CHAPTER 6

Repo Market Strategies in Financial Engineering

1. Introduction

This is a nontechnical chapter which deals with a potentially confusing operation. The chapter briefly reviews *repo* markets and some uses of repo. This is essential for understanding many standard operations in financial markets.

Many financial engineering strategies require the use of the repo market. The repo market is both a complement and an alternative to swap markets. During a swap transaction, the market practitioner conducts a simultaneous "sale" and "purchase" of two sequences of cash flows generated by two different securities. For example, returns of an equity instrument are swapped for a floating rate Libor. This is equivalent to selling the equity, receiving cash, and then buying a floating rate note (FRN). These operations are combined in an equity swap and accomplished without actually buying and selling the involved assets or exchanging the original principals. With no exchange of cash, flexible maturities, and liquid markets, swaps become a fundamental tool. Using swaps, a complex sequence of operations can be accomplished efficiently, quickly, and with little risk.

Repo transactions provide similar efficiencies, with two major differences. In swaps, the use of cash is minimized and the ownership of the underlying instruments does not change. In a repo transaction both cash and (temporary) ownership changes hands. Suppose a practitioner *does* need cash or needs to own a security. Yet, he or she does not want to give up or assume the ownership of the security permanently. Swaps are of no help, but a repo is.

Repo is a tool that can provide us cash without requiring the sale, or giving up eventual ownership of the involved assets. Alternatively, we may need a security, but we may not want to own this security permanently. Then we must use a tool that secures ownership, without really requiring the purchase of the security. In each case, these operations require either a temporary use of cash or a temporary ownership of securities. Repo markets provide tools for such operations. With repo transactions, we can "buy" without really buying, and we can "sell" without really selling. This is similar to swaps in a sense, but most repo transactions involve exchanges of cash or securities, and this is the main difference with swap instruments.

In each case, the purpose behind these operations is not "long-term." Rather, the objective is to conduct daily operations rather smoothly, take directional positions, or hedge a position more efficiently.

2. What Is Repo?

We begin with the standard definition. A repo is a *repurchase agreement* where a *repo dealer* sells a security to a counterparty and *simultaneously* agrees to buy it back at a predetermined price and at a predetermined date. Thus, it is a sale and a repurchase written on the same ticket. In a repo, the *dealer* first delivers the security and receives cash from the client. If the operation is reversed—that is to say, the dealer first buys the security and simultaneously sells it back at a predetermined date and time—the operation is called a *reverse repo*, or is simply referred to as *reverse*.

At first glance, the repo operation looks like a fairly simple transaction that would not contribute to the methodology of financial engineering. This is not true. In fact, in terms of practical applications of financial engineering repo may be as common as swaps.

Consider the following experiment. Suppose an investor wants to buy a security using short-term funding. If he borrows these funds from a bank and then goes to another dealer to buy the bond, the original loan will be *nonsecured*. This implies higher interest costs. Now, if the investor uses repo by buying first, and then repoing the security, he can get the needed funds cheaper because there will be collateral behind the "loan." As a result, both the transaction costs and the interest rate will be lower. In addition, transactions are grouped and written on a single ticket. Given the lower risks, higher flexibility, and other conveniences, repo transactions are very liquid and practical.

With a repo the sequence of transactions changes. In a typical outright purchase a market professional would

$$\text{Secure funds} \rightarrow \text{Pay for the security} \rightarrow \text{Receive the security} \tag{1}$$

When repo markets are used for buying a security, the sequence of transactions becomes:

$$\text{Buy the bond} \rightarrow \text{Immediately repo it out} \rightarrow \text{Secure the funds} \rightarrow \text{Pay for the bond} \tag{2}$$

In this case, the repo market is used for finding cheap funding for the purchases the practitioner needs to make. The bond is used as collateral. If this is a default-free security, borrowed funds will come with a relatively low *repo rate*.

Similarly, shorting securities also becomes possible. The market participant will use the repo market and go through the following steps:

$$\text{Deliver the cash and borrow the bond} \rightarrow \text{Return the bond and receive cash plus interest} \tag{3}$$

The market practitioner will earn the *repo rate* while borrowing the bond. This is equivalent to the market practitioner holding a short-term bond position. The bond is not purchased, but it is "leased."

2.1. A Convention

The following can get very confusing if not enough attention is paid to it. In repo markets most of the terminology is set from the point of view of the *repo dealer*. Also, words such as

"borrowing" and "lending" are used as if the item that changes hands is *not* cash, but a *security* such as a bond or equity. In particular, the terms "lender" or "borrower" are determined by the lending and borrowing of a security and not of "cash"—although in the actual exchange, cash is changing hands.

Accordingly, in a repo transaction where the security is first delivered to a client and cash is received, the repo dealer is the "lender"—he or she lends the security and gets cash. This way, the repo dealer has raised cash. If, on the other hand, the same operation was initiated by a client and the counterparty was a repo dealer, the deal becomes a *reverse repo*. The dealer is borrowing the security, the reverse of what happens in a repo operation.

2.2. Special versus General Collateral

Repo transactions can be classified into two categories. Sometimes, specific securities receive special attention from markets. For, example, some bonds become cheapest-to-deliver. The "shorts" who promised delivery in the bond futures markets are interested in a particular bond and not in others that are similar. This particular bond becomes very much in demand and *goes special* in the repo markets. A repo transaction that specifies the particular security in detail is called a *special repo*. The security remains *special* as long as the relative scarcity persists in the market.

Otherwise, in a repo deal, the party that lends the securities can lend any security of a similar risk class. This type of security is called *general collateral*. One party lends U.S. government bonds against cash, and the counterparty does not care about the particular bonds this basket contains. Then the collateral could be any Treasury bond.

The *special* security will have a higher price than its peers, as long as it remains special. This means that to borrow this security, the client gives up his or her cash at a lower interest rate. After all, the client really needs this particular bond and will therefore have to pay a "price"—agreeing to a lower repo rate.

