Spring 5-1-2009

Swaps

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Swaps

A Capstone Project Submitted in Partial Fulfillment of the Requirements
of the Renée Crown University Honors Program at Syracuse University

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May 2009

Honors Capstone Project in Finance

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Abstract

Swaps are versatile financial derivatives that create contracts to exchange future cash flows. Throughout the last several decades the uses and importance of swaps have grown substantially. This document examines swaps from a historical perspective and includes a discussion on issues such as economic justification, industry standardization, market participation, and day-count conventions. Four main classifications of swaps are discussed: interest rate swaps, currency swaps, equity swaps, and commodity swaps. Interest rate swaps are by far the most common; however, each classification offers unique traits that demonstrate the versatility and efficacy of swaps as an asset class. Each class of swap will have a section devoted to its history, basic structure, pricing, valuation, and customization.

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Introduction

What is a swap? Many people have heard the term in recent months referring to risky bets that traders made on Wall Street, but very few individuals could ~~share with you~~offer an explanation on what a swap is. A swap in its simplest form is the exchange of two streams of future cash flows. However, like most things that appear simple, swaps can become as complex as the two parties swapping payments can make them. Complex swaps, also known as "exotic swaps", require the assistance of a financial engineer to create and are beyond the scope of this document. The focus of this thesis will be to assist the reader in gaining an understanding of the swaps market, the different instruments in it, and how they are used.

Parallel Loans

Swaps evolved in the late 1970's to get around inefficient market regulations and constraints. This is similar to the manner in which most financial innovations come to fruition. The first swaps are descendents from the parallel loan market of the 1970's (Flavell, 2002). At the time there were exchange controls in Europe, which made it either very difficult or very expensive for international investment both into and out of Europe.

Flavell uses the example of a UK subsidiary trying to borrow in the United States. Because the parent was restricted in aiding its subsidiary in borrowing without violating the exchange controls, the subsidiary was left trying to raise funds with a lower credit rating in a foreign country where investors might not be familiar with the company and thus less likely to lend it money. A parallel loan

market emerged where two parent companies could borrow in their respective currencies, in this case the US parent company in dollars and the UK parent company in sterling, and transfer the loan to the other's subsidiary doing business in that currency. The US parent would transfer the loan to a subsidiary of the UK parent operating in the US. The UK parent would transfer the loan to a subsidiary of the US parent company operating in the UK. This allowed both subsidiaries to benefit from a higher credit rating in the countries in which they were operating ~~in~~ and thus lower borrowing costs. Essentially the two parent companies were taking out loans and "swapping" them to each other's subsidiaries. ~~and~~ In doing so both parties benefitted from lower borrowing costs.

Back-to-Back Loans

Upon the removal of exchange controls, parallel loans were replaced with back-to-back loans, where the parent companies in different countries would exchange the loans directly with one another (Flavell, 2002). Essentially a company took out a loan in its home currency and transferred it to a company in another country in exchange for a loan in its desired currency. The reason for these transactions rests on the notion of comparative advantage, which will be discussed shortly. The shortcoming of the back-to-back loans is that they showed up on both sides of the parties' balance sheets. This is undesirable for a company looking to maintain certain financial ratios.

Cross-currency swaps evolved soon after where a company could establish forward conditional commitments to exchange the payments of the two loans in the future (Flavell, 2002). So, if a UK company and a US company each

borrowed in their home currency, the forward commitments were agreements to exchange the principal borrowed and the interest payments between the parties over the life of the swap; effectively "swapping" the loans. Each payment of these forward agreements was classified as a contingent sale or purchase, which is an off-balance sheet item. Thus, the first swaps were created to move the transition of borrowing in one currency to another off the balance sheet.

Comparative Advantage

Comparative advantage is an economics term and serves as a possible explanation for why swaps exist. It is often used to demonstrate that even if one trading party can out produce another in all goods, both can still benefit from trade. The logic rests in an idea best explained through an example. Suppose you and I decide to trade the only two goods that we produce and consume: gumballs and lollipops. I can produce up to 100 gumballs or 50 lollipops in a given period of time and you can produce as many as 300 gumballs or 75 lollipops in the same period. We both maximize utility when consuming these goods in equal quantities. Let's say I would maximize utility at consuming 33 of each and you would maximize your utility consuming 60 of each. Clearly you have a higher standard of living, but we both can still gain from trade because I have a comparative advantage at producing lollipops, as I only need to give up 2 gumballs to produce an additional lollipop. You would need to give up 4 gumballs to do the same.

Let us assume that there is a simple trade rate of 3:1 where you and I are willing to exchange 3 gumballs for each lollipop. In this situation, I would

produce no gumballs and 50 lollipops, and you would produce 100 gumballs and 50 lollipops. I could trade 12.5 of my lollipops for 37.5 of your gumballs. My new consumption is 37.5 units of each good. You would receive 12.5 lollipops and give up 37.5 gumballs to consume 62.5 units of each good. We both gain from trade through the increases of our respective consumption and utilities. Therefore so long as significant costs to trade do not exist (we did not assume any shipping or transaction costs) both parties can benefit when one has a comparative advantage. The above example was modeled after one provided by Van Horne (2001).

The idea of comparative advantage applies to borrowing costs as well. Recall the above example where each of the two parent companies borrowed and transferred funds to the others subsidiary. This is because each had an advantage in borrowing in its home market that it then shared with the other so both could gain. Even if one party had an absolute advantage in both markets there is still potential for gains.

After nearly 30 years of functioning swap markets one would think that the comparative advantages and subsequent savings from swaps have been arbitraged away. However, this is assuming that markets are efficient. Van Horne (2001) offers his thoughts on why swaps are still present and growing. He doubts that persistent arbitrage from comparative advantage is the main reason. Another explanation is that swaps provide many useful functions that no other derivative security can provide. Most forward agreements, futures, and options have a maximum expiration of 4-5 years. For those looking for a long-term hedge, swaps

with liquid contracts up to 30 years fill that gap in the marketplace. In addition, just the way some debt securities are structured makes them more expensive than the coupon on a swap, which allows for cost savings by employing a swap. A convertible bond with its built in call option is such an example. Also, general market inefficiencies persist and swaps can be used to exploit them.

Size of Swap Market

Chance (2003) also feels that swaps have found a niche in the derivatives market due to their ready comparison to loans. Referring to interest rate swaps, he states that for banks and corporate treasuries it is a derivative that is easy to understand and very flexible to their needs provides an effective tool for managing risks. This might help explain how annual growth rates for swaps have exceeded 30% every year since the late 1980's and sometimes more than 100% (Kapner and Marshall, 1993). The current market size in terms of the principal or notional outstanding for swaps is more than $400 trillion for all swaps. The most common swaps are interest rates swaps taking up most of that sum with $350 trillion in notional outstanding, up from $200 trillion in June 2006 (Bank for International Settlements, 2008). Figure 1 shows the growth of the overall swaps market since June 2006. Figure 2 shows the size of each swap class over the same period.

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Figure 1

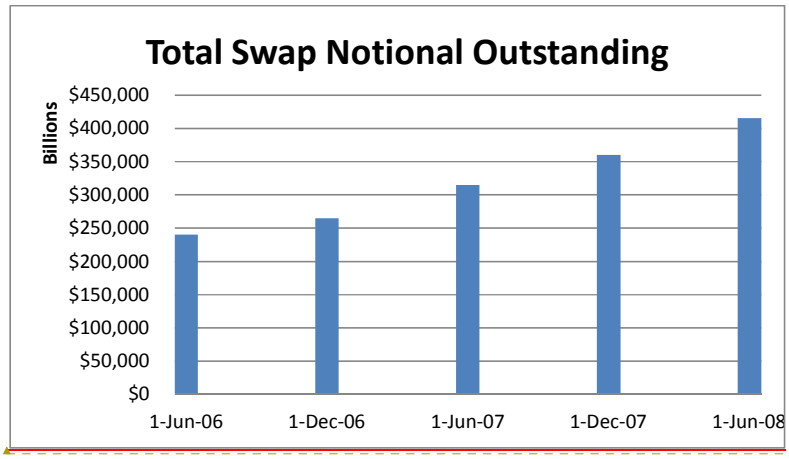

Figure 2

	Jun-06	Dec-06	Jun-07	Dec-07	Jun-08
Currency Swaps, Forwards, and Forex Swaps	$29,103	$30,674	$36,842	$43,491	$48,273
Interest Rate Swaps	$207,588	$229,693	$272,216	$309,588	$356,772
Equity Forwards and Swaps	$1,430	$1,767	$2,470	$2,233	$2,657
Commodity Forwards and Swaps	$2,188	$2,813	$3,447	$5,085	$7,561
Total	$240,309	$264,947	$314,975	$360,397	$415,263

