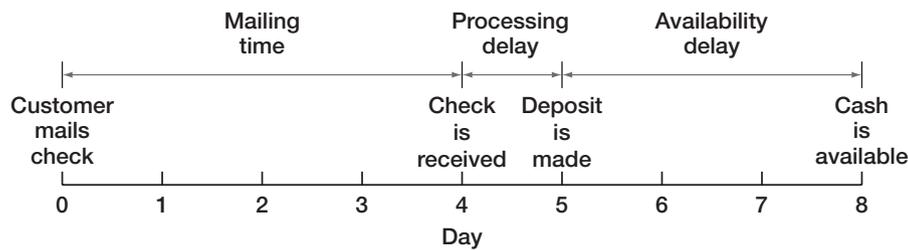


The cash flows for the lockbox collection operation will be as follows:
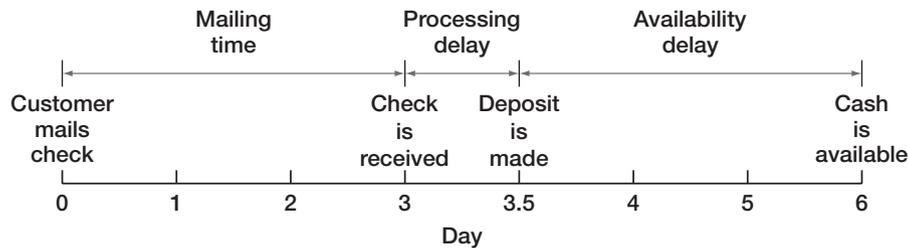
The Pacific Bank has agreed to operate this lockbox system for a fee of 25 cents per check processed. Should Atlantic give the go-ahead?

We first need to determine the benefit of the system. The average daily collections from the southwestern region are $1.2 million (2,000 × $600). The collection time will be decreased by two days, so the lockbox system will increase the collected bank balance by $1.2 million × 2 = $2.4 million. In other words, the lockbox system releases $2.4 million to the firm by reducing processing, mailing, and clearing time by two days. From our earlier discussion, we know that this $2.4 million is the PV of the proposal.

To calculate the NPV, we need to determine the PV of the costs. There are several different ways to proceed. First, at 2,000 checks per day and $.25 per check, the daily cost is $500. This cost will be incurred every day forever. At an interest rate of .025 percent per day, the PV is therefore $500/.00025 = $2 million. The NPV is thus $2.4 million − 2 million = $400,000, and the system appears to be desirable.

Alternatively, Atlantic could invest the $2.4 million at .025 percent per day. The interest earned would be $2.4 million × .00025 = $600 per day. The cost of the system is $500 per day; so, running it obviously generates a profit in the amount of $100 per day. The PV of $100 per day forever is $100/.00025 = $400,000, just as we had before.

Finally, and most simply, each check is for $600 and is available two days sooner if the system is used. The interest on $600 for two days is 2 × $600 × .00025 = $.30. The cost is 25 cents per check, so Atlantic makes a nickel ($.30 − .25) on every check. With 2,000 checks per day, the profit is $.05 × 2,000 checks = $100 per day, as we calculated.

| EXAMPLE 20.4 | **Accelerating Collections** |
|---|---|

In our example concerning the Atlantic Corporation's proposed lockbox system, suppose the Pacific Bank wants a $20,000 fixed fee (paid annually) in addition to the 25 cents per check. Is the system still a good idea?

To answer, we need to calculate the PV of the fixed fee. The daily interest rate is .025 percent. The annual rate is therefore $1.00025^{365} - 1 = 9.553\%$. The PV of the fixed fee (which is paid each year forever) is $20,000/.09553 = $209,358. Because the NPV without the fee is $400,000, the NPV with the fee is $400,000 − 209,358 = $190,642. It's still a good idea.

---

**Concept Questions**

**20.3a**  What is a lockbox? What purpose does it serve?

**20.3b**  What is a concentration bank? What purpose does it serve?

---

## 20.4 Managing Cash Disbursements

From the firm's point of view, disbursement float is desirable, so the goal in managing disbursement float is to slow down disbursements. To do this, the firm may develop strategies to *increase* mail float, processing float, and availability float on the checks it writes. Beyond this, firms have developed procedures for minimizing cash held for payment purposes. We discuss the most common of these in this section.

*For a free cash budgeting spreadsheet, go to* www.toolkit.cch.com/tools/tools.asp.

### INCREASING DISBURSEMENT FLOAT

As we have seen, slowing down payments comes from the time involved in mail delivery, check processing, and collection of funds. Disbursement float can be increased by writing

a check on a geographically distant bank. For example, a New York supplier might be paid with checks drawn on a Los Angeles bank. This will increase the time required for the checks to clear through the banking system. Mailing checks from remote post offices is another way firms slow down disbursement.

Tactics for maximizing disbursement float are debatable on both ethical and economic grounds. First, as we discuss in some detail in the next chapter, payment terms frequently offer a substantial discount for early payment. The discount is usually much larger than any possible savings from "playing the float game." In such cases, increasing mailing time will be of no benefit if the recipient dates payments based on the date received (as is common) as opposed to the postmark date.

Beyond this, suppliers are not likely to be fooled by attempts to slow down disbursements. The negative consequences of poor relations with suppliers can be costly. In broader terms, intentionally delaying payments by taking advantage of mailing times or unsophisticated suppliers may amount to avoiding paying bills when they are due—an unethical business procedure.

## CONTROLLING DISBURSEMENTS

We have seen that maximizing disbursement float is probably poor business practice. However, a firm will still wish to tie up as little cash as possible in disbursements. Firms have therefore developed systems for efficiently managing the disbursement process. The general idea in such systems is to have no more than the minimum amount necessary to pay bills on deposit in the bank. We discuss some approaches to accomplishing this goal next.

**Zero-Balance Accounts**   With a **zero-balance account** system, the firm, in cooperation with its bank, maintains a master account and a set of subaccounts. When a check written on one of the subaccounts must be paid, the necessary funds are transferred in from the master account. Figure 20.5 illustrates how such a system might work. In this case, the firm maintains two disbursement accounts, one for suppliers and one for payroll. As shown, if the firm does not use zero-balance accounts, then each of these accounts must have a safety stock of cash to meet unanticipated demands. If the firm does use zero-balance accounts, then it can keep one safety stock in a master account and transfer the funds to the two subsidiary accounts as needed. The key is that the total amount of cash held as a buffer is smaller under the zero-balance arrangement, which frees up cash to be used elsewhere.

**zero-balance account**
A disbursement account in which the firm maintains a zero balance, transferring funds in from a master account only as needed to cover checks presented for payment.

**FIGURE 20.5**   Zero-Balance Accounts



**No zero-balance accounts**

Payroll account     Supplier account

Safety stocks

**Two zero-balance accounts**

Master account

Safety stock

Cash transfers     Cash transfers

Payroll account     Supplier account

With no zero-balance accounts, separate safety stocks must be maintained, which ties up cash unnecessarily. With zero-balance accounts, the firm keeps a single safety stock of cash in a master account. Funds are transferred into disbursement accounts as needed.