The interest rate for general collateral is called the *repo rate*. Specials command a repo rate that is significantly lower. In this case, the cash can be re-lent at a higher rate via a general repo and the original owner of the "special" benefits.

EXAMPLE:

Suppose repo rate quotes are 4.5% to 4.6%. You own a bond worth 100, which by chance goes special the next day. You can lend your bond for, say, USD100, and get cash for 1 week and pay only 2.5%. This is good, since you can immediately repo this sum against general collateral and earn an annual rate of 4.5% on the 100. You have earned an enhanced return on your bond because you just happened to hold something special.

When using bond market data in research, it is important to take into account the existence of specials in repo transactions. If "repo specials" are mixed with transactions dealing with general collateral, the data may exhibit strange variations and may be quite misleading. This point is quite relevant since about 20% of repo transactions involve specials.

2.2.1. Why Do Bonds Go Special?

There are at least two reasons why some securities go special systematically. For one, some bonds are *cheapest-to-deliver* (CTD) in bond futures trading (see the case study at the end of this chapter). The second reason is that *on-the-run* issues are more liquid and are therefore more in demand by traders in order to support hedging and position-taking activities. Such

"benchmark" bonds often go special. This is somewhat paradoxical, as the more liquid bonds become the more expensive they are to obtain relative to others.[1]

As an example, consider the so-called *butterfly trades* in the fixed-income sector. Nonparallel shifts that involve the *belly* of the yield curve are sometimes called *butterfly shifts*. These shifts may have severe implications for balance sheets and fixed-income portfolios. Traders use 2-5-10 year on-the-run bonds to put together hedging trades, to guard, or speculate against such yield curve movements. These trades are called butterfly trades. The on-the-run bonds used in such strategies may become "benchmarks" and may go special.

2.3. Summary

We can now summarize the discussion. What are the advantages of repo transactions?

1. A repo provides *double security* when lending cash. These are the (high) credit rating of a repo dealer and the collateral.
2. A "special" repo is a unique and convenient way to enhance returns.
3. By using repo markets, traders can short the market and raise funding efficiently. This improves general market efficiency and trading.
4. Financial strategies and product structuring will benefit due to lower transaction costs, more efficient use of time, and lower funding costs.

We now consider various types of repo or repo-type transactions.

3. Types of Repo

The term "repo" is used for selling and then simultaneously repurchasing the same instrument. But in practice, this operation can be done in different ways, and these lead to slightly different repo categories.

3.1. Classic Repo

A *classic repo* is also called a U.S.-style repo. This is the operation that we just discussed. A repo dealer owns a security that he or she sells at a price, 100. This security he or she immediately promises to repurchase at 100, say in 1 month. At that time, the repo dealer returns the original cash received, *plus* the repo interest due on the sum.

EXAMPLE:

An investor with a fixed income portfolio wants to raise cash for a period of one week only. This will be done through lending a bond on the portfolio. Suppose the trade date is Monday morning. The parameters of the deal are as follows:

Value date: Deal date + 2 days

Start proceeds: 50 million euro

Collateral: 6 3/4% 4/2003 Bund (the NOMINAL value equals 47.407m)

[1] An *on-the-run* issue is the latest issue for a particular maturity, in a particular risk class. For example, an on-the-run 10-year treasury will be the last 10-year bond sold in a treasury auction. Other 10-year bonds will be *off-the-run*.

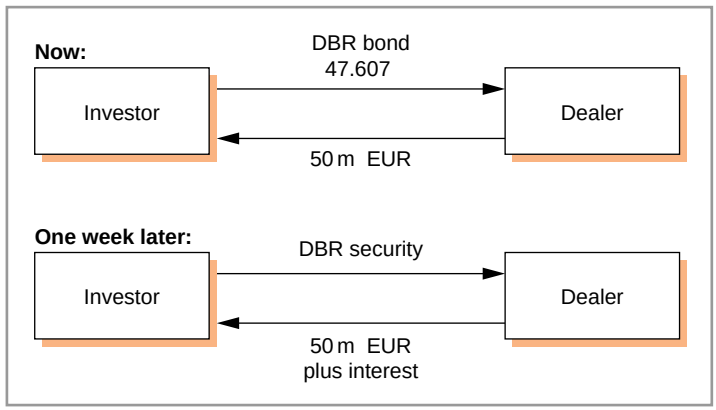

FIGURE 6-1

Term: 7 days

Repo rate: 4.05%

End proceeds: Start proceeds + (start proceeds × repo rate × term)

This gives

EUR 50m + (EUR 50 m × .0405 × 7/360) = EUR 50,039,375

Repo interest: 39,375

Thus, by lending 47,407,000 of nominal bonds (DBRs), the investor borrows EUR 50 million. (See Figure 6-1).

The difference between the nominal and 50m is due to the existence of accrued interest. Accrued interest needs to be added to the nominal. That is to say, the calculations are done using bond's dirty price.

Before we look at further real-life examples, we need to consider other repo types.

3.2. Sell and Buy-Back

A second type of repo is called *sell and buy-back*. The end result of a sell and buy-back is no different from the classic repo. But, the legal foundations differ, which means that credit risks may also be different. In fact, sell and buy-backs exist in two different ways. Some are undocumented. Two parties write two separate contracts at the same time t_0. One contract involves a spot sale of a security, while the other involves a forward repurchase of the same security at a future date. Everything else being the same, the two prices should incorporate the same interest component as in the classic repo. In the documented sell and buy-back, there is a single contract, but the two operations are again treated as separate.