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Notable Example: IBM and the World Bank

Moving ahead with our analysis of swaps, early trades ~~like the ones above~~similar to the back-to-back loans above began to occur. Often these were large companies who agreed to work with one another to save on borrowing costs on international investments. Banks were only just getting involved in the process and usually acted as brokers not counterparties (Kapner and Marshall, 1993). The market remained relatively small until a highly publicized swap took place

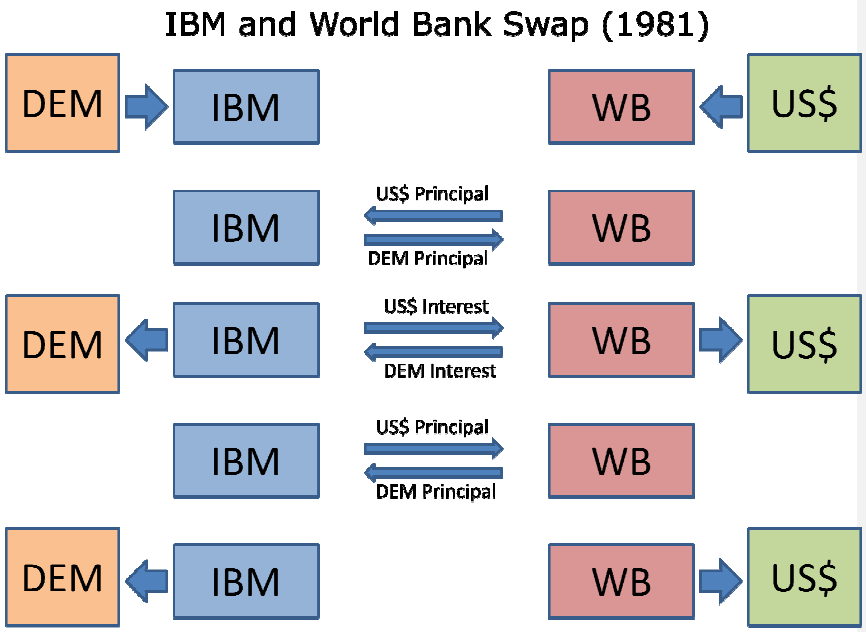
between two reputable organizations in 1981. The famous swap between IBM and the World Bank created a great deal of awareness of the efficacies of swaps. Seeing as this is the deal that put swaps on the map, Flavell's simplified interpretation of this swap will serve as an excellent first real world example and demonstration of comparative advantage. To keep things even simpler only one of the transactions will be discussed.

In 1981, IBM was planning to go on a worldwide fundraising campaign. Its goal was to raise money in other currencies, exchange that money back into dollars and use the funds for general corporate purposes. They did this ~~reason for this was~~ to save money since it could obtain better rates in other currencies. Doing so, though, left it exposed to exchange rate risks as it still had to pay interest payments in a foreign currency,~~;~~ in this case deutschmarks, which will be referred to as DEM. IBM was seeking a way to eliminate this exchange rate risk and treat the debt as if it had been borrowed in dollars. The World Bank liked to raise funds in hard currencies like the DEM.~~,~~ However~~but~~ it had floated so much debt in that currency that the market was flush with World Bank paper and it was not getting funds as~~as~~ cheaply ~~of funds~~ as it would have liked. Therefore in a deal negotiated by Salomon Brothers the two parties agreed to the following.

The World Bank could borrow relatively cheaply in dollars, so it would issue Eurodollar bonds with the principal and maturity matching IBM's DEM borrowings. The two then agreed to swap the principals, in this instance the equivalent of $210 million and pay one another interest in those currencies until termination at which point they would swap the principals back to one another.

This deal effectively removed IBM's exchange rate risk as it was now holding dollars and paying dollars in interest. This move ~~and~~ allowed it to continue borrowing cheaply abroad. The World Bank received lower cost financing in DEM by receiving DEM principal and paying IBM in DEM. Both used their advantages of borrowing in other markets to receive their desired method of financing. This transaction can be seen in Figure 3~~1~~.

Figure 3~~1~~



Looking at Figure 3~~1~~ above, one can clearly see the swap that has taken place. IBM borrows from lenders in deutschmarks and the World Bank borrows in dollars. In the second row, they exchange the principals that they each received from the debt holders. Throughout the life of the swap each pays the interest on the principal swapped, which gets paid through to the debt holders. At expiration

the principals are then swapped back. IBM and the World Bank then repay the debt holders with the principal each just received back from the swap. The net effect is IBM borrowing in dollars and the World Bank in DEM, both at a lower rate than they would have achieved independently. Again, due to comparative advantage, it would not be necessary for each to have lower costs in their respective borrowing currency. The World Bank might have an absolute borrowing advantage in both currencies, but at each party~~least one of the parties~~ has a comparative advantage borrowing in one currency that allows for gains to be made on the swap.

Definition of a Swap and Important Terms

We have discussed a historical context, a brief example, and reasons for swaps to exist, but just what is a swap exactly? As defined by Kapner and Marshall (1993), "a swap is a contractual agreement evidenced by a single document in which two parties, called counterparties, agree to make periodic payments to each other". The two series of cash flows or the legs of the swap can be based on either a fixed or floating interest rate, but at least one side will usually be floating. The fixed rate is called the swap coupon. The real distinguisher for the different types of swaps is what constitutes the floating or variable leg. If the variable leg is a commodity price then unsurprisingly the swap would be called a "commodity swap". The four types of swaps that will be discussed in this document are interest rate, commodity, equity, and currency swaps.

There are some important terms for a first time swap observer to understand~~ so that he or she might understand a conversation about swaps~~. The

first and one of the most important terms is the word “notional”. Often times the amount of money or the principal used to calculate the payments is not exchanged if both legs are in the same currency because it is unnecessary~~would not benefit or change the transaction in anyway~~. Therefore the principal is often referred to as the “notional” value (Van Horne, 2001).

Important dates to keep in mind are: the trade date when the transaction occurs, the effective date when the swap commences, and the maturity date when the swap expires (Kapner and Marshall, 1993). The time length of a swap or the amount of time between the effective date and the maturity date is referred to as its tenor.

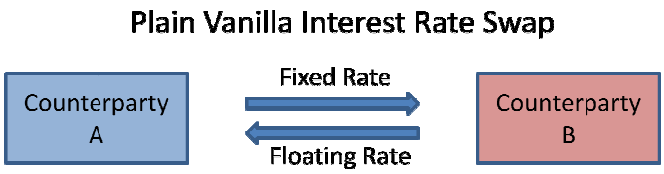
Simple Swap Example

The simplest example of a swap is a plain vanilla interest rate swap. A plain vanilla interest rate swap occurs in the same currency and has one fixed and one floating leg making payments on the same notional value. The most common floating rate is LIBOR or the London Interbank Offered Rate (Hull, 2008). It is usually quoted in frequencies of one, three, six, and twelve months. It is the rate at which a bank would make a deposit at another bank in the Eurocurrency market. These banks are usually highly rated, approximately AA on the S&P rating scale. Though it is not technically risk free as a US Treasury obligation is considered, for all intents and purposes when pricing swaps, LIBOR can be considered a risk free rate.

Figure 4~~2~~ shows a plain vanilla interest rate swap. After the transaction date and beginning on the effective date, interest starts to accrue. The swaps value

is usually set to zero at the start so usually no payments are made at initiation. Pricing for swaps will be discussed in later sections. The first payments are both known with certainty, but the variable payment will reset at the agreed upon interval, usually six months. Once the first payment is made six months after the effective date, the LIBOR rate that is used to calculate the floating payment will be reset to the current market conditions. This will serve as the interest rate for the next floating payment. This continues until the payment date before the maturity date when the very last rate is set, which determines the final payment.