**controlled disbursement account**
A disbursement account to which the firm transfers an amount that is sufficient to cover demands for payment.

**Controlled Disbursement Accounts**   With a **controlled disbursement account** system, almost all payments that must be made in a given day are known in the morning. The bank informs the firm of the total, and the firm transfers (usually by wire) the amount needed.

> **Concept Questions**
>
> **20.4a**  Is maximizing disbursement float a sound business practice?
>
> **20.4b**  What is a zero-balance account? What is the advantage of such an account?

## 20.5 Investing Idle Cash

If a firm has a temporary cash surplus, it can invest in short-term securities. As we have mentioned at various times, the market for short-term financial assets is called the *money market*. The maturity of short-term financial assets that trade in the money market is one year or less.

Most large firms manage their own short-term financial assets, carrying out transactions through banks and dealers. Some large firms and many small firms use money market mutual funds. These are funds that invest in short-term financial assets for a management fee. The management fee is compensation for the professional expertise and diversification provided by the fund manager.

Among the many money market mutual funds, some specialize in corporate customers. In addition, banks offer arrangements in which the bank takes all excess available funds at the close of each business day and invests them for the firm.

### TEMPORARY CASH SURPLUSES

Firms have temporary cash surpluses for various reasons. Two of the most important are the financing of seasonal or cyclical activities of the firm and the financing of planned or possible expenditures.

**Seasonal or Cyclical Activities**   Some firms have a predictable cash flow pattern. They have surplus cash flows during part of the year and deficit cash flows the rest of the year. For example, Toys "Я" Us, a retail toy firm, has a seasonal cash flow pattern influenced by the holiday season.

A firm such as Toys "Я" Us may buy marketable securities when surplus cash flows occur and sell marketable securities when deficits occur. Of course, bank loans are another short-term financing device. The use of bank loans and marketable securities to meet temporary financing needs is illustrated in Figure 20.6. In this case, the firm is following a compromise working capital policy in the sense we discussed in the previous chapter.

**Planned or Possible Expenditures**   Firms frequently accumulate temporary investments in marketable securities to provide the cash for a plant construction program, dividend payment, or other large expenditure. Thus, firms may issue bonds and stocks before the cash is needed, investing the proceeds in short-term marketable securities and then selling the securities to finance the expenditures. Also, firms may face the possibility of having to make a large cash outlay. An obvious example would involve the possibility of losing a large lawsuit. Firms may build up cash surpluses against such a contingency.
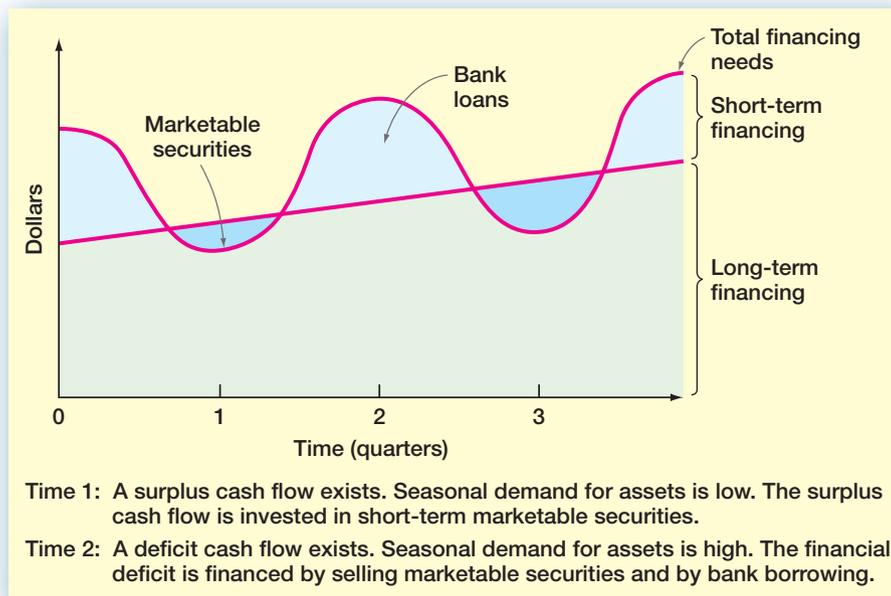
**FIGURE 20.6**

Seasonal Cash Demands

**Time 1:** A surplus cash flow exists. Seasonal demand for assets is low. The surplus cash flow is invested in short-term marketable securities.

**Time 2:** A deficit cash flow exists. Seasonal demand for assets is high. The financial deficit is financed by selling marketable securities and by bank borrowing.

## CHARACTERISTICS OF SHORT-TERM SECURITIES

Given that a firm has some temporarily idle cash, a variety of short-term securities are available for investing. The most important characteristics of these short-term marketable securities are their maturity, default risk, marketability, and taxability.

**Maturity**    From Chapter 7, we know that for a given change in the level of interest rates, the prices of longer-maturity securities will change more than those of shorter-maturity securities. As a consequence, firms that invest in long-term securities are accepting greater risk than firms that invest in securities with short-term maturities.

   We called this type of risk *interest rate risk.* Firms often limit their investments in marketable securities to those maturing in less than 90 days to avoid the risk of losses in value from changing interest rates. Of course, the expected return on securities with short-term maturities is usually less than the expected return on securities with longer maturities.

**Default Risk**    *Default risk* refers to the probability that interest and principal will not be paid in the promised amounts on the due dates (or will not be paid at all). In Chapter 7, we observed that various financial reporting agencies, such as Moody's Investors Service and Standard and Poor's, compile and publish ratings of various corporate and other publicly held securities. These ratings are connected to default risk. Of course, some securities have negligible default risk, such as U.S. Treasury bills. Given the purposes of investing idle corporate cash, firms typically avoid investing in marketable securities with significant default risk.

**Marketability**    *Marketability* refers to how easy it is to convert an asset to cash; so marketability and liquidity mean much the same thing. Some money market instruments are much more marketable than others. At the top of the list are U.S. Treasury bills, which can be bought and sold very cheaply and very quickly.

**Taxes**    Interest earned on money market securities that are not some kind of government obligation (either federal or state) is taxable at the local, state, and federal levels. U.S.

Treasury obligations such as T-bills are exempt from state taxation, but other government-backed debt is not. Municipal securities are exempt from federal taxes, but they may be taxed at the state level.

### SOME DIFFERENT TYPES OF MONEY MARKET SECURITIES

Money market securities are generally highly marketable and short-term. They usually have low risk of default. They are issued by the U.S. government (for example, U.S. Treasury bills), domestic and foreign banks (for example, certificates of deposit), and business corporations (for example, commercial paper). There are many types in all, and we illustrate only a few of the most common here.

U.S. Treasury bills are obligations of the U.S. government that mature in 30, 90, or 180 days. Bills are sold by auction every week.