EXAMPLE:

We use the same parameters as in the previous example, but the way we look at the operation is different although the interest earned is the same:

Nominal: EUR 47.607 million Bund 6 3/4% 4/2003

Start price: 101.971

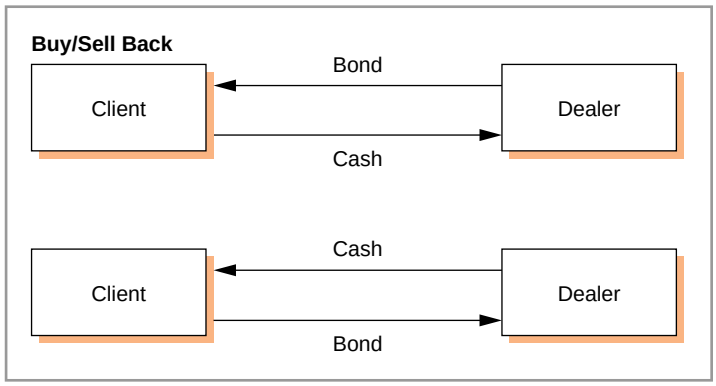

FIGURE 6-2

Plus accrued interest: 3.05625

Total price: 105.02725

Start proceeds: EUR 50,000,322.91

End price: 101.922459

Plus accrued interest: 3.1875

Total price 105.109959

End proceeds: 50,039,698.16

Repo interest earned: EUR $50000322.91 \times .0405 \times 7/360 = 39375$

In this case the investor's interest cost is the difference between the purchase price and selling price. The interest earned is exactly the same as in classic repo, but the way interest rate is characterized is different. We show the deal in Figure 6-2.

The major difference between the two repo types lies not in the mechanics, or in interest earned, but in the legal and risk management aspects. First of all, sell and buy-backs have no mark-to-market. So they are "easier" to book. Second, in case of undocumented sell and buy-backs, no documentation means lower legal expenses and lower administrative costs. Yet, associated credit risks may be higher. In particular, with sell and buy-backs there is no specific right to offset during default.

3.3. Securities Lending

Securities lending is older than repo as a transaction. It is also somewhat less practical than repo. However, the mechanics of the operation are similar. The main difference is that one of the parties to the transaction may not really need the cash that a repo would generate. But this party may still want to earn a return, hence, the party simply lends out the security for a fee. Any cash received may be deposited as collateral with another entity.

Clearing firms such as Euroclear and Cedel do securities lending. Suppose a bond dealer is a member of Cedel. The dealer sold a bond that he or she did not own, and could not find in the markets for an on-time delivery. This may result in a *failure to deliver*. Cedel can automatically lend this dealer a security by borrowing (at random) from another member.

Notice that here securities can be lent not only against cash but against other securities as well. The reason is simple: the lender of the security does not need cash, but rather needs collateral. The collateral can even be a letter of credit or any other acceptable form.

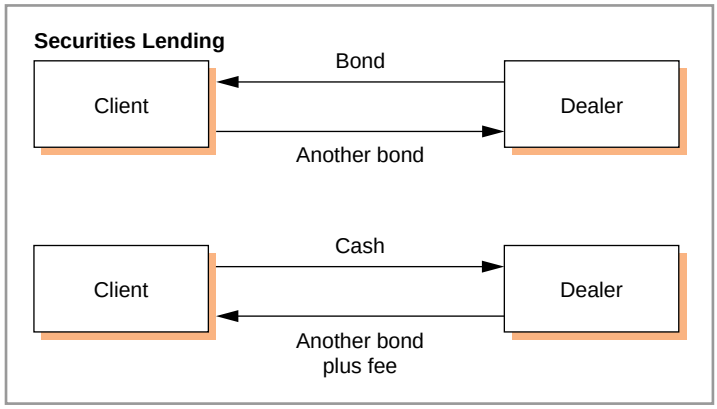

FIGURE 6-3

One difference between securities lending and repo is in their quotation. In securities lending, a fee is quoted instead of a repo rate.

EXAMPLE:

Nominal: GBP 10 million 8.5% 12/07/05 is lent for 2 weeks

Collateral: GBP 10.62 million 8% 10/07/06

Fee: 50 bp

Total fee: 50 bp × (14 days/360) × GBP10 million

Obviously, the market value of the collateral will be at least equal to the value of borrowed securities. All other terms of the deal will be negotiated depending on the credit of the borrowing counterparty and the term. This transaction is shown in Figure 6-3.

3.4. Custody and Repo Types

There are different ways of holding the collateral. A classic type is *delivery-repo*. Here the security is delivered to the counterparty. It is done either by physical delivery or as a transfer of a book entry. A second category is called *hold-in-custody repo*, where the "seller" (lender) keeps the security on behalf of the buyer during the *term* of the repo. This is either because it is impossible to make the transfer or because it is not worth it due to time or other limitations.

The third type of *custody* handling is through a *triparty repo*, where a third party holds the collateral on behalf of the "buyer" (borrower). Often the two parties have accounts with the same custodian, in which case the triparty repo involves simply a transfer of securities from one account to another. This will be cheaper since fewer fees or commissions are paid. In this case, the custodian also handles the technical details of the repo transaction such as (1) ensuring that delivery versus payment is made and (2) ensuring marking to market of the collateral.

Based on all of this, a good clearing, custody, and settlement infrastructure is an essential prerequisite for a well-functioning repo market.

3.4.1. What Is a Matched-Book Repo Dealer?

Repo dealers are in the business of writing repo contracts. At any time, they post bid and ask repo rates for general, as well as special, collateral. In a typical repo contributor page of Reuters or Bloomberg, the specials will be clearly indicated and will command special prices (i.e., special

repo rates). At any time, the repo dealer is ready to borrow and lend securities, whether they are special or general collateral. This way, books are "matched." But this does not mean that dealers don't take one-way positions in the repo book. Their profit comes from bid-ask spreads and from taking market exposure when they think it is appropriate to do so.

3.5. *Aspects of the Repo Deal*

We briefly summarize some further aspects of repo transactions.

1. A repo is a temporary exchange of securities against cash. But it is important to realize that the party who borrows the security *has* temporary ownership of the security. The underlying security can be sold. Thus, repo can be used for short-selling.
2. Because securities borrowed through repo can, in general, be sold, the securities returned in the second leg of the repo do not have to be identical. They can be "equivalent," unless specified otherwise in the repo deal.
3. In a repo deal, the lender of the security transfers the title for a short period of time. But the original owner *keeps* the risk and the return associated with the security. Thus, coupon payments due during the term of the repo are passed on to the original owner of the security.