Figure ~~42~~



Users of Swaps

~~It appears that swaps might serve a purpose, but you do not see people walking around swapping their mortgage payments, so who uses them?~~Who uses swaps? Beidleman (1991) suggests that there are natural fixed rate payers and natural floating rate payers at least as far as interest rate swaps go, but this can be applied to other types of swaps as well. A US bank looking to protect itself from interest rate swings would be an excellent candidate for a fixed receiver swap. This is because most of its assets or loans are at fixed rates, while it is financed with variable rate liabilities like savings accounts and certificates of deposit. If rates go too high the bank can find itself borrowing at higher costs than it is receiving on its older loans. This very thing happened in the 1970's and 80's and

led to the closing of many banks. By locking in to pay a fixed rate the bank will match the payment streams of its assets and its liabilities and hopefully secure a profitable spread.

A European bank would typically want the opposite exposure as many of its loans are geared to use LIBOR as the interest rate. Therefore to better match the cash flows of its assets and liabilities a European bank would want to serve as a fixed receiver and pay variable. This is due to the deposit structures where many of their liabilities are at a fixed rate. Since its assets (the loans) are variable, the bank stands to lose money if interest rates go down too much. Therefore the European bank will want to pay the returns from its fixed funding sources in return for variable funding.

Banks are not the only counterparties who benefit from swaps. A gold mine that produces a fairly stable amount of gold each year might be interested in fixing the price it will receive. Therefore it would arrange to pay the spot price to a counterparty and receive a fixed payment. Likewise an equity manager whose portfolio resembles the returns of the S&P 500 may not want to take on any more risk. The manager can swap the variable returns of the S&P 500 and receive a fixed payment. It almost seems as if you can swap anything if you could find a suitable counterparty. Indeed there are hundreds of different swaps available. The variable leg can be signed to such observable phenomena as rainfall, electricity prices, or weather-related damage. However, as mentioned before, commodity, currency, interest rate, and equity swaps form the basic building blocks for most of these instruments~~m~~.

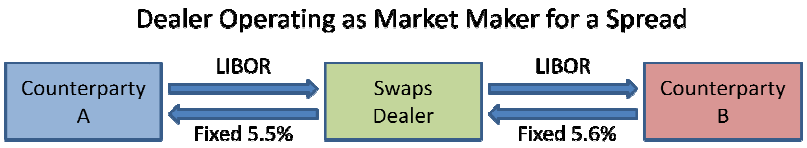
Development of the Modern Swap Market

Looking back at Figure 42 it appears that these two counterparties are making the payments directly to one another. How did they find each other? It was likely necessary to use a broker and pay them a fee. What happens if the two counterparties' needs, once they are matched up, do not match exactly? This was the problem in early swaps markets. Flavell (2002) feels that there were three phases to the development of the swaps market. The first can be found in the IBM – World Bank example. This is when a bank would advise deals, but not take on any risk. Usually the parties involved were highly rated and were not afraid to deal directly with one another. These swaps took time as each deal had to be tailored for each transaction and contracts were started from scratch. This method was expensive and not very efficient.

The next phase occurred in the 1980's when commercial banks began to act as an intermediary. The two parties would go through the bank, which provided more standardized documents and a credit guarantee. The bank would not take on market risk, only credit risk, and the two sides of the swap would still balance one another. This likely allowed more parties to participate in the swaps market, as those who might have been concerned due to ~~raised doubt due to their~~ credit risk were now able to participate. Credit risk is the likelihood that a counterparty will default on its swap payments. With the bank acting in the middle, both counterparties only needed to be concerned about the credit risk of the bank.

The third and final phase began later in the 1980's when commercial and investment banks began to make markets in swaps. This meant that someone~~you~~ could approach a swap dealer and they would quote ~~you~~ a price at which they would be ready to enter a swap. The dealer makes a profit in the spread (see Figure 5~~3~~). For example, it might offer to pay 5.5% fixed and receive 5.6% fixed when the variable leg is LIBOR. If the bank enters into two swaps, one to pay fixed and one to receive, the two LIBOR legs will cancel leaving just the fixed payments. As a result the bank will earn 0.1% or 10 basis points from the spread between what it receives and what it pays. For the positions that were not offset, the bank would then need to hedge in another market such as treasury notes or Eurodollar futures.

Figure 5~~3~~



Industry Structure and Standards

The entrance of banks as full market participants created a marketplace for swap contracts and also led to standardization in the industry. In 1985, the International Swap Dealers Association (ISDA) established the first standard terms for swaps contracts (Kapner and Marshall, 1993). ISDA also eventually created a standard swaps contract that could be modified to meet a client's needs. This meant that each contract did not need to be negotiated from scratch, which

helped make it easier for a secondary market to develop because it was much quicker to identify the key elements of the swap being considered.

Since a swap can be customized to meet a client's needs it requires more attention than trading stocks or bonds. This type of market is referred to as "over-the-counter". The reason for this is if a person would like to enter into a swap contract he/she would need to work with a dealer to settle on the specifics. This method contrasts with exchanges were everything is standardized and there is a central trading location. The over-the-counter market involves many customers and broker deals working through phone lines and the internet. As of 2002 the main players for interest rate swaps were JP Morgan Chase, Bank of America, and Morgan Stanley for dollar denominated contracts (Chance, 2003). They were also among the biggest users of the instruments.

Day-count Conventions

Virtually all types of swaps must deal with day-count conventions. Day-count conventions are used to calculate the amount of interest paid over a period of time. For example, how much interest should have accrued after 91 days if we know the annual interest rate? For most people this is a simple question: divide 91 by 365 to get the fraction of the annual interest that should be applied. This was not always such an easy calculation. Before computers it was necessary to simplify these calculations so that market participants could get answers more quickly.

Markets developed the habit of calculating interest using simplified calendars such as a 30-day month and a 360-day year. This is known as 30/360.

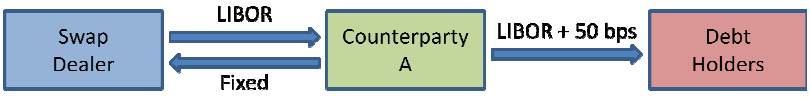
Other conventions can be Actual/360 where the actual number of days over the period is used divided by 360 to get the interest rate (Hull, 2008). Other conventions that exist are Actual/Actual and Actual/365, both of which are rather self-explanatory. Seeing that swaps are intended to bridge the gaps between markets, day-count conventions can be a big source of confusion for those looking to calculate swap payments. To assist the counterparties the day-count conventions are listed in the ISDA master agreement (Hull, 2008).

An example of a day-count adjustment that might need to be made is if a counterparty issued floating rate debt plus a spread, for example LIBOR plus 50 basis points. For a visual of this transaction see Figure 64. Counterparty A arranges a swap to receive LIBOR and pay a fixed rate. The LIBOR legs will net out since counterparty A receives LIBOR and pays LIBOR plus 50 basis points to its lenders. Therefore the cost to the counterparty will be the quoted fixed rate plus 50 basis points. However, the fixed leg is quoted on a bond equivalent basis which uses a 365-day year, while the floating leg is calculated using the money market basis because it is LIBOR and this uses a 360-day year. To simply add the 50 basis points from the money market size to the fixed payment, which is calculated on a bond basis, would be adding three yards plus four meters and getting an answer of seventwo unlike numbers. Therefore an adjustment for the different day-count conventions needs toshould be made. This can be seen in Figure 75. The way to do this is to divide the 50 basis points by 360, which will remove the money market day-count convention and then multiply by 365 to give it the rate on a bond basis. The five extra compounding days cause the rate to go

up to 50.7 basis points and summing this with the fixed side of the swap will result in the accurate borrowing costs for the counterparty. This example is from Kapner and Marshall (2003).

Figure 64

Day Count Example Swap Transaction



Cost of Financing = Fixed Rate (Calculated using a 365 day year) + 50 bps of Floating Rate LIBOR (Calculated using a 360 day year)

Day-Count Adjustment

Cost of Financing = Fixed Rate + 50.7 bps

Although, it is perfectly natural to be a little confused by day-count conventions, the computation method is straight forward. ~~Sometimes it is best to just not over think it.~~ For example, if the quoted annual interest rate on a sum of $1,000,000 is 8%, the day-count convention is Actual/360, and a payment is due after 161 days, how much is the interest payment? The answer is:

The same calculation can be repeated by entering in different day-count conventions. As the reader can see this is a rather basic calculation. Any complexity that arises comes from the conversion between different conventions, which requires some thought.