Short-term tax-exempts are short-term securities issued by states, municipalities, local housing agencies, and urban renewal agencies. Because these are all considered municipal securities, they are exempt from federal taxes. RANs, BANs, and TANs, for example, are revenue, bond, and tax anticipation notes, respectively. In other words, they represent short-term borrowing by municipalities in anticipation of cash receipts.

Short-term tax-exempts have more default risk than U.S. Treasury issues and are less marketable. Because the interest is exempt from federal income tax, the pretax yield on tax-exempts is lower than that on comparable securities such as Treasury bills. Also, corporations face restrictions on holding tax-exempts as investments.

Commercial paper consists of short-term securities issued by finance companies, banks, and corporations. Typically, commercial paper is unsecured. Maturities range from a few weeks to 270 days.

*Check out short-term rates online at www.bloomberg.com.*

There is no especially active secondary market in commercial paper. As a consequence, the marketability can be low; however, firms that issue commercial paper will often repurchase it directly before maturity. The default risk of commercial paper depends on the financial strength of the issuer. Moody's and S&P publish quality ratings for commercial paper. These ratings are similar to the bond ratings we discussed in Chapter 7.

Certificates of deposit (CDs) are short-term loans to commercial banks. The most common are jumbo CDs—those in excess of $100,000. There are active markets in CDs of 3-month, 6-month, 9-month, and 12-month maturities.

Repurchase agreements (repos) are sales of government securities (for example, U.S. Treasury bills) by a bank or securities dealer with an agreement to repurchase. Typically, an investor buys some Treasury securities from a bond dealer and simultaneously agrees to sell them back at a later date at a specified higher price. Repurchase agreements usually involve a very short term—overnight to a few days.

Because 70 to 80 percent of the dividends received by one corporation from another are exempt from taxation, the relatively high dividend yields on preferred stock provide a strong incentive for investment. The only problem is that the dividend is fixed with ordinary preferred stock, so the price can fluctuate more than is desirable in a short-term investment. However, money market preferred stock is a fairly recent innovation featuring a floating dividend. The dividend is reset fairly often (usually every 49 days); so this type of preferred has much less price volatility than ordinary preferred, and it has become a popular short-term investment.

### Concept Questions

**20.5a** What are some reasons why firms find themselves with idle cash?

**20.5b** What are some types of money market securities?

**20.5c** Why are money market preferred stocks an attractive short-term investment?

## Summary and Conclusions                          20.6

In this chapter, we have examined cash and liquidity management. We saw the following:

1. A firm holds cash to conduct transactions and to compensate banks for the various services they render.

2. The difference between a firm's available balance and its book balance is the firm's net float. The float reflects the fact that some checks have not cleared and are thus uncollected. The financial manager must always work with collected cash balances and not with the company's book balance. To do otherwise is to use the bank's cash without the bank's knowing it, which raises ethical and legal questions.

3. The firm can make use of a variety of procedures to manage the collection and disbursement of cash in such a way as to speed up the collection of cash and slow down the payments. Some methods to speed up the collection are the use of lockboxes, concentration banking, and wire transfers.

4. Because of seasonal and cyclical activities, to help finance planned expenditures, or as a contingency reserve, firms temporarily hold a cash surplus. The money market offers a variety of possible vehicles for "parking" this idle cash.

### CHAPTER REVIEW AND SELF-TEST PROBLEM

**20.1 Float Measurement** On a typical day, a firm writes checks totaling $3,000. These checks clear in seven days. Simultaneously, the firm receives $1,700. The cash is available in two days on average. Calculate the disbursement, the collection, and the net floats. How do you interpret the answer?

### ANSWER TO CHAPTER REVIEW AND SELF-TEST PROBLEM

**20.1** The disbursement float is 7 days $\times$ $3,000 = $21,000. The collection float is 2 days $\times$ (−$1,700) = −$3,400. The net float is $21,000 + (−3,400) = $17,600. In other words, at any given time, the firm typically has uncashed checks outstanding of $21,000. At the same time, it has uncollected receipts of $3,400. Thus the firm's book balance is typically $17,600 less than its available balance, for a positive $17,600 net float.

### CONCEPTS REVIEW AND CRITICAL THINKING QUESTIONS

1. **Cash Management** Is it possible for a firm to have too much cash? Why would shareholders care if a firm accumulates large amounts of cash?

2. **Cash Management** What options are available to a firm if it believes it has too much cash? How about too little?

3. **Agency Issues** Are stockholders and creditors likely to agree on how much cash a firm should keep on hand?

4. **Motivations for Holding Cash** In the chapter opening, we discussed the enormous cash positions of several companies. Why would firms such as these hold such large quantities of cash?

5. **Cash Management versus Liquidity Management** What is the difference between cash management and liquidity management?

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6. **Short-Term Investments**  Why is a preferred stock with a dividend tied to short-term interest rates an attractive short-term investment for corporations with excess cash?

7. **Collection and Disbursement Floats**  Which would a firm prefer: a net collection float or a net disbursement float? Why?

8. **Float**  Suppose a firm has a book balance of $2 million. At the automatic teller machine (ATM), the cash manager finds out that the bank balance is $2.5 million. What is the situation here? If this is an ongoing situation, what ethical dilemma arises?

9. **Short-Term Investments**  For each of the short-term marketable securities given here, provide an example of the potential disadvantages the investment has for meeting a corporation's cash management goals:

   **a.** U.S. Treasury bills.
   **b.** Ordinary preferred stock.
   **c.** Negotiable certificates of deposit (NCDs).
   **d.** Commercial paper.
   **e.** Revenue anticipation notes.
   **f.** Repurchase agreements.

10. **Agency Issues**  It is sometimes argued that excess cash held by a firm can aggravate agency problems (discussed in Chapter 1) and, more generally, reduce incentives for shareholder wealth maximization. How would you frame the issue here?

11. **Use of Excess Cash**  One option a firm usually has with any excess cash is to pay its suppliers more quickly. What are the advantages and disadvantages of this use of excess cash?

12. **Use of Excess Cash**  Another option usually available is to reduce the firm's outstanding debt. What are the advantages and disadvantages of this use of excess cash?

13. **Float**  An unfortunately common practice goes like this (warning: don't try this at home): Suppose you are out of money in your checking account; however, your local grocery store will, as a convenience to you as a customer, cash a check for you. So, you cash a check for $200. Of course, this check will bounce unless you do something. To prevent this, you go to the grocery the next day and cash another check for $200. You take this $200 and deposit it. You repeat this process every day, and, in doing so, you make sure that no checks bounce. Eventually, manna from heaven arrives (perhaps in the form of money from home), and you are able to cover your outstanding checks.

    To make it interesting, suppose you are absolutely certain that no checks will bounce along the way. Assuming this is true, and ignoring any question of legality (what we have described is probably illegal check kiting), is there anything unethical about this? If you say yes, then why? In particular, who is harmed?

**QUESTIONS AND PROBLEMS**  HM™

**BASIC**
(Questions 1–10)

1. **Calculating Float**  In a typical month, the Timmons Corporation receives 90 checks totaling $135,000. These are delayed five days on average. What is the average daily float?