   The risk remains with the original owner also because of the marking to market of the borrowed securities. For example, during the term of the repo, markets might crash and the value of the collateral may decrease. The borrower of the security then has the right to demand additional collateral. If the value of the securities increases, some of the collateral has to be returned.
4. Coupon or dividend payments during the term of the repo are passed on to the original owner. This is called *manufactured dividend*, and can occur at the end of the repo deal or some time during the term of the repo.[2]
5. Repo markets have a practice similar to that of initial margin in futures markets. It is called *haircut*. The party borrowing the bonds may demand additional security for delivering cash. For example, if the current market value of the securities is 100, the party may pay only 98 against this collateral. Note that if a client faces a 2% haircut when he or she borrows cash in the repo market, the repo dealer can repo the same security with zero haircut and benefit from this transaction.
6. In the United States and the United Kingdom, repo documentation is standardized. A standard repo contract is known as a PSA/ISMA global repo agreement.
7. In the standard repo contract, it is possible to substitute other securities for the original collateral, if the lender desires so.
8. As mentioned earlier, the legal title of the repo passes on to the borrower (in a classic repo), so that in case of default, the security automatically belongs to the borrower (buyer). There will be no need to establish ownership.

Finally we should mention that settlement in a classic repo is delivery versus payment (DVP). For international securities, the parties will in general use Euroclear and Cedel.

There are three possible ways to settle repo transactions: (1) *cash settlement*, which involves the same-day receipt of "cash"; (2) *regular settlement*, where the cash is received on the first business date following a trade date; and (3) *skip settlement*, when cash is received 2 business days after the trade date.

[2] Manufactured dividend is due on the same date as the date of the coupon. But for sell and buy-back this changes. The coupon is paid at the second leg.

3.6. Types of Collateral

The best-known repo collateral is, of course, government bonds, such as U.S. Treasuries. Every economy with a liquid government bond market will also have a liquid repo market if it is permissible legally. Yet, there are many types of collateral other than sovereign bonds. One of the most common collateral types is MBS or ABS securities. Many hedge funds carry such securities with repo funding. Other collateral types are emerging market repo and equity repo, discussed below.

3.7. Repo and Credit Risk

During the unfolding of the credit crisis of 2007, repo strategies played a significant role. Several "vehicles" established by backs had repoed structured assets to secure funding. Among these were senior tranches of CDOs that carried an AAA rating. However, repo is senior to senior tranches. During a margin call, the repo dealer has the first right to the collateralized assets, if additional margin is not posted. In this sense, repo funding does introduce additional credit risk.

4. Equity Repos

If we can repo bonds out, can we do the same with equities? This would indeed be very useful. Equity repos are becoming more popular, but, from a financial engineering perspective, there are potential technical difficulties:

1. Equities pay dividends and make rights issues. There are mergers and acquisitions. How would we take these events into consideration in a repo deal? It is easy to account for coupons because these are homogeneous payouts. But mergers, acquisitions, and rights issues imply much more complicated changes in the underlying equity.
2. It is relatively easy to find 100 million USD of a single bond to repo out; how do we proceed with equities? To repo equities worth 100 million USD, a portfolio needs to be put together. This complicates the instrument, and makes it harder to design a liquid contract.
3. The nonexistence of a standard equity repo agreement also hampers liquidity. In the UK, this business is conducted with an equity annex to the standard repo agreement.
4. Finally, we should remember that equity has higher volatility which implies more frequent marking to market.

We should also point out that some investment houses carry old-fashioned equity swaps and equity loans, and then label them as equity repos.

5. Repo Market Strategies

The previous sections dealt with repo mechanics and terminology. In this section, we start using repo instruments to devise financial engineering strategies.

5.1. Funding a Bond Position

The most classic use of repo is in funding fixed-income portfolios. A dealer thinks that it is the right time to buy a bond. But, as is the case for market professionals, the dealer does not have

cash in hand, but he can use the repo market. A bond is bought and repoed out at the same time to secure the funds needed to pay for it. The dealer earns the bond return; his cost will be the repo rate.

The same procedure may be used to fund a fixed-income portfolio and to benefit from any opportunities in the market, as the following reading shows.

EXAMPLE:

Foreign fund managers have recently been putting on bond versus swap spread plays in the Singapore dollar-denominated market to take advantage of an expected widening in the spread between the term repo rate and swap spreads. "It's one of the oldest trades in the book," said [a trader] noting that it has only recently become feasible in the local market. . . .

In a typical trade, an investor buys 10-year fixed-rate Singapore government bonds yielding 3.58%, and then raises cash on these bonds via the repo market and pays an annualized funding rate of 2.05%. . . . At the same time the investor enters a 10-year interest-rate swap in which it pays 3.715% fixed and receives the floating swap offer rate, currently 2.31%. While the investor is paying out 13.5 basis points on the difference between the bond yield it receives and the fixed rate it pays in the swap, the position makes 26 bps on the spread between the floating rate the investor receives in the swap and the term repo funding rate. The absolute levels of the repo and swap offer rate may change, but the spread between them is most likely to widen, increasing the profitability of the transaction.

One of the most significant factors that has driven liquidity in the repo is that in the last few months the Monetary Authority of Singapore has started using the repo market for monetary authority intervention, rather than the foreign exchange market which it had traditionally used . . . (Based on an article in Derivatives Week).

We will analyze this episode in detail using the financial engineering tools developed in earlier chapters. For simplicity, we assume that the underlying are par bonds and that the swap has a 3-year maturity with the numerical values given in the example above.[3] The bond position of the trader is shown in Figure 6-4a. A price of 100 is paid at t_0 to receive the coupons, denoted by C_{t_0}, and the principal. Figure 6-4b shows the swap position. The swap "hedges" the fixed coupon payments, and "converts" the fixed coupon receipts from the bond into floating interest receipts. The equivalent of Libor in Singapore is Sibor. After the swap, the trader receives Sibor-13.5 bp. This is shown in Figure 6-4c which adds the first two cash flows vertically. At this point, we see another characteristic of the position: The trader receives the floating payments, but still has to make the initial payment of 100. This means the trader has to get these funds from somewhere.