Naturally there is more to swaps than what has been covered up to this point, but the information provided should give the reader a basic understanding of swaps as an asset class. We will now move to discuss the four selected types of

swaps in greater detail. ~~The first will be interest rate swaps.~~ Each section will begin by going over the basic structure of that type of swap. Following this will be pricing and valuation examples. Finally, any non-trivial~~if there are any worthwhile~~ variations to the pricing of the swap ~~these~~ will be examined. The first will be interest rate swaps.

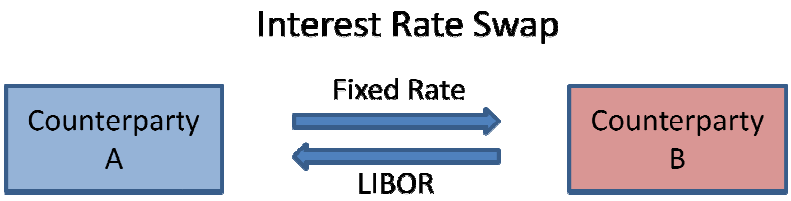
Interest Rate Swaps

Basic Structure of Interest Rate Swaps

As mentioned above, interest rate swaps are by far the most common swap. The reason is ~~for this is~~ that interest rate swaps are an excellent hedge for both borrowing and lending risks. Given that the global credit markets are enormous, ~~this makes~~ interest rate swaps are a very useful tool for banks and corporate treasury offices.

The basic structure that can be seen in Figure 8~~6~~ is once again the plain vanilla interest rate swap. The floating leg is assumed to be six-month LIBOR flat and the fixed leg is quoted on a semiannual basis. Quoting on a semiannual basis means that the semiannual interest rate can be derived from the annual interest rate by dividing by two. Likewise if one were using a quarterly basis, dividing the annual interest by four would return the quarterly interest rate.

Figure 8~~6~~



Valuing Interest Rate Swaps

When it comes to valuing a swap, the present values of the two legs are compared. If you agree to pay a fixed rate and receive LIBOR (like Counterparty A) you will have a positive position in the swap if the present value of the LIBOR payments is greater than the present value of the fixed payments. The opposite is true for Counterparty B. Very few parties would be interested in entering a swap in which they are already in a negative value position. For this reason, "Pricing an interest rate swap means finding the fixed rate that equates the present value of the fixed payments to the present value of the floating payments, a process that sets the market value of the swap to zero at the start" (Chance, 2003).

Finding the present value of the fixed side is rather simple: just discount each coupon payment by the appropriate discount rate back to the present. But what about the floating leg? We cannot tell the future and will be unable to predict with absolute certainty what the floating rates will be two, three, or ten years from now. We can however use approximations. For any relatively short-term swap, out to a maximum of five years, expected floating rates can be obtained from Eurodollar futures (Kapner and Marshall, 1993).

Eurodollar Futures

Eurodollar futures are cash-settled contracts that are written on Eurodollar deposits (Kapner and Marshall, 1993). Eurodollars are dollar deposits in banks outside the US. This market was already discussed when we defined LIBOR. Eurodollar futures are essentially contracts to lock in an interest rate at some time in the future. Eurodollar futures use three-month LIBOR as that interest rate and are quoted as 100 less three-month LIBOR. For example, if the June 2010 Eurodollar future was quoted at 98 then one would expect that the future three-month LIBOR rate, beginning on the third Friday in June 2010, would be 2%.

Another example that helps one understand Eurodollar futures is a hypothetical trade. Imagine you run a business that anticipates receiving $1,000,000 in June of 2010. You know that your company will not have a use for it for at least three months. Therefore you will need to invest that money in a liquid instrument that provides a competitive rate of return. Often businesses turn to the LIBOR market for this. Suppose you think that interest rates will go lower and you would like to lock into a fixed rate today. You see the Eurodollar futures contract implying an interest rate of 2%. You "go long" on this contract meaning that you feel that rates will go lower. There are no actual loans taking place since futures are cash-settled instruments, but the payoffs mimic similar cash agreements. Let us say that at expiration date the futures contract is priced at 98.2, implying an interest rate of 1.8%. Having been correct you will receive the difference which is $500. This is calculated as the difference in value between investments at the two rates for one quarter of a year on a principal of $1,000,000. The understanding behind this example comes from Hull (2008).

As mentioned above, to price a swap the present value of the fixed side must be set equal to the present value of the floating side. Now that we have a strip of Eurodollar futures to use, the expected floating rate payments can be determined. According to Kapner and Marshall (1993) using these futures to price swaps hinges on two main assumptions. The first is that the implied forward interest rates are unbiased estimates of future spot LIBOR rates. The second is that these rates are based on the pure expectations theory, which means there are no additional premiums included in these rates and that long-term interest rates are the geometric average of the interest rates that come before them.

Pricing a Short-Term Interest Rate Swap Using a Eurodollar Strip

Kapner and Marshall (1993) offer a four step approach to pricing a short-term swap off a Eurodollar strip. Using the Eurodollar futures as of March 10, 2009 we will use real world figures to price a plain vanilla interest rate swap (CME Eurodollar, 2009). The swap will have a tenor of two years and each leg will be on a semiannual basis. Steps one and two can be found in Figure 97.

Figure 97

Step One						Step Two	
Date	Futures Price	Implied LIBOR	Days	Quarterly Rate	Implied Value of $1	Zeros	Quarterly Bond Basis
10-Mar-09	98.683	1.32%	92	1.0034	1.0034	1.354%	1.364%
10-Jun-09	98.785	1.22%	92	1.0031	1.0065	1.301%	1.351%
10-Sep-09	98.780	1.22%	91	1.0031	1.0096	1.280%	1.345%
10-Dec-09	98.615	1.39%	90	1.0035	1.0131	1.308%	1.353%
10-Mar-10	98.555	1.44%	92	1.0037	1.0168	1.344%	1.362%
10-Jun-10	98.390	1.61%	92	1.0041	1.0210	1.396%	1.375%
10-Sep-10	98.205	1.80%	91	1.0045	1.0256	1.457%	1.390%
10-Dec-10	97.995	2.01%	90	1.0050	1.0308	1.527%	1.406%

Step one involves calculating the implied value of $1 at the end of each quarter. For example, we know that the current LIBOR rate is 1.32% and that there are 92 days in the next three months. We divide 92 by 360 which is the day-count convention for LIBOR and multiply this by the annual rate of 1.32% to get the interest rate that is then used to find the value of $1 dollar at the end of this quarter. We get $1.0034 as the implied value at the end of this quarter. We then find the quarterly rate three months from now using the futures contract and multiply that by $1.0034 to get the implied value of a $1 today six months from now. This practice is continued until we have two years of quarterly implied values.

Step two involves calculating the implied zero-coupon swap rates at each quarterly interval and converting them into a quarterly bond basis. The reason for converting to a quarterly bond basis is that we are using three-month Eurodollar futures. There are no six-month futures that could be used to give us the six-month fixed rate directly; therefore we must go through the intermediate step of converting to quarterly compounded rates. Zero-coupon instruments are those that pay no coupons and all of the interest is recouped from the final principal payment. This means the zero-coupon interest rate is the interest rate that discounts the future principal payment back to the present value. Finding these zero-coupon rates will give us the discount factors necessary to calculate the price of the swap later in this example. Using the six-month time period as an example we will solve for the six-month zero-coupon rate. This rate is expressed on an annual basis. Looking at Figure 9~~7~~ this zero-coupon rate is approximately 1.3%.