2. **Calculating Net Float**  Each business day, on average, a company writes checks totaling $17,000 to pay its suppliers. The usual clearing time for the checks is four days. Meanwhile, the company is receiving payments from its customers each day, in the form of checks, totaling $29,000. The cash from the payments is available to the firm after two days.

   **a.** Calculate the company's disbursement float, collection float, and net float.

   **b.** How would your answer to part (a) change if the collected funds were available in one day instead of two?

3. **Costs of Float** Purple Feet Wine, Inc., receives an average of $11,000 in checks per day. The delay in clearing is typically four days. The current interest rate is .016 percent per day.

   **a.** What is the company's float?

   **b.** What is the most Purple Feet should be willing to pay today to eliminate its float entirely?

   **c.** What is the highest daily fee the company should be willing to pay to eliminate its float entirely?

4. **Float and Weighted Average Delay** Your neighbor goes to the post office once a month and picks up two checks, one for $13,000 and one for $4,000. The larger check takes four days to clear after it is deposited; the smaller one takes five days.

   **a.** What is the total float for the month?

   **b.** What is the average daily float?

   **c.** What are the average daily receipts and weighted average delay?

5. **NPV and Collection Time** Your firm has an average receipt size of $95. A bank has approached you concerning a lockbox service that will decrease your total collection time by two days. You typically receive 9,400 checks per day. The daily interest rate is .016 percent. If the bank charges a fee of $190 per day, should the lockbox project be accepted? What would the net annual savings be if the service were adopted?

6. **Using Weighted Average Delay** A mail-order firm processes 4,500 checks per month. Of these, 60 percent are for $50 and 40 percent are for $70. The $50 checks are delayed two days on average; the $70 checks are delayed three days on average.

   **a.** What is the average daily collection float? How do you interpret your answer?

   **b.** What is the weighted average delay? Use the result to calculate the average daily float.

   **c.** How much should the firm be willing to pay to eliminate the float?

   **d.** If the interest rate is 7 percent per year, calculate the daily cost of the float.

   **e.** How much should the firm be willing to pay to reduce the weighted average float by 1.5 days?

7. **Value of Lockboxes** Paper Submarine Manufacturing is investigating a lockbox system to reduce its collection time. It has determined the following:

| | |
|---|---:|
| Average number of payments per day | 410 |
| Average value of payment | $1,350 |
| Variable lockbox fee (per transaction) | $.75 |
| Daily interest rate on money market securities | .02% |

The total collection time will be reduced by three days if the lockbox system is adopted.

   **a.** What is the PV of adopting the system?

   **b.** What is the NPV of adopting the system?

   **c.** What is the net cash flow per day from adopting? Per check?

8. **Lockboxes and Collections** It takes Cookie Cutter Modular Homes, Inc., about six days to receive and deposit checks from customers. Cookie Cutter's management is considering a lockbox system to reduce the firm's collection times. It is expected that the lockbox system will reduce receipt and deposit times to three days total. Average daily collections are $98,000, and the required rate of return is 9 percent per year.

**a.** What is the reduction in outstanding cash balances as a result of implementing the lockbox system?

**b.** What is the dollar return that could be earned on these savings?

**c.** What is the maximum monthly charge Cookie Cutter should pay for this lockbox system if the payment is due at the end of the month? What if the payment is due at the beginning of the month?

**9.** **Value of Delay**  No More Pencils, Inc., disburses checks every two weeks that average $57,000 and take seven days to clear. How much interest can the company earn annually if it delays transfer of funds from an interest-bearing account that pays .02 percent per day for these seven days? Ignore the effects of compounding interest.

**10.** **NPV and Reducing Float**  No More Books Corporation has an agreement with Lollipop Bank whereby the bank handles $6 million in collections a day and requires a $450,000 compensating balance. No More Books is contemplating canceling the agreement and dividing its eastern region so that two other banks will handle its business. Banks A and B will each handle $3 million of collections a day, and each requires a compensating balance of $300,000. No More Books' financial management expects that collections will be accelerated by one day if the eastern region is divided. Should the company proceed with the new system? What will be the annual net savings? Assume that the T-bill rate is 5 percent annually.

**INTERMEDIATE**
(Questions 11–12)

**11.** **Lockboxes and Collection Time**  Bird's Eye Treehouses, Inc., a Kentucky company, has determined that a majority of its customers are located in the Pennsylvania area. It therefore is considering using a lockbox system offered by a bank located in Pittsburgh. The bank has estimated that use of the system will reduce collection time by two days. Based on the following information, should the lockbox system be adopted?

| | |
|---|---:|
| Average number of payments per day | 400 |
| Average value of payment | $1,200 |
| Variable lockbox fee (per transaction) | $.35 |
| Annual interest rate on money market securities | 6.0% |

How would your answer change if there were a fixed charge of $6,000 per year in addition to the variable charge?

**12.** **Calculating Transactions Required**  Cow Chips, Inc., a large fertilizer distributor based in California, is planning to use a lockbox system to speed up collections from its customers located on the East Coast. A Philadelphia-area bank will provide this service for an annual fee of $25,000 plus 10 cents per transaction. The estimated reduction in collection and processing time is one day. If the average customer payment in this region is $4,800, how many customers each day, on average, are needed to make the system profitable for Cow Chips? Treasury bills are currently yielding 5 percent per year.

**WEB EXERCISE**

**20.1** **Commercial Paper Rates**  What are the highest and lowest historical interest rates for commercial paper? Go to www.stlouisfed.org and follow the "FRED II®" link. Look under the "Interest Rate" link to find the one-, two-, and three-month AA nonfinancial commercial paper rates. Looking at the monthly series, what were the highest and lowest interest rates for one-, two-, and three-month nonfinancial commercial paper over the time reported? When did they occur?

## Cash Management at Webb Corporation

Webb Corporation was founded 20 years ago by its president, Bryan Webb. The company originally began as a mail-order company, but has grown rapidly in recent years, in large part due to its Web site. Because of the wide geographical dispersion of the company's customers, it currently employs a lockbox system with collection centers in San Francisco, St. Louis, Atlanta, and Boston.

Holly Lennon, the company's treasurer, has been examining the current cash collection policies. On average, each lockbox center handles $130,000 in payments each day. The company's current policy is to invest these payments in short-term marketable securities daily at the collection center banks. Every two weeks, the investment accounts are swept; the proceeds are wire-transferred to Webb's headquarters in Dallas to meet the company's payroll. The investment accounts each earn 0.015 percent per day, and the wire transfers cost 0.15 percent of the amount transferred.

Holly has been approached by Third National Bank, located just outside Dallas, about the possibility of setting up a con-centration banking system for Webb Corp. Third National will accept each of the lockbox center's daily payments via auto-mated clearinghouse (ACH) transfers in lieu of wire transfers. The ACH-transferred funds will not be available for use for one day. Once cleared, the funds will be deposited in a short-term account, which will also yield 0.015 percent per day. Each ACH transfer will cost $700. Bryan has asked Holly to determine which cash management system will be the best for the company. As her assistant, Holly has asked you to answer the following questions:

1. What is Webb Corporation's total net cash flow available from the current lockbox system to meet payroll?

2. Under the terms outlined by the Third National Bank, should the company proceed with the concentration banking system?