One possibility is to borrow them from the market. A better way to obtain them is the repo. By lending the bond as collateral, the player can get the needed funds, 100 – assuming zero haircut. This situation is shown in Figure 6-5. We consider, artificially, a 1-year repo contract and assume that the repo can be rolled over at unknown repo rates R_{t_1} and R_{t_2} in future periods. According to the reading, the current repo rate is known:

$$R_{t_0} = 2.05\% \tag{4}$$

Adding the first two positions in Figure 6-5 vertically, we obtain the final exposure of the market participant.

[3] It is straightforward for the reader to extend the graphs given here to 10-year cash flows.

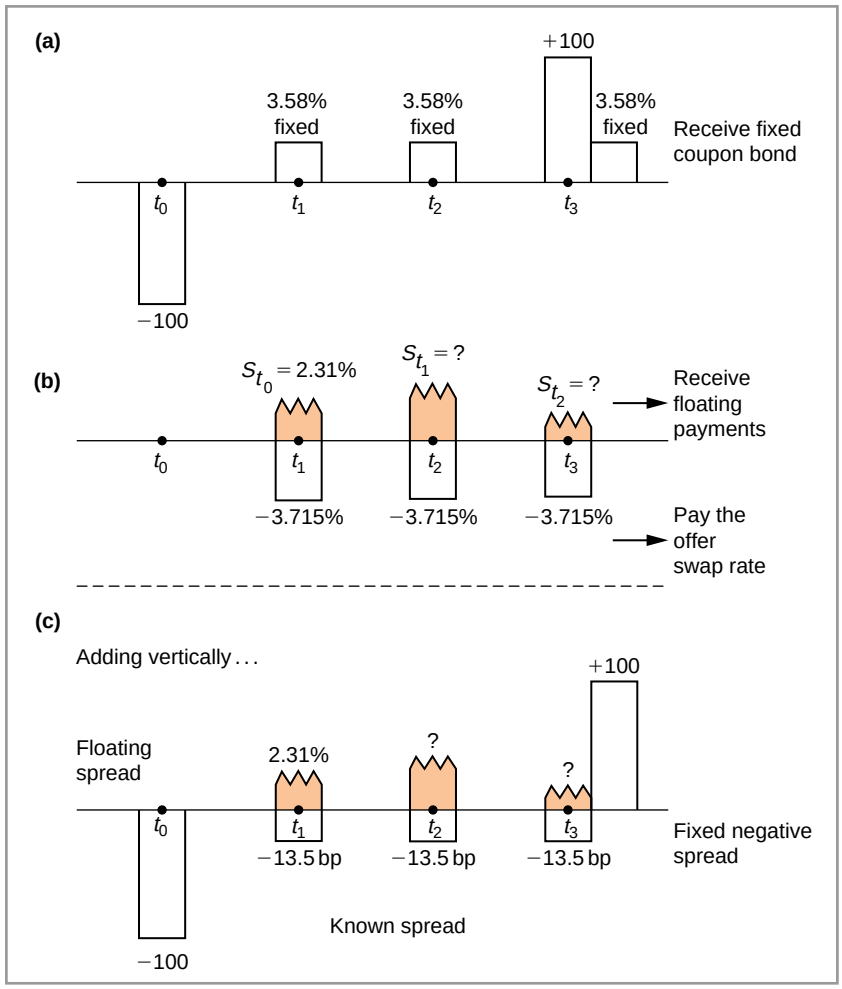

FIGURE 6-4

The market participant has a 12.5 bp net gain for 1 year. But, more important, the final position has the following characteristic: the market participant is long a forward floating rate bond, which pays the floating Sibor rates S_{t_1} and S_{t_2}, minus the spread, with the following expectation:

$$S_{t_1} > R_{t_1} + 13.5\,\text{bp} \tag{5}$$

$$S_{t_2} > R_{t_2} + 13.5\,\text{bp} \tag{6}$$

That is to say, if the spread between future repo rates and Sibor tightens below 13.5 bp, the position will be losing money. This is one of the risks implied by the overall position. The lower part of Figure 6-5 shows how this exposure can be hedged. To hedge the position, we would need to go short the same bond forward.

5.1.1. A Subtle Risk

There is another, more subtle risk in this "classical" position. The investor is short the bond, and is paying a fixed swap rate. It is true that if the rates move in a similar way, the par bond and the par swap gains or losses would cancel each other.