This is calculated by squaring the six-month yield implied by the value of $1. This should make sense since if we know the six-month zero rate, compounding it twice should give us the 1-year zero rate. The next step is to convert this zero rate so that it can be quoted on a quarterly basis. The formula for this is as follows:

$$Quarterly\ basis = [(1 + zero\ rate)^{\frac{1}{4}} - 1] \times 4$$

Step three is to use these zero-coupon rates to find the fixed coupon rate on a quarterly basis – this requires the use of a formula. The notation can be a bit tricky, but the concept remains relatively simple. According to Chance (2003) we can view the fixed leg as a coupon bond trading at par and the floating leg as a variable rate bond also trading at par; by doing so we can set the fixed leg equal to 100. To find the value of a fixed rate bond we need to discount the future principal and interest payments back to present values using the appropriate zero rates. Barkley (2009) presents this formula in an easy to follow form that can be seen below where C is equal to the coupon payment, the principal is equal to 100, and r_t is equal to the appropriate discount rate for each time interval. This simplified example ignores the quarterly compounding and assumes four annual periods. However, ~~, but~~ the reader will see how quarterly compounding is incorporated shortly.

$$100 = \frac{C}{(1 + r_1)^1} + \frac{C}{(1 + r_2)^2} + \frac{C}{(1 + r_3)^3} + \frac{C}{(1 + r_4)^4} + \frac{100}{(1 + r_4)^4}$$

Using the annual zero discount rates that were just calculated we could calculate the appropriate coupon payment. ~~, which s~~Since the principal is 100, it would also be the fixed coupon percentage rate. However, we already converted these annual zeros to quarterly rates and we are looking to find a quarterly fixed

rate. To keep the equation of a manageable size the discounting of the coupon rates will be expressed as a summation as seen below.

$$100 = \frac{1}{4}\, C \left[\sum_{t\,=\,1}^{T} (1 + \frac{r_t}{4})^{-t}\right] + \; 100\,(1 + \frac{r_T}{4})^{-T}$$

Also, to keep the formula simple the sometimes confusing notation that identifies the rates and coupon as being quarterly has been removed. Just understand that both are on a quarterly basis. What is taking place in the above equation is the same as in the simplified equation. The small t represents each of the quarterly time periods throughout the tenor. The big T is the final quarter and is two years from now in this example. We can see one quarter of the annual coupon being discounted by each quarterly rate or time t. The principal is discounted by the rate at time T, which is the two-year zero rate in this example. The negative exponents are the same thing as discounting by one over the appropriate discount rate. The above equation can be set to solve for C.

$$C = \frac{100 - 100(1 + \frac{r_T}{4})^{-T}}{\sum_{t\,=\,1}^{T}(1 + \frac{r_t}{4})^{-t}} \times 4$$

The values used to compute the appropriate coupon in the above equation can be found in Figure 10~~8~~. The denominator is just the sum of all the discount factors. Also located in Figure 10~~8~~ are the calculations necessary for step four. The fourth and final step of pricing this plain vanilla interest rate swap is to restate the coupon rate on a semiannual basis. This can be done by converting the quarterly compounded rate first to an annual basis as seen in Figure 10~~8~~ and then to the semiannual basis seen in the bottom row.

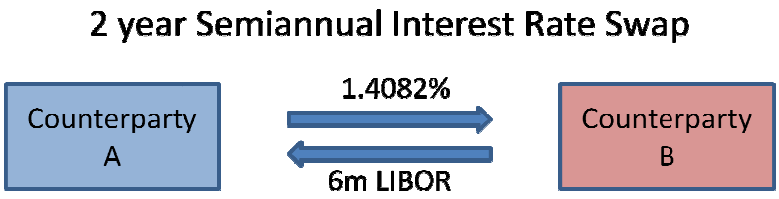
Figure 108

Numerator	2.77
Denominator	7.88
Fixed Swap Coupon	1.4057%
Annual Basis	1.4132%
Semiannual	**1.4082%**

A brief review of what just took place might be helpful. The example began by taking the implied LIBOR forward rates and converting them into zero-coupon rates. Next we changed the zero rates to reflect quarterly compounding. We then solved for the coupon rate of a bond trading at par using the formula above and the calculated discount rates. Finally, this coupon rate was converted from a quarterly basis to a semiannual basis. The reason for having to switch to a quarterly basis as an intermediate calculation is because the futures strips are also quarterly. There are no futures contracts on six-month LIBOR.

The final result of this example can be seen in Figure 119. This is a plain vanilla interest rate swap with six-month LIBOR as the variable leg and the fixed coupon quoted on a semiannual basis. Since these payments employ the same currency and the same notional value the payments will be netted and the party owing the most will make a payment. Obviously, the first payments will be known at the start of the swap when the first variable rate is set, but for the next three payments the variable rate will likely change and result in a payment from one party to the other.

Figure 119



Interest Rate Swaps in the Context of Other Financial Instruments

Sometimes even the simple examples can seem complex. That is why some have taken to explaining swap pricing in the context of other financial instruments. The reason for this is that individuals can apply their knowledge from other securities to help them understand swap transactions. The two methods are to either look at swaps as going long one bond and short another or to see swaps as a series of forward rate agreements.

Bonds

We will begin with the bond explanation since most people have more experience with bonds than forward rate agreements. The idea is that if you are the fixed rate payer in a swap you have agreed to make fixed payments and receive variable payments. This is the net equivalent of shorting a fixed rate bond and buying a variable rate bond (Chance, 2003). To apply this to pricing at the beginning of the swap it is just necessary to set the price of the two bonds equal to each other like we did above. The reason for this at the time, however, was not fully explained. There was discussion on the fixed rate side, but what about the floating rate side?

The important thing to understand is that the value of a floating rate security on a coupon payment day will be equal to 100 or simply par. This is

because on that day the interest is paid and the new coupon rate is set. This future payment is then discounted at the same rate at which the coupon was set. Therefore at each payment date, maturity, and when the floating rate note is issued the value will be set to 100 or par (Hull, 2008). By setting the floating rate note to equal 100 and the fixed rate note to equal 100 they are equal to one another and the example above could be used to calculate the fixed leg of the swap that allows the swap to have a present value of zero at initiation.

Forward Rate Agreements

A forward rate agreement is similar to a futures contract except that it is traded over-the-counter and not on an exchange (Flavell, 2002). In a forward rate agreement, the buyer is locking in a rate to pay. S, so if rates go up the buyer will benefit. Such a position can be viewed as agreeing to pay a fixed interest rate and receive a floating interest rate. The floating part comes from changes in interest rates. If rates increase the buyer is paid the higher rate at expiration while only being obligated to pay the agreed lower fixed rate. Likewise if rates go down the buyer is stuck paying the higher fixed rate while only receiving the current lower rate of interest at maturity. Since the agreement is for a loan over some period of time the actual payments would not be made until after maturity of the agreement. Parties usually agree to exchange the present value of this payment at maturity (Flavell, 2002). Since forward agreements are traded over-the-counter they can be customized in terms of notional principal and length of the agreement to fit the client's needs.

To any reader paying attention to the elements of an interest rate swap, a forward rate agreement sounds very similar. In fact, a swap can be viewed as a

series of forward rate agreements (Hull, 2008). The fixed rate is chosen so that the value of all of the forward rate agreements will be zero at the outset. This does not mean that all of the forward rate agreements are equal to zero. Some of the values of the forward rate agreements will be positive and some will be negative. For example, in an upward sloping yield curve environment with a fixed rate of four percent some of the earlier forward rate agreements would have a negative value since the short term expected rates are likely to be lower than that. Likewise the later agreements will have a positive value because the expected rates are likely to be higher than four percent (Hull, 2008). So if one took a series of forward rate agreements and set the fixed rate so that all of them would be equal to zero, one would have the swap coupon of the same tenor swap with the same terms.

Variations on Interest Rate Swaps

Thus far we have priced an interest rate swap and seen how it can be viewed from the context of different securities, but what if a plain vanilla swap does not meet a customer's needs? For example, a client wishes to pay a higher or lower fixed rate than the one quoted. Let us say that the quoted rate on a five year swap is six percent and the customer would like to pay five and half percent. The difference is 50 basis points per year or 25 basis points semiannually. This can be viewed as an annuity and its present value is paid up front by the client; this is called a buy down (Kapner and Marshall, 1993). The present value is calculated by multiplying the number of basis points paid semiannually by the notional principal to get the payments being made. These payments are viewed as an annuity stream, which is discounted back to present value terms using the original

fixed coupon rate as a discount rate. Banks will use buy ups and buy downs to make swaps more attractive for clients. For example, a client with short term cash needs may decide to take a cash payment upfront in exchange for a higher fixed rate.