3. What cost of ACH transfers would make the company indifferent between the two systems?

# Determining the Target Cash Balance

## 20A

Based on our general discussion of current assets in the previous chapter, the **target cash balance** involves a trade-off between the opportunity costs of holding too much cash (the carrying costs) and the costs of holding too little (the shortage costs, also called **adjustment costs**). The nature of these costs depends on the firm's working capital policy.

If the firm has a flexible working capital policy, it will probably maintain a marketable securities portfolio. In this case, the adjustment, or shortage, costs will be the trading costs associated with buying and selling securities. If the firm has a restrictive working capital policy, it will probably borrow in the short term to meet cash shortages. The costs in this case will be the interest and other expenses associated with arranging a loan.

In our discussion that follows, we will assume the firm has a flexible policy. Its cash management, then, consists of moving money in and out of marketable securities. This is a traditional approach to the subject, and it is a nice way of illustrating the costs and benefits of holding cash. Keep in mind, however, that the distinction between cash and money market investments is becoming increasingly blurred.

For example, how do we classify a money market fund with check-writing privileges? Such near-cash arrangements are becoming more common. It may be that the prime reason they are not universal is regulation limiting their usage. We will return to this subject of such arrangements at various points in the following discussion.

**target cash balance**
A firm's desired cash level as determined by the trade-off between carrying costs and shortage costs.

**adjustment costs**
The costs associated with holding too little cash. Also, shortage costs.

### THE BASIC IDEA

Figure 20A.1 presents the cash management problem for our flexible firm. If a firm tries to keep its cash holdings too low, it will find itself running out of cash more often than is desirable and thus selling marketable securities (and perhaps later buying marketable

**FIGURE 20A.1**

Cost of Holding Cash



Trading costs are increased when the firm must sell securities to establish a cash balance. Opportunity costs are increased when there is a cash balance because there is no return on cash.
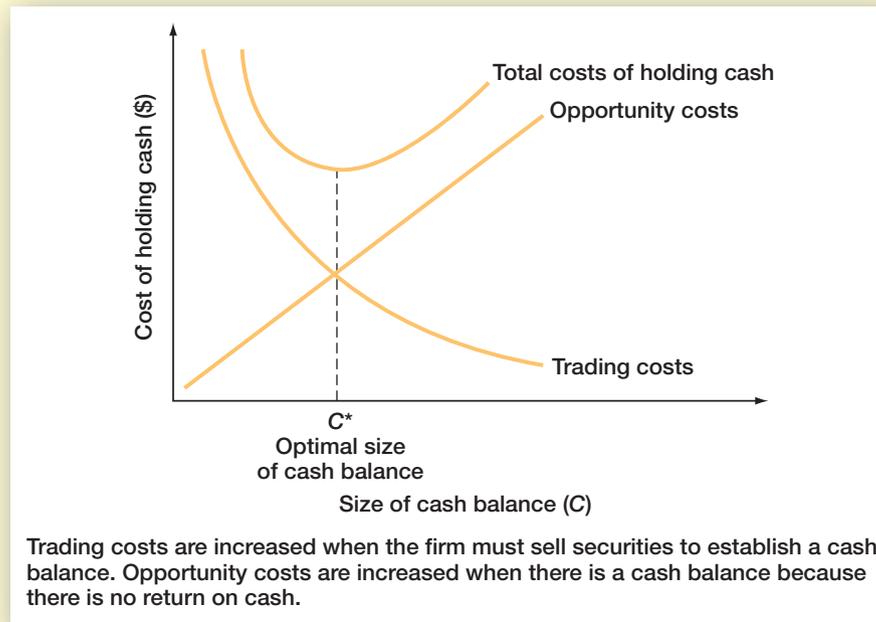
securities to replace those sold) more frequently than would be the case if the cash balance were higher. Thus trading costs will be high when the cash balance is small. These costs will fall as the cash balance becomes larger.

In contrast, the opportunity costs of holding cash are low if the firm holds little cash. These costs increase as the cash holdings rise because the firm is giving up more interest that could have been earned.

In Figure 20A.1, the sum of the costs is given by the total cost curve. As shown, the minimum total cost occurs where the two individual cost curves cross at point $C^*$. At this point, the opportunity costs and the trading costs are equal. This point represents the target cash balance, and it is the point the firm should try to find.

Figure 20A.1 is essentially the same as Figure 19.2 in the previous chapter. As we discuss next, however, we can now say more about the optimal investment in cash and the factors that influence it.

### THE BAT MODEL

The Baumol–Allais–Tobin (BAT) model is a classic means of analyzing our cash management problem. We will show how this model can be used to actually establish the target cash balance. It is a straightforward model useful for illustrating the factors in cash management and, more generally, current asset management.

To develop the BAT model, suppose the Golden Socks Corporation starts off at week 0 with a cash balance of $C = \$1.2$ million. Each week, outflows exceed inflows by \$600,000. As a result, the cash balance will drop to zero at the end of week 2. The average cash balance will be the beginning balance (\$1.2 million) plus the ending balance (\$0) divided by 2, or (\$1.2 million + 0)/2 = \$600,000, over the two-week period. At the end of week 2, Golden Socks replenishes its cash by depositing another \$1.2 million.

As we have described, the simple cash management strategy for Golden Socks boils down to depositing \$1.2 million every two weeks. This policy is shown in Figure 20A.2. Notice how the cash balance declines by \$600,000 per week. Because the company brings
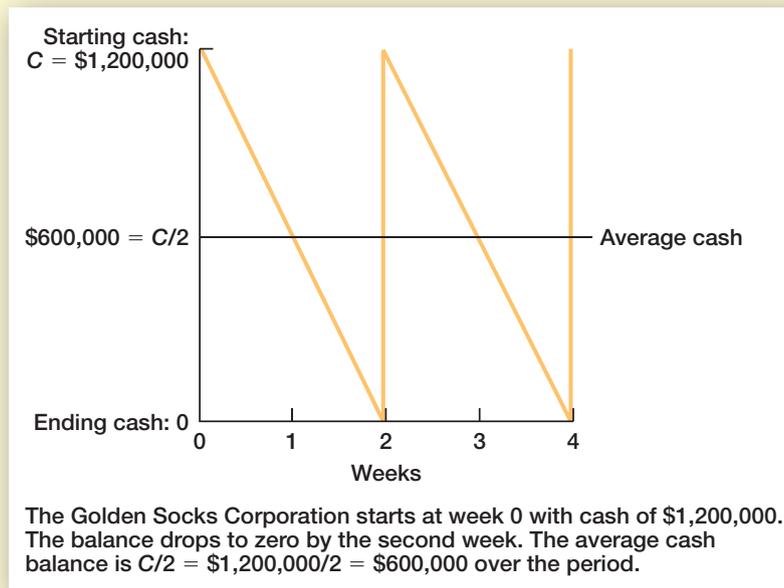
**FIGURE 20A.2**

Cash Balances for the
Golden Socks Corporation



The Golden Socks Corporation starts at week 0 with cash of $1,200,000.
The balance drops to zero by the second week. The average cash
balance is C/2 = $1,200,000/2 = $600,000 over the period.

the account up to $1.2 million, the balance hits zero every two weeks. This results in the sawtooth pattern displayed in Figure 20A.2.