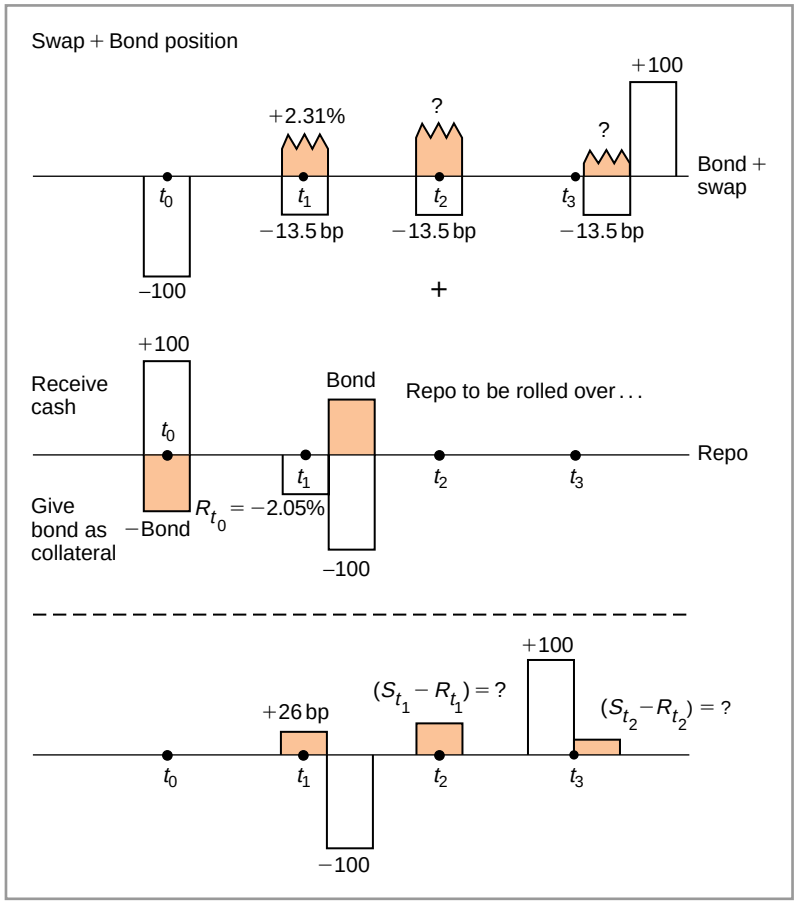

FIGURE 6-5

Yet, the swap spread, $S_{t_0} - C_{t_0}$ can also change. For example, suppose S_t remains the same but C_t increases significantly, implying a lower swap spread. Then, the value of the swap would remain the same, but the value of the bond would decline. Overall, the bond plus swap position would lose money.

More important, the repo dealer would ask for more collateral since the original collateral is now less than the funds lent.

5.1.2. The Asset Swap

There is another way we can describe this position. The investor is buying the bond using repo and *asset swapping* it. This terminology is more current.

5.1.3. Risks and Pricing Aspects

The position studied in the previous section is quite common in financial markets. Practitioners call these *arbitrage plays* or just *arb*. But it is clear from the cash flow diagrams that this is not the arbitrage that an academic would refer to. In the preceding example, there was no initial investment. The immediate net gain was positive, but the practitioner had an open position which was risky. The position was paying net 12.5 bp today, however, the trader was

taking the risk that the future spreads between repo rates and Sibor could tighten below 13.5 basis points. It is true that a 6-month Sibor has a longer tenor than, say, a 1-month repo rate and, assuming a positively sloped yield curve, the spread will be positive; but this cannot be guaranteed.

Second, the player is assuming different credit risks. He or she is paying a low 2.05% on the repo financing because it is backed by Singapore government bonds. On the other hand, the 2.31% received from the Sibor side is on a loan made to a high-quality *private* sector credit. Thus, the question remains: Is the net return of 12.5 bp worth the risks taken?

5.1.4. An Arbitrage Approach

There *is* a way to evaluate the appropriateness of the 12.5 bp return mentioned in the example. In fact, the market practitioner's final position is equivalent to owning a *basis swap* between the repo rate and the floating swap reference rate (assuming swap spreads do not change). After all, the position taker is receiving the floating rate in the swap and paying the repo rate.

Suppose the repo and swap have identical settlement dates t_i. The final position is one where, at each settlement date, the position taker will receive

$$(L_{t_{i-1}} + 12.5\,\text{bp} - R_{t_{i-1}})\delta N \tag{7}$$

Clearly, this is similar to the settlement of a basis swap with a 12.5 bp spread and notional amount N. If such basis swaps traded actively in the Singapore market, one could evaluate the strategy by comparing the net return of 12.5 bp with the basis swap spread observed in the market. If they are equal, then the same position can be taken directly in the basis swap market. Otherwise, if the basis swap rate is different than 12.5 bp, then a true arbitrage position may be put in place by buying the cheaper one and simultaneously selling the more expensive position.

5.2. *Futures Arbitrage*

Repo plays a special role in bond and T-bill futures markets. Consider a futures position with expiration $t_0 + 30$ days. In 30 days, we will take possession of a default-free zero coupon bond with maturity T at the predetermined futures price P_{t_0}. Hence, at settlement, P_{t_0} dollars will be paid and the 1-year bond will be received. Of course, at $t_0 + 30$ the market value of the bond will be given by $B(t_0 + 30, T)$ and will, in general, be different than the contracted P_{t_0}. The repo market can be used to hedge this position. This leads us to the important notion of *implied repo rate*.

How can we use repo to hedge a short bond futures position? We dealt with this idea earlier in the discussion of cash and carry trades: secure funding, and buy a $T + 30$ day maturity bond at t_0. When time $t_0 + 30$ arrives, the maturity left on this bond will be T, and thus the cash and carry will result in the same position as the futures. The practitioner borrows USD at t_0, buys the $B(t_0, T + 30)$ bond, and keeps this bond until time $t_0 + 30$.

The novelty here is that we can collapse the two steps into one by buying the bond, and then immediately repoing it to secure financing. The result should be a futures position with an equivalent price.

This means that the following equation must be satisfied:

$$P_{t_0} = B(t_0, T + 30)\left(1 + R_{t_0}\frac{30}{360}\right) \tag{8}$$

In other words, once the carry cost of buying the $T + 30$–day maturity bond is included, the total amount paid should equal P_{t_0}, the futures price of the bond.

Given the market quotes on the P_{t_0}, $B(t_0, T+30)$, market practitioners solve for the unknown R_{t_0} and call this the *implied repo rate*:

$$R_{t_0} = \left[\frac{P_{t_0}}{B(t_0, T+30)} - 1\right]\frac{360}{30} \tag{9}$$

The implied repo rate is a pure arbitrage concept and shows the carry cost for fixed-income dealers.

5.3. Hedging a Swap

Repo can also be used to hedge swap positions. Suppose a dealer transacts a 100 million 2-year swap with a client. The dealer will *pay* the fixed 2-year treasury plus 30 bp, which brings the bid swap rate to, say, 5.95%. As usual, Libor will be received. The dealer hedges the position by buying a 2-year treasury.

In doing this, the dealer expects to transact another 2-year swap "soon" with another client, and *receives* the fixed rate. Given that the asking rate is higher than the bid swap rate, the dealer will capture the bid-ask spread. Suppose the ask side swap spread is 33 bp. Where does the repo market come in? The dealer has hedged the swap with a 2-year treasury, but how is this treasury funded? The answer is the repo market. The dealer buys the treasury and then immediately repos it out overnight. The repo rate is 5.61%. The dealer expects to find a matching order in a few days. During this time, the trader has exposure to (1) changes in the swap spread and (2) changes in the repo rate.