There are several other ways in which a basic interest rate swap can be tailored to meet a customer's needs. These will not be discussed in great detail, but the reader may find it interesting to see how a few basic adjustments can greatly increase the uses of a simple interest rate swap. Swaps can be constructed with an amortizing principal to match the cash flows of companies who issue bonds with sinking funds (Kapner and Marshall, 1993). A sinking fund makes it possible for a company to retire certain amounts of principal outstanding each year. By creating a swap with amortizing notional principal the bank is matching the new debt payments that the client will be making after retiring its debt through a sinking fund. T~~, and t~~his maintains the role of the swap as a hedge. Another alteration to the basic structure includes changing the payment frequencies of one or both of the legs.

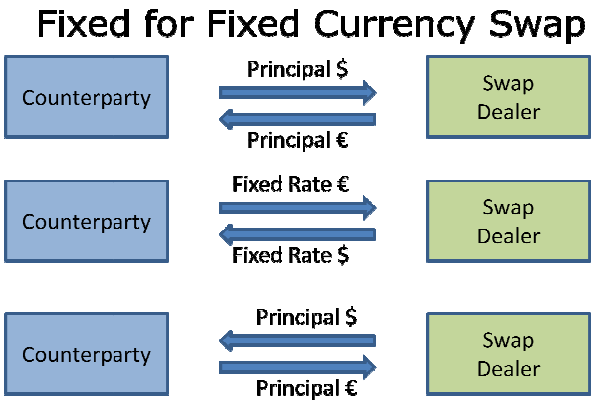
Currency Swaps

Basic Structure of Currency Swaps

The basic structure of a currency swap can be seen in Figure 12~~10~~. This example uses a swap dealer as the counterparty, which in today's market is almost always the case. Let's assume that the counterparty has borrowed in dollars, its home currency, and would now like to invest abroad in a country that uses euros.

The counterparty would contact a swap dealer and they would negotiate the appropriate fixed rates for this transaction. They would then swap principals, the counterparty handing over the money it just borrowed for an equivalent value of funds in euros. The counterparty will then pay interest in euros. Fixed rate payments in dollars will be made to the counterparty so that it can continue to service its debt payments at home. On the maturity date of the swap the two parties will swap the currencies back at the exchange rate established in the swap agreement (Kapner and Marshall, 1993).

Figure 102



A couple things worth noting here are that the principals are exchanged at the beginning of the swap and at the end of the swap. The first exchange of principal takes place at the current spot rate. The final exchange of principal is made at the forecast forward exchange rate that is calculated at the initiation of the swap. Also, the swap does not have to involve fixed-for-fixed rates. It could be fixed-for-floating, floating-for-fixed, or floating-for-floating.

The Interest Rate Parity Theory

The interest rate parity theory is of special application to currency swaps. ~~The three other types of swaps will not utilize this theorem unless they involve payments in a foreign currency.~~ The idea behind this theory is that spot and forward exchange rates between two currencies are related to one another in a way that neutralizes the interest rates of each currency (Kapner and Marshall, 1993). Therefore the exchange rates incorporate each of the countries' interest rates. This theorem helps explain why the interest rates used for two different currencies can be so different. The three other types of swaps will not utilize this theorem unless they involve payments in a foreign currency.

To give additional thought about this theorem one just needs to think about the arbitrage opportunity that might exist if you could borrow in one currency at one interest rate and invest in another at a higher interest rate while hedging the foreign exchange rate risk. This would essentially be free money and the trade would take place until the arbitrage opportunity disappeared. Basically what this theory tells us is that the spot and forward exchange rates between countries consider their different interest rates and are arbitrage free estimates of one currency's value in another.

Application of Comparative Advantage

Currency swaps incorporate the idea of comparative advantage to lower borrowing costs and can also be used to transform one type of asset in one currency to a different type of asset in another country. F~~;~~ ~~f~~or example, one can convert~~ing~~ a fixed stream of cash flows in one currency to a floating stream of cash flows in another currency. Both of these uses expose a company to credit

risk (Chance, 2003). If a company simply wanted to issue debt in another currency it would not be exposed to credit risk, but may have higher costs. The savings come from assuming credit risk. Thus a swap dealer could also be seen as a dealer of credit risk. This idea applies to other types of swaps as well. However, it~~, but~~ is especially relevant to currency swaps given the theme of comparative advantage in international financing.

Currency Swaps in the Context of Other Financial Instruments

"Like interest rate swaps, fixed-for-fixed currency swaps can be decomposed into either the difference between two bonds or a portfolio of forward contracts" (Hull, 2008). Chance (2003) offers a common sense approach to viewing currency swaps. If in the example above, the counterparty issued a bond in euros, the swap dealer could buy it~~bought it.~~~~, and~~ ~~t~~The company could then convert~~ed~~ the money into dollars and buy~~ought~~ a bond. T~~t~~hese~~is~~ transactions would have the same cash flows as a currency swap. The cash flows are the counterparty receiving principal in euros, making payments in euros, receiving payments in dollars, and then having to pay the principal in euros while receiving the principal in dollars. Obviously all of these transactions would show up on the balance sheet so the swap is still preferred, but the cash flows are the same.

Employing the forward rate logic to currency swaps is~~ a bit~~ more complicated. It involves comparing the interest rates of the two exchange rates and compounding current spot rates (Hull, 2008). This explanation~~ will likely not clear things up for the reader and so~~ will not be included in this discussion.

Pricing a Currency Swap

Currency swaps are relatively easy to price as long as one has~~you have~~ the interest rate swap quotes for both currencies at the same tenor. Looking at the opening example, where do the fixed rates come from? They come from the plain vanilla interest rate swaps in each currency (Chance, 2003). This is because these fixed rates set the value of the fixed leg of the swap equal to par. Pricing a fixed-for-floating swap requires a similar approach. The floating leg is simple to determine since it is already equal to par. The important thing to remember is that the levels of par are in different currencies. So~~ and~~ in order for both sides of the swap to be equal the exchange rate will need to be considered.

Chance (2003) feels that this process can be simplified. For example, assume that you have set the notional principal to one dollar and would like to know what the appropriate foreign currency notional value would be to make the two legs equal. Dividing the dollar by the exchange rate in units~~ denoted in terms~~ of how many dollars it would take to purchase one unit of the other currency gives this foreign notional principal. For example, convert one dollar of notional principal into pounds when it is two dollars per pound requires dividing one by two to get half a pound in notional value is equal to one dollar. If the desired notional is any amount other than one dollar the same rule applies: just divide the new notional by the exchange rate to get the appropriate value in another currency.

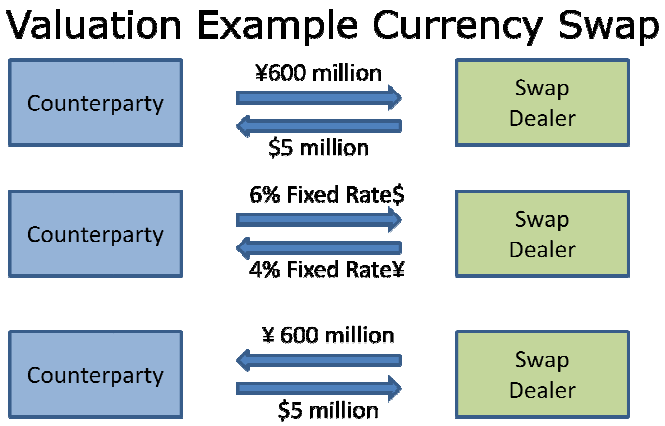
Fixed-for-floating currency swap contracts follow the same logic given that both legs of an interest rate swap, which is used to price the currency swap, have the same present value (Chance, 2003). For a floating-for-floating bond

pricing is even simpler. The reason for this is that no pricing is necessary. Both floating legs begin at par value as we have already discussed. However, it is important not to forget to adjust the notional principals using the exchange rate so that both sides are still equal.

Valuing a Currency Swap

Now we~~it is time to~~ move on to valuing a currency swap that is already outstanding. This should be more interesting than pricing the swap since it will look very similar to pricing an interest rate swap. Thinking about each of the legs as a bond will be very helpful in seeing how this swap is priced. Figure 13~~1~~ shows the swap diagram for a fixed-for-fixed currency swap. The two currencies are dollars and yen. The following example is adapted from Hull (2008).