Implicitly, we assume that the net cash outflow is the same every day and is known with certainty. These two assumptions make the model easy to handle. We will indicate in the next section what happens when they do not hold.

If $C$ were set higher, say, at $2.4 million, cash would last four weeks before the firm would have to sell marketable securities; but the firm's average cash balance would increase to $1.2 million (from $600,000). If $C$ were set at $600,000, cash would run out in one week, and the firm would have to replenish cash more frequently; but the average cash balance would fall from $600,000 to $300,000.

Because transaction costs (for example, the brokerage costs of selling marketable securities) must be incurred whenever cash is replenished, establishing large initial balances will lower the trading costs connected with cash management. However, the larger the average cash balance, the greater is the opportunity cost (the return that could have been earned on marketable securities).

To determine the optimal strategy, Golden Socks needs to know the following three things:

$F$ = The fixed cost of making a securities trade to replenish cash.

$T$ = The total amount of new cash needed for transaction purposes over the relevant planning period—say, one year.

$R$ = The opportunity cost of holding cash. This is the interest rate on marketable securities.

With this information, Golden Socks can determine the total costs of any particular cash balance policy. It can then determine the optimal cash balance policy.

**The Opportunity Costs**   To determine the opportunity costs of holding cash, we have to find out how much interest is forgone. Golden Socks has, on average, $C/2$ in cash. This amount could be earning interest at rate $R$. So the total dollar opportunity costs of cash

balances are equal to the average cash balance multiplied by the interest rate:

$$\text{Opportunity costs} = (C/2) \times R \qquad\qquad\qquad [20\text{A}.1]$$

For example, the opportunity costs of various alternatives are given here, assuming that the interest rate is 10 percent:

| Initial Cash Balance | Average Cash Balance | Opportunity Cost ($R = .10$) |
|:---:|:---:|:---:|
| $C$ | $C/2$ | $(C/2) \times R$ |
| $4,800,000 | $2,400,000 | $240,000 |
| 2,400,000 | 1,200,000 | 120,000 |
| 1,200,000 | 600,000 | 60,000 |
| 600,000 | 300,000 | 30,000 |
| 300,000 | 150,000 | 15,000 |

In our original case, in which the initial cash balance is $1.2 million, the average balance is $600,000. The interest Golden Socks could have earned on this (at 10 percent) is $60,000, so this is what the firm gives up with this strategy. Notice that the opportunity costs increase as the initial (and average) cash balance rises.

**The Trading Costs**   To determine the total trading costs for the year, we need to know how many times Golden Socks will have to sell marketable securities during the year. First, the total amount of cash disbursed during the year is $600,000 per week, so $T = \$600,000 \times 52$ weeks $= \$31.2$ million. If the initial cash balance is set at $C = \$1.2$ million, Golden Socks will sell $1.2 million in marketable securities: $T/C = \$31.2$ million/1.2 million $= 26$ times per year. It costs $F$ dollars each time, so trading costs are given by:

$$\frac{\$31.2 \text{ million}}{\$1.2 \text{ million}} \times F = 26 \times F$$

In general, the total trading costs will be given by:

$$\text{Trading costs} = (T/C) \times F \qquad\qquad\qquad [20\text{A}.2]$$

In this example, if $F$ were $1,000 (an unrealistically large amount), the trading costs would be $26,000.

We can calculate the trading costs associated with some different strategies as follows:

| Total Amount of Disbursements during Relevant Period | Initial Cash Balance | Trading Costs ($F = \$1,000$) |
|:---:|:---:|:---:|
| $T$ | $C$ | $(T/C) \times F$ |
| $31,200,000 | $4,800,000 | $  6,500 |
| 31,200,000 | 2,400,000 | 13,000 |
| 31,200,000 | 1,200,000 | 26,000 |
| 31,200,000 | 600,000 | 52,000 |
| 31,200,000 | 300,000 | 104,000 |

**The Total Cost**   Now that we have the opportunity costs and the trading costs, we can calculate the total cost by adding them together:

$$\begin{aligned} \text{Total cost} &= \text{Opportunity costs} + \text{Trading costs} \\ &= (C/2) \times R + (T/C) \times F \qquad\qquad [20\text{A}.3] \end{aligned}$$

Using the numbers generated earlier, we have the following:

| Cash Balance | Opportunity Costs | + | Trading Costs | = | Total Cost |
|---|---|---|---|---|---|
| $4,800,000 | $240,000 | | $  6,500 | | $246,500 |
| 2,400,000 | 120,000 | | 13,000 | | 133,000 |
| 1,200,000 | 60,000 | | 26,000 | | 86,000 |
| 600,000 | 30,000 | | 52,000 | | 82,000 |
| 300,000 | 15,000 | | 104,000 | | 119,000 |

Notice how the total cost starts out at almost $250,000 and declines to about $82,000 before starting to rise again.

**The Solution**   We can see from the preceding schedule that a $600,000 cash balance results in the lowest total cost of the possibilities presented: $82,000. But what about $700,000 or $500,000 or other possibilities? It appears that the optimal balance is some-where between $300,000 and $1.2 million. With this in mind, we could easily proceed by trial and error to find the optimal balance. It is not difficult to find it directly, however, so we do this next.

Take a look back at Figure 20A.1. As the figure is drawn, the optimal size of the cash balance, $C^*$, occurs right where the two lines cross. At this point, the opportunity costs and the trading costs are exactly equal. So at $C^*$, we must have that:

Opportunity costs = Trading costs

$$(C^*/2) \times R = (T/C^*) \times F$$

With a little algebra, we can write:

$$C^{*2} = (2T \times F)/R$$

To solve for $C^*$, we take the square root of both sides to get:

$$C^* = \sqrt{(2T \times F)/R} \qquad\qquad [20A.4]$$

This is the optimal initial cash balance.

For Golden Socks, we have $T$ = $31.2 million, $F$ = $1,000, and $R$ = 10%. We can now find the optimal cash balance:

$$C^* = \sqrt{(2 \times \$31,200,000 \times 1,000)/.10}$$
$$= \sqrt{\$624 \text{ billion}}$$
$$= \$789,937$$

We can verify this answer by calculating the various costs at this balance, as well as a little above and a little below:

| Cash Balance | Opportunity Costs | + | Trading Costs | = | Total Cost |
|---|---|---|---|---|---|
| $850,000 | $42,500 | | $36,706 | | $79,206 |
| 800,000 | 40,000 | | 39,000 | | 79,000 |
| 789,937 | 39,497 | | 39,497 | | 78,994 |
| 750,000 | 37,500 | | 41,600 | | 79,100 |
| 700,000 | 35,000 | | 44,571 | | 79,571 |

The total cost at the optimal cash level is $78,994, and it does appear to increase as we move in either direction.

| EXAMPLE 20A.1 | The BAT Model |
|---|---|

The Vulcan Corporation has cash outflows of $100 per day, seven days a week. The interest rate is 5 percent, and the fixed cost of replenishing cash balances is $10 per transaction. What is the optimal initial cash balance? What is the total cost?