5.4. Tax Strategies

Consider the following situation:

- Domestic bond holders pay a withholding tax, while foreign owners don't. Foreign investors receive the gross coupons.

The following operation can be used. The domestic bond holder repos out the bond just before the coupon payment date to a foreign dealer (i.e., a tax-exempt counterparty). Then, the lender receives a manufactured dividend, which is a gross coupon.[4]

This is legal in some economies. In others, the bond holder would be taxed on the theoretical coupon he or she would have received if the bond had not been repoed out. Repoing out the bond to avoid taxation is called *coupon washing*.

EXAMPLE:

Demand for Thai bonds for both secondary trading and investment has partly been spurred by the emergence of more domestic mutual funds, which have been launching fixed-income funds. However, foreign participation in the Thai bond market is limited because of withholding taxes.

"Nobody's figured out an effective way to wash the coupon to avoid paying withholding taxes," said one investment banker in Hong Kong. Coupon washing typically involves an offshore investor selling a bond just before the coupon payment date to a domestic

[4] Note that one of the critical points is "when" a manufactured dividend is paid. If this is paid at the expiration date, coupons can be transferred into the next tax year.

counterparty. Offshore entities resident in a country having a tax treaty with the country of the bond's origin can also serve to wash coupons.

In return, the entity washing the coupon pays the offshore investor the accrued interest earned for the period before it was sold—less a small margin. Coupon washing for Thai issues is apparently widespread but is becoming more difficult, according to some sources. (IFR, Issue 1129).

Another example of this important repo application is from Indonesia.

EXAMPLE:

A new directive from Indonesia's Ministry of Finance has put a temporary stop to coupon-washing activities undertaken by domestic institutions on behalf of offshore players. The new directive, among other things, requires that tax be withheld on the accrued interest investors earn from their bond holdings. . . .

Before the directive was issued a fortnight ago, taxes were withheld only from institutions that held the bond on coupon payment date. Offshore holders of Indonesian bonds got around paying the withholding tax by having the coupons washed.

Typically, coupon-washing involves an offshore institution selling and buying its bonds—just before and after the coupon payment dates—to tax-exempt institutions in Indonesia. As such, few bond holders—domestic or offshore—paid withholding taxes on bond holdings. Because the new directive requires that accrued interest on bonds be withheld, many domestic institutions have stopped coupon washing for international firms. (IFR, Issue 1168)

The relevance of repo to taxation issues is much higher than what these readings indicate. The following example shows another use of repo.

EXAMPLE:

In Japan there is a transaction tax on buying/selling bonds—the transfer tax. To (cut costs), repo dealers lend and borrow Japanese Government Bonds (JGB's) and mark them to market every day.

The traders don't trade the bond but trade the name registration forms *(NRF). NRF are "memos" sent to Central Bank asking for ownership change. They are delivered to local custodians. The bond remains in the hands of the original owner, which will be the issuer of the NRF.*

JGB trading also has a no-fail *rule, that is to say failure to deliver carries a very high cost and is considered taboo. (IFR, Issue 942)*

Many of the standard transactions in finance have their roots in taxation strategies as these examples illustrate.

6. Synthetics Using Repos

We will now analyze repo strategies by using contractual equations that we introduced in previous chapters. We show several examples. The first example deals with using repos in *cash-and-carry arbitrage*, we then manipulate the resulting contractual equations to get further synthetics.

6.1. A Contractual Equation

Let F_t be the forward price observed at time t, for a Treasury bond to be delivered at a future date T, with $t < T$. Suppose the bond to be delivered at time T needs to have a maturity of U years. Then, at time t, we can (1) buy a $(T - t) + U$ year Treasury bond, (2) repo it out to get the necessary cash to pay for it, and (3) hold this repo position until T. At time T, cash plus the repo interest has to be returned to the repo dealer and the bond is received. The bond will have a maturity of U years. As seen above, these steps will result in exactly the same outcome as a bond forward. We express these steps using a contractual equation. This equation provides a synthetic forward.

Forward purchase a $U-$ year bond to be delivered at T	$=$	Buy a $T+U-t$ year bond at t	$+$	Repo the bond with term $T-t$

(10)

According to this, futures positions can be fully hedged by transactions shown on the right-hand side of the equation. This contractual equation can be used in several interesting applications of repo transactions. We discuss two examples.

6.2. A Synthetic Repo

Now rearrange the preceding contractual equation so that repo is on the left-hand side:

Bond repo with term $T-t$	$=$	Forward purchase of $U-$ year bond to be delivered at T	$-$	Buy a $T+U-t$ year bond at t

(11)

Thus, we can easily create a synthetic repo transaction by using a spot *sale* along with a forward purchase of the underlying asset.[5]

6.3. A Synthetic Outright Purchase

Suppose for some reason we don't want to buy the underlying asset directly. We can use the contractual equation to create a spot purchase synthetically. Moving the spot operation to the left-hand side,

[5] Remember that a minus sign before a contract means that the transaction is reversed. Hence, the spot purchase becomes a spot sale.

Outright purchase of $T+U-t$ year bond at t	$=-$	Repo with term $T-t$	$+$	Forward purchase of a $U-$ year bond at T	(12)

The right-hand side operations are equivalent to the outright purchase of the security.

6.4. *Swaps versus Repo*

There may be some interesting connections between strips, swaps, and repo market strategies. For example, if strips are purchased by investors who hold them until maturity, there will be fewer whole-coupon bonds. This by itself raises the probability that these bonds will trade as "special." As a result, the repo rate will on the average be lower, since the trader who is *short* the instrument will have to accept a "low" repo rate to get the security that is "special" to him or her.[6]

According to some traders, this may lead to an increase in the average swap spread because the availability of cheap funding makes *paying* fixed relatively more attractive than *receiving* fixed.