Figure 13~~1~~



It is important to remember that this is an existing swap and we are trying to determine its value in the context of any changes in interest or exchange rates. The initial rates are quoted as annual with the assumption that dollar and yen day-

count conventions are the same. The payments are also annual. These, along with the original principals, can be seen in Figure 13~~1~~. Let us assume that there are four years left on the swap. To keep things simple we will also assume that the term structures in both countries for the next four years are relatively flat. This will allow us to focus on what is taking place with each currency and not on discounting, since we have already done this with interest rate swaps.

Suppose the following: the annual interest rates for the next four years are 5% in yen and 6.5% in dollars. The current exchange rate is 100 yen equals one dollar. Figure 14~~2~~ shows the payments on the existing swap discounted by the new interest rates to give the current values of each leg.

Figure 14~~2~~

Year	Dollar Cash Flows	Present Value ($)	Yen Cash Flows	Present Value (¥)
1	300,000	281,690	24,000,000	22,857,143
2	300,000	264,498	24,000,000	21,768,707
3	300,000	248,355	24,000,000	20,732,102
4	300,000	233,197	24,000,000	19,744,859
4	5,000,000	3,886,615	600,000,000	493,621,485
Total		4,914,355		578,724,297

Now that we have the present value of the cash flows from each leg the current exchange rate can be used to put them into the same currency for comparison. Dividing the present value of the yen cash flows by 100 gives a present value of $5,787,243. This is good for the counterparty since it essentially issued a bond in dollars and used the proceeds to buy one in yen. The value of this swap to the counterparty is the difference between the two present values, each expressed in US dollars, -or $872,888. This sum could also be converted to yen by

multiplying by 100. Since swaps are a zero sum game, this new valuation also represents a negative present value of $872,888 to the swap dealer who has likely hedged this risk with an offsetting swap.

A Currency Swap with No Exchange of Principals

Some currency swaps do not necessitate the exchange of principals. Chance (2003) offers a similar example with different figures of a company that generates €16 million annually and converts it back to dollars twice a year. This exposes the company to exchange rate risk. It could enter into a swap to pay its euros and receive dollars. Though no notional principals will be exchanged the euro notional principal still needs to be calculated so that an equivalent notional in dollars can be used to calculate the dollars received.

Suppose euro swap rates are four percent. What notional principal earning four percent would generate €8 million semiannually? The answer is €400 million because half of four percent of €400 million equals €8million. The exchange rate equals $1.50 per €1. Multiplying €400 million by 1.5 provides the dollar notional of $600 million. Current dollar swap rates are 3%. The company will receive half of 3% on $600 million semiannually for the life of the swap. This equates to $9 million dollars paid semiannually. Thus the company has successfully removed its exchange rate risk without exchanging notional principals.

Relationship of Interest Rate and Currency Swaps

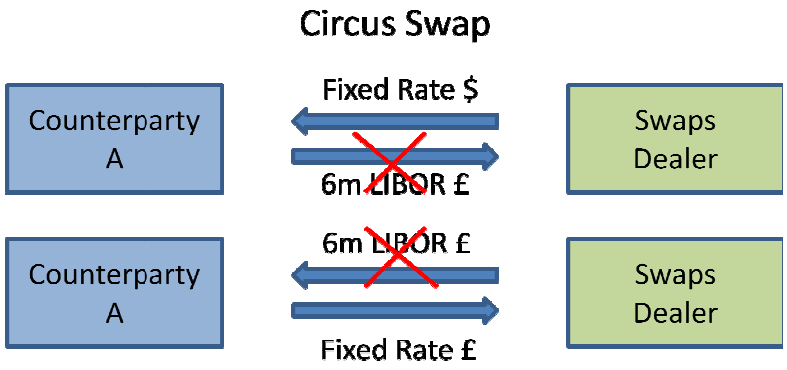
The right combination of currency swaps can also result in an interest rate swap (Chance, 2003). For example, a dollar-to-euros fixed-for-floating currency swap combined with a euro-to-dollars floating-for-floating currency swap forms a

dollar fixed-for-floating interest rate swap. This is because the floating euro payments cancel out leaving just the dollar payments. Obviously no one would go about entering into an interest rate swap via two currency swaps because you would be paying twice the fees, but it is an important connection between the two types of swaps. In fact, they are fairly interrelated as we saw when using the interest rate swap coupons to price a currency swap.

Sometimes combining the two types of swaps can allow for the synthetic creation of a currency swap. A circus swap exists when combining a plain vanilla currency swap, meaning one fixed payment and one variable payment, with a plain vanilla interest rate swap (Kapner and Marshall, 1993). Figure 153 depicts a circus swap. Essentially the cancelling of the two LIBORs leaves a fixed-for-fixed currency swap.

Circus Swap

Figure 153



Variations on a Currency Swap

There are many variations on a currency swap. One ~~such~~ extreme example involves using the variable interest rate in one currency to calculate the variable payments in another currency (Hull, 2008). This is known as a quanto and is a very complex instrument. There is also off-market pricing similar to what was discussed at the end of the section on interest rate swaps. It is a bit more complicated with currency swaps since an annuity in one currency is not the same in another currency.

Pricing an Off-Market Currency Swap

There are several steps to take to determine the price of an off market currency swap (Kapner and Marshall, 1993). First, just consider an example where the swap coupon to pay six-month dollar LIBOR and receive euros is six percent. A US client has a euro obligation that requires seven percent interest and does not want to be exposed to any exchange rate risk. "The trick to pricing off-market swaps is to create cash flow streams with equivalent present values" (Kapner and Marshall, 1993). This requires the swap rates for both currencies of the appropriate tenor. We already know the Euro swap rate; let us say now that the dollar swap rate is eight percent. The first step is to determine the rate differential on the euro side; in this case it is one percent. The next step is to determine the present value of an annuity much like the interest rate swap off market pricing.

The formula for the present value of an annuity can be seen below.

$$Present\ Value\ of\ an\ Annuity\ = PMT\ \times \left[\frac{(1-\frac{R}{m})^{-mn}}{\frac{R}{m}}\right]$$

Assuming both sides pay semiannually we need to determine the present value of a semiannual payment of half a percent in euros. R is the euro swap rate, which we know is 6%, m is the frequency of interest payments, which is 2, and n is the tenor of the swap, which we will say is 10 years. The payment denoted by PMT in the equation is equal to the half a percent in euros. Inputting these values into the equation, the present value of the euro annuity equals 7.44.

Since the two sides need to be equal this present value factor can be plugged into the equation with the dollar rates to solve for the necessary dollar payment. This payment will be in the form of additional interest that will be added to the LIBOR leg of the swap. Substituting the dollar numbers in with the present value factor, the additional interest to be added onto the dollar LIBOR leg is 0.547%. However, this rate is derived from semiannual fixed bond rates and is thus not comparable with the LIBOR money market rate. To adjust for this day-count convention mismatch it is necessary to multiply this figure by 360 and divide by 365 to get this rate in money market terms. The resulting addition to LIBOR is 0.54%.

The result of this exercise is a swap that meets the client's needs. The client will receive seven percent interest on the notional of its obligation in euros. In exchange for removing all exchange rate risk the client will pay LIBOR plus 54 basis points. Neither of these figures includes the swap dealer's spread. As one can see there are many options when it comes to currency swaps.

Equity Swaps

Interest rate and currency swaps are by far the most common types of swaps (Hull, 2008). Even though equity and commodity swaps have a smaller share of the market (Bank for International Settlements, 2008), the-y have many useful applications~~reader should still benefit from understanding them~~. In fact, these two swaps may be easier for a reader new to swaps to figure out because the legs of these swaps are more intuitive to the average person.

History of Equity Swaps

Equity swaps were introduced in 1989 by financial engineers at Bankers Trust (Chance, 2003). "An equity swap is an agreement to exchange the total return (dividends and capital gains) realized on an equity index for either a fixed or a floating rate of interest" (Hull, 2008). Equity swaps have defined tenors, notional principals, payment periods, and fixed or floating legs (Chance, 2003). Basically they are normal swaps, but with one of the legs paying the total returns of an equity index as the variable rate. Chance (2003) identifies two distinguishing features that differentiate equity swaps from interest rate and currency swaps.