The total cash needed for the year is 365 days $\times$ $100 = $36,500. From the BAT model, we have that the optimal initial balance is:

$$C^* = \sqrt{(2T \times F)/R}$$
$$= \sqrt{(2 \times \$36{,}500 \times 10)/.05}$$
$$= \sqrt{\$14.6 \text{ million}}$$
$$= \$3{,}821$$

The average cash balance is $3,821/2 = $1,911, so the opportunity cost is $1,911 $\times$ .05 = $96. Because Vulcan needs $100 per day, the $3,821 balance will last $3,821/100 = 38.21 days. The firm needs to resupply the account 365/38.21 = 9.6 times per year, so the trading (order) cost is $96. The total cost is $192.

**Conclusion**   The BAT model is possibly the simplest and most stripped-down sensible model for determining the optimal cash position. Its chief weakness is that it assumes steady, certain cash outflows. We next discuss a more involved model designed to deal with this limitation.

### THE MILLER–ORR MODEL: A MORE GENERAL APPROACH

We now describe a cash management system designed to deal with cash inflows and outflows that fluctuate randomly from day to day. With this model, we again concentrate on the cash balance. But in contrast to the situation with the BAT model, we assume that this balance fluctuates up and down randomly and that the average change is zero.

**The Basic Idea**   Figure 20A.3 shows how the system works. It operates in terms of an upper limit and a lower limit ($L$) to the amount of cash ($U^*$), as well as a target cash balance ($C^*$). The firm allows its cash balance to wander around between the lower and upper limits. As long as the cash balance is somewhere between $U^*$ and $L$, nothing happens.

When the cash balance reaches the upper limit ($U^*$), as it does at point $X$, the firm moves $U^* - C^*$ dollars out of the account and into marketable securities. This action moves the cash balance down to $C^*$. In the same way, if the cash balance falls to the lower limit ($L$), as it does at point $Y$, the firm will sell $C^* - L$ worth of securities and deposit the cash in the account. This action takes the cash balance up to $C^*$.

**Using the Model**   To get started, management sets the lower limit ($L$). This limit essentially defines a safety stock; so where it is set depends on how much risk of a cash shortfall the firm is willing to tolerate. Alternatively, the minimum might just equal a required compensating balance.

As with the BAT model, the optimal cash balance depends on trading costs and opportunity costs. Once again, the cost per transaction of buying and selling marketable securities, $F$, is assumed to be fixed. Also, the opportunity cost of holding cash is $R$, the interest rate per period on marketable securities.

*U\** is the upper control limit. *L* is the lower control limit. The target cash balance is *C\**. As long as cash is between *L* and *U\**, no transaction is made.
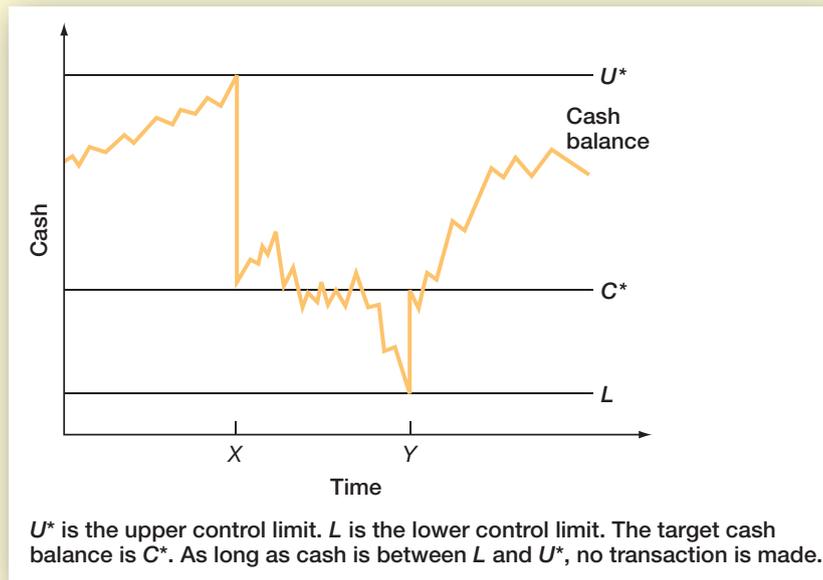
The only extra piece of information needed is $\sigma^2$, the variance of the net cash flow per period. For our purposes, the period can be anything—a day or a week, for example—as long as the interest rate and the variance are based on the same length of time.

Given *L*, which is set by the firm, Miller and Orr show that the cash balance target, *C\**, and the upper limit, *U\**, that minimize the total costs of holding cash are:[2]

$$C^* = L + (3/4 \times F \times \sigma^2/R)^{(1/3)} \qquad \text{[20A.5]}$$
$$U^* = 3 \times C^* - 2 \times L \qquad \text{[20A.6]}$$

Also, the average cash balance in the Miller–Orr model is:

$$\text{Average cash balance} = (4 \times C^* - L)/3 \qquad \text{[20A.7]}$$

The derivation of these expressions is relatively complex, so we will not present it here. Fortunately, as we illustrate next, the results are not difficult to use.

For example, suppose $F = \$10$, the interest rate is 1 percent per month, and the standard deviation of the monthly net cash flows is \$200. The variance of the monthly net cash flows is:

$$\sigma^2 = \$200^2 = \$40,000$$

We assume a minimum cash balance of $L = \$100$. We can calculate the cash balance target, *C\**, as follows:

$$
\begin{aligned}
C^* &= L + (3/4 \times F \times \sigma^2/R)^{(1/3)} \\
&= \$100 + (3/4 \times 10 \times 40{,}000/.01)^{(1/3)} \\
&= \$100 + 30{,}000{,}000^{(1/3)} \\
&= \$100 + 311 = \$411
\end{aligned}
$$

---

[2]M.H. Miller and D. Orr, "A Model of the Demand for Money by Firms," *Quarterly Journal of Economics,* August 1966.

The upper limit, $U^*$, is thus:

$$U^* = 3 \times C^* - 2 \times L$$
$$= 3 \times \$411 - 2 \times 100$$
$$= \$1,033$$

Finally, the average cash balance will be:

$$\text{Average cash balance} = (4 \times C^* - L)/3$$
$$= (4 \times \$411 - 100)/3$$
$$= \$515$$

### IMPLICATIONS OF THE BAT AND MILLER–ORR MODELS

Our two cash management models differ in complexity, but they have some similar implications. In both cases, all other things being equal, we see that:

1. The greater the interest rate, the lower is the target cash balance.
2. The greater the order cost, the higher is the target balance.