7. Conclusions

Repo markets may seem obscure. Yet, they are crucial for a smooth operation of financial systems. Many financial strategies would be difficult to implement if it weren't for the repo. This chapter has shown that repos can be analyzed with the same techniques discussed in earlier chapters.

Suggested Reading

Relatively few sources are available on repos, but the ones that exist are good. One good text is ***Steiner*** *(1997). Risk, Euromoney, and similar publications have periodic supplements that deal with repo. These supplements contain interesting examples in terms of recent repo market strategies. Many of the examples in this chapter are taken from such past supplements.*

[6] But according to other traders, there is little relation between strips and U.S. repo rates, because what is mostly stripped are off-the-run bonds. And off-the-run issues do not, in general, go "special."

Exercises

1. A dealer needs to borrow EUR 30 million. He uses a Bund as collateral. The Bund has the following characteristics:

   - Collateral 4.3% Bund, June 12, 2004
   - Price: 100.50
   - Start date: September 10
   - Term: 7 days
   - Repo rate: 2.7%
   - Haircut: 0%

   (a) How much collateral does the dealer need?
   (b) Two days after the start of the repo, the value of the Bund increases to 101. How much of the securities will be transferred to whom?
   (c) What repo interest will be paid?

2. A dealer repos $10 million T-bills. The haircut is 5%. The parameters of the deal are as follows:

   - T-bill yield: 2%
   - Maturity of T-bills: 90 days
   - Repo rate: 2.5% term: 1 week

   (a) How much cash does the dealer receive?
   (b) How much interest will be paid at the end of the repo deal?

3. A treasurer in Europe would like to borrow USD for 3 months. But instead of an outright loan, the treasurer decides to use the repo market. The company has holdings of Euro 40 million bonds. The treasurer uses a *cross-currency* repo. The details of the transaction are as follows:

   - Clean price of the bonds: 97.00
   - Term: September 1 to December 1
   - Last coupon date on the bond: August 12
   - Bond coupon 4% item EUR/USD exchange rate: 1.1150
   - 3-month USD repo rate: 3%
   - Haircut: 3%

   (a) What is the invoice price (*dirty price*) of the bond in question?
   (b) Should the repo be done on the dirty price or the clean price?
   (c) How much in dollars is received on September 1?
   (d) How much repo interest is paid on December 1?

CASE STUDY: CTD and Repo Arbitrage

Two readings follow. Please read them carefully and answer the questions that follow. You may have to first review three basic concepts: (1) special repo versus general collateral, (2) the notion of cheapest-to-deliver bonds, and (3) failure to deliver. You must understand these well, otherwise the following strategies will not make sense.

Readings

DB Bank is believed to have pocketed over EUR100 million (USD89.4 million) after reportedly squeezing repo traders in a massive interest-rate futures position. The bank was able to take advantage of illiquidity in the cheapest-to-deliver bond that would have been used to settle a long futures position it entered, in a move that drew sharp criticism from some City rivals.

In the trade, the Bank entered a calendar spread in which it went long the Eurex-listed BOBL March '01 future on German medium-term government bonds and sold the June '01 contract to offset the long position, said traders familiar with the transaction. One trader estimated the Bank had bought 145,000 March '01 contracts and sold the same number of June '01 futures. At the same time the Bank built up a massive long position via the repo market in the cheapest-to-deliver bond to settle the March future, in this case a 10-year Bund maturing in October 2005.

Since the size of the '05 Bund issue is a paltry EUR10.2 billion, players short the March future would have needed to round up 82% of the outstanding bonds to deliver against their futures obligations. "It is almost inconceivable that this many of the Bunds can be delivered," said a director-derivatives strategy in London. "Typically traders would be able to rustle up no more than 25% of a cheapest-to-deliver bond issue," he added.

At the same time it was building the futures position, the Bank borrowed the cheapest-to-deliver bonds in size via the repo market. Several traders claim the Bank failed to return the bonds to repo players by the agreed term, forcing players short the March future to deliver more expensive bonds or else buy back the now more expensive future.

The Bank was able to do this because penalties for failure to deliver in the repo market are less onerous than those governing failure to deliver on a future for physical delivery. Under Eurex rules, traders that fail to deliver on a future must pay 40 basis points of the face value of the bond per day. After a week the exchange is entitled to buy any eligible bond on behalf of the party with the long futures position and send the bill to the player with the short futures position, according to traders. Conversely, the equivalent penalty for failure to deliver in the repo market is 1.33 bps per day (IFR, March 2001).

Eurex Reforms Bobl Future

Eurex is introducing position limits for its September contracts in its two, five, and 10-year German government bond futures. "If we want, we will do it in December as well," said a spokesman for the exchange.

The move is aimed at supporting the early transfer of open positions to the next trading cycle and is a reaction to the successful squeeze of its Bundesobligation (Bobl) or five-year German government bond futures contract in March.

"The new trading rules limit the long positions held by market participants, covering proprietary and customer trading positions," said Eurex's spokesman. Position limits will be set in relation to the issue size of the cheapest-to-deliver bond and will be published six exchange trading days before the rollover period begins (IFR, June 9, 2001).

Part A. First Reading

1. What is a calendar spread? Show DB's position using cash flow diagrams.
2. Put this together with DB's position in the repo market.
3. What is DB's position aiming for?
4. What is the importance of the size of '05 Bund issue? How do traders "rustle up" such bonds to be delivered?
5. Why are penalties for failure to deliver relevant?
6. Would an asset swap (e.g., swapping Libor against the relevant bond mentioned in the paper) have helped the *shorts*? Explain.
7. Could taking a carefully chosen position in the relevant maturity FRA, offset the losses that *shorts* have suffered? Explain carefully.
8. Explain how cheapest-to-deliver (CTD) bonds are determined. For needed information go to Web sites of futures exchanges.

Part B. Second Reading

1. Eurex has made some changes in the Bund futures trading rules. What are these?
2. Suppose these rules had been in effect during March, would they have prevented DB's arbitrage position?
3. Would there be ways DB can still take such a position? What are they?