These implications are both fairly obvious. The advantage of the Miller–Orr model is that it improves our understanding of the problem of cash management by considering the effect of uncertainty as measured by the variation in net cash inflows.

The Miller–Orr model shows that the greater the uncertainty is (the higher $\sigma^2$ is), the greater is the difference between the target balance and the minimum balance. Similarly, the greater the uncertainty is, the higher is the upper limit and the higher is the average cash balance. These statements all make intuitive sense. For example, the greater the variability is, the greater is the chance that the balance will drop below the minimum. We thus keep a higher balance to guard against this happening.

### OTHER FACTORS INFLUENCING THE TARGET CASH BALANCE

Before moving on, we briefly discuss two additional considerations that affect the target cash balance.

First, in our discussion of cash management, we assume cash is invested in marketable securities such as Treasury bills. The firm obtains cash by selling these securities. Another alternative is to borrow cash. Borrowing introduces additional considerations to cash management:

1. Borrowing is likely to be more expensive than selling marketable securities because the interest rate is likely to be higher.
2. The need to borrow will depend on management's desire to hold low cash balances. A firm is more likely to have to borrow to cover an unexpected cash outflow with greater cash flow variability and lower investment in marketable securities.

Second, for large firms, the trading costs of buying and selling securities are small when compared to the opportunity costs of holding cash. For example, suppose a firm has $1 million in cash that won't be needed for 24 hours. Should the firm invest the money or leave it sitting?

Suppose the firm can invest the money at an annualized rate of 7.57 percent per year. The daily rate in this case is about two basis points (.02 percent or .0002).[3] The daily return earned on $1 million is thus .0002 × $1 million = $200. In many cases, the order cost will

---

[3]A basis point is 1 percent of 1 percent. Also, the annual interest rate is calculated as $(1 + R)^{365} = 1.0757$, implying a daily rate of .02 percent.

be much less than this; so a large firm will buy and sell securities very often before it will leave substantial amounts of cash idle.

> ### Concept Questions
>
> **20A.1a** What is a target cash balance?
> **20A.1b** What is the basic trade-off in the BAT model?
> **20A.1c** Describe how the Miller–Orr model works.

## APPENDIX REVIEW AND SELF-TEST PROBLEM

**20A.1**   **The BAT Model**   Given the following information, calculate the target cash balance using the BAT model:

| | |
|---|---:|
| Annual interest rate | 12% |
| Fixed order cost | $100 |
| Total cash needed | $240,000 |

What are the opportunity cost of holding cash, the trading cost, and the total cost? What would these be if $15,000 were held instead? If $25,000 were held?

## ANSWER TO APPENDIX REVIEW AND SELF-TEST PROBLEM

**20A.1**   From the BAT model, we know that the target cash balance is:

$$
\begin{aligned}
C^* &= \sqrt{(2T \times F)/R} \\
&= \sqrt{(2 \times \$240{,}000 \times 100)/.12} \\
&= \sqrt{\$400{,}000{,}000} \\
&= \$20{,}000
\end{aligned}
$$

The average cash balance will be $C^*/2 = \$20{,}000/2 = \$10{,}000$. The opportunity cost of holding $10,000 when the going rate is 12 percent is $\$10{,}000 \times .12 = \$1{,}200$. There will be $\$240{,}000/20{,}000 = 12$ orders during the year, so the order cost, or trading cost, is also $12 \times \$100 = \$1{,}200$. The total cost is thus $2,400.

If $15,000 is held, the average balance is $7,500. Verify that the opportunity, trading, and total costs in this case are $900, $1,600, and $2,500, respectively. If $25,000 is held, these numbers are $1,500, $960, and $2,460, respectively.

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## QUESTIONS AND PROBLEMS

1.   **Changes in Target Cash Balances**   Indicate the likely impact of each of the following on a company's target cash balance. Use the letter *I* to denote an increase and *D* to denote a decrease. Briefly explain your reasoning in each case:

**BASIC**
(Questions 1–10)

   **a.** Commissions charged by brokers decrease.
   **b.** Interest rates paid on money market securities rise.
   **c.** The compensating balance requirement of a bank is raised.
   **d.** The firm's credit rating improves.
   **e.** The cost of borrowing increases.
   **f.** Direct fees for banking services are established.

2. **Using the BAT Model**  Given the following information, calculate the target cash balance using the BAT model:

| | |
|---|---|
| Annual interest rate | 7% |
| Fixed order cost | $25 |
| Total cash needed | $9,000 |

How do you interpret your answer?

3. **Opportunity versus Trading Costs**  White Whale Corporation has an average daily cash balance of $900. Total cash needed for the year is $37,000. The interest rate is 5 percent, and replenishing the cash costs $8 each time. What are the opportunity cost of holding cash, the trading cost, and the total cost? What do you think of White Whale's strategy?

4. **Costs and the BAT Model**  Debit and Credit Bookkeepers needs a total of $7,000 in cash during the year for transactions and other purposes. Whenever cash runs low, it sells $450 in securities and transfers the cash in. The interest rate is 6 percent per year, and selling securities costs $25 per sale.

   a. What is the opportunity cost under the current policy? The trading cost? With no additional calculations, would you say that Debit and Credit keeps too much or too little cash? Explain.

   b. What is the target cash balance derived using the BAT model?

5. **Determining Optimal Cash Balances**  The All Day Company is currently holding $670,000 in cash. It projects that over the next year its cash outflows will exceed cash inflows by $125,000 per month. How much of the current cash holdings should be retained, and how much should be used to increase the company's holdings of marketable securities? Each time these securities are bought or sold through a broker, the company pays a fee of $500. The annual interest rate on money market securities is 6.5 percent. After the initial investment of excess cash, how many times during the next 12 months will securities be sold?

6. **Interpreting Miller–Orr**  Econoline Crush, Inc., uses a Miller–Orr cash management approach with a lower limit of $50,000, an upper limit of $130,000, and a target balance of $75,000. Explain what each of these points represents; then explain how the system will work.

7. **Using Miller–Orr**  Slap Shot Corporation has a fixed cost associated with buying and selling marketable securities of $75. The interest rate is currently .021 percent per day, and the firm has estimated that the standard deviation of its daily net cash flows is $60. Management has set a lower limit of $1,200 on cash holdings. Calculate the target cash balance and upper limit using the Miller–Orr model. Describe how the system will work.

8. **Interpreting Miller–Orr**  Based on the Miller–Orr model, describe what will happen to the lower limit, the upper limit, and the spread (the distance between the two) if the variation in net cash flow grows. Give an intuitive explanation for why this happens. What happens if the variance drops to zero?

9. **Using Miller–Orr**  The variance of the daily cash flows for the Pele Bicycle Shop is $840,000. The opportunity cost to the firm of holding cash is 7 percent per year. What should the target cash level and the upper limit be if the tolerable lower limit has been established as $150,000? The fixed cost of buying and selling securities is $500 per transaction.

10. **Using BAT**  All Night Corporation has determined that its target cash balance if it uses the BAT model is $2,600. The total cash needed for the year is $23,000, and the order cost is $10. What interest rate must All Night be using?