Distinguishers of Equity Swaps

The first and most interesting is that the fixed payer in an equity swap could also have to make additional variable payments. The reason for this is by receiving the return on an equity index as a variable payment, the receipts also include negative returns on the market. For example, you agree to pay a fixed rate and receive the return on the S&P 500. If the S&P 500 goes up in value the dealer will pay you the percentage increase on the agreed up notional. However, if the

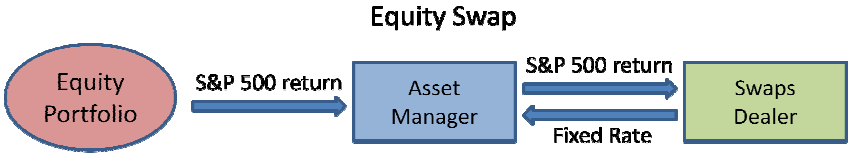
market goes down you will have to pay the fixed payment and the percentage the market has gone down multiplied by the notional principal. Therefore there are no free rides on an equity swap where an individual can pay a fixed rate and receive only the upside of market moves, although this could likely be created with the right set of financial instruments.

The second differentiator of equity swaps is that the payment is not known until the payment date. In interest and currency swaps the payment rate was set at the beginning of the period. However, the return on the market is not known until the end of the period. Therefore the two parties will not know what is owed until the payment date.

Basic Structure of an Equity Swap

The basic structure of an equity swap can be seen in Figure 164. In this structure it is assumed that the counterparty is an asset manager with a portfolio mimicking the S&P 500 and looking to lock in a fixed rate for the next several years. This structure can be found in Kapner and Marshall (1993). It is interesting to note that if the asset manager also entered into a plain vanilla interest rate swap to pay fixed and receive floating it would then be swapping equity returns for a floating rate (Kapner and Marshall, 1993).

Figure 146



The swaps dealer will look for an offsetting swap to hedge his/her exposure. For swap portfolio mismatches that cannot be offset the dealer will turn to equity index futures to hedge the rest of their book (Kapner and Marshall, 1993). Some might view an equity swap as a long-dated futures contract (Kapner and Marshall, 1993). The important difference is that there is little to no margin posted for these swaps. This feature~~, which~~ gives the purchasers, such as hedge funds, tremendous leverage for speculating. Since a margin system guarantees that payments will be made, the lack of one exposes counterparties to credit risk. As a result, equity swaps usually have shorter time periods between payments, likely a quarterly or even monthly basis (Kapner and Marshall, 1993).

Calculation of the Variable Leg of an Equity Swap

Before moving ahead to pricing an equity swap it is important to know how the variable rate is calculated. This is best illustrated through an example. Suppose the market has a value of 1000 at the initiation of a two-period swap. The value at the first period is 1050 and the value at the second period is 1025. To calculate the first variable payment we take the percentage change of the index from the beginning of the first period to the end, which in this case is 1050 divided by 1000 and equals five percent. We then reset the initial value to 1050 and calculate the percentage change again at the end of period two. The value 1025 divided by 1050 is just under negative two and a half percent. This is the rate that would be multiplied by the notional principal to determine the variable equity leg payment.

Pricing an Equity Swap

To price a plain vanilla equity swap, which is the exchange of a fixed payment for a variable equity index payment, the two legs need to be set equal to one another. In this way ~~so that,~~ the value to either party at the beginning of the swap is zero. Interest rate and currency swaps could be looked on purchasing~~as being long~~ one type of bond and selling~~short~~ another. Equity swaps are similar except going long equity and shorting a fixed rate bond will not exactly track the payments of an equity swap. One of the reasons for this is holding an equity position over a long period of time does not behave the same way as paying the return every quarter. The shares would have to be sold and repurchased every quarter to match the variable rate of an equity swap. Another reason is that equity swaps pay the return on the index which includes dividends, not just the price. So setting the variable leg as a function of price would not be correct.

An equity swap can be priced using other assets that provide the same cash flows. If two sets of equal risk securities have the same cash flows arbitragers will prevent them from trading at different prices. Therefore if we can construct a set of cash flows equal to that of an equity swap and know the price of those, we can price the swap. The following example is extracted from Chance (2003).

In a two-year annual plain vanilla equity swap we will have two equity returns. Let us say that the first is eight percent and the second is twelve percent. Let us begin with variable leg. To keep things simple suppose we start with a notional of one dollar and invest it in the equity index at the start of the swap. At the end of year one we would then sell the index for one dollar and eight cents,

withdraw the eight cents and reinvest the dollar. At the end of year two we would do the same by selling the index and keeping the return. However, we are still holding the dollar. There are no exchanges of notionals in an equity swap so we will need another transaction to remove this dollar.

The way to remove the dollar is to take out a loan at the beginning of the swap for the present value of one dollar two years from. The discount rates are like the ones we used in the interest rate swap example. Therefore to get this value we would discount one dollar back to the present using the two-year zero calculated on an annual basis. The left over dollar at the end of two years will be used to pay off the loan. We now have the variable leg of cash flows, which is just the returns on the equity index with the notional being balanced by the present value loan at the beginning.

As we are receiving the equity returns in the variable leg we know that we would be paying the fixed rate on the fixed leg. To match this stream of cash flows we would use a similar mechanism to the variable leg. We would borrow the present value of each of the two fixed payments at the start of the swap. Again the discount rates are the appropriate zeros. Thus at each payment date we would be obligated to pay the fixed payment in order to satisfy the loan obligations.

We now have our two streams of cash flows. So ~~and~~ we can add the inflows from the loans to the outflows of the initial dollar to determine how much money it would take to do this trade. This can be seen in the equation below. Since no money is exchanged at the start of the swap we want this initial amount of money to be equal to zero; in other words the values of the loans should be

equal to one dollar. By setting this equation equal to zero we can solve for the fixed payments that will make this possible, which is the next equation. The letter n represents the number of periods.

$$\$1 - PV\$1 - Fixed\ Payments \sum_{1}^{n} discount\ rates = 0$$

$$Fixed\ Payments = \frac{\$1 - PV\$1}{\sum_{1}^{n} discount\ rates}$$

Hopefully the reader will recognize that this is the same equation as the one used to determine the fixed coupon payments in the interest rate swap pricing example. The difference in appearance results from this equation not using quarterly compounding and the use of words instead of letters. The fixed leg calculated for an equity swap is the same as the fixed leg calculated for a comparable interest rate swap. So, just like a currency swap, when pricing the fixed leg of an equity swap, the fixed coupon for an interest rate swap of the same tenor can be used. This is also true if a counterparty desired to pay or receive a floating interest rate in exchange for the equity index returns. The reason for this is that the variable rate and fixed rate sides are set to equal one another at the outset of the swap. So if we can use the fixed rate of an interest rate swap to price an equity swap we can also use the floating rate.

There is no need to price a swap where both of the variable legs are an equity index because the market value of the swap is zero at the start. If you wanted to look at this transaction in the context of comparable cash flows one could buy index one and short the other (Chance, 2003). For example, say the two

indexes are the Dow Jones Industrial Average and the Japanese Nikkei. If you were going to receive the returns on the Dow and pay the Nikkei returns, you would short the Nikkei and use the proceeds to buy the Dow. At the end of the first period you would sell the Dow and close out the Nikkei short. The process would then be repeated for the tenor of the swap.

Valuing an Equity Swap

Since a pricing example would be the same as the interest rate example we will instead attempt to value a plain vanilla equity swap with quarterly payments sixty days after the initiation of the swap. This is similar to an example in Chance (2003). Valuing the swap requires constructing the cash flows of the future payments, much like how we priced the swap. Essentially we need to find the present value of each leg of cash flows. Once we determine the different cash flows we can plug them into the equation below to solve for the value of the swap. The cash flows will be expressed as a percentage of the notional value. We know the fixed payment because it is determined at the initiation of the swap. In this case the fixed payment is six percent annually or one and a half percent quarterly. We can value the fixed side by discounting it by the new term structure of interest rates at day sixty. To simplify this example we are going to assign a value of 0.1 to the fixed side, which means that the fixed side has a present value equal to ten percent of the notional value.

To value the variable side we need to know the return on the index since the first day of the swap through day sixty. It is easiest just to think of wanting to know the return that would be paid if day sixty were the payment day. Suppose

the swap is set against the returns of the S&P 500. The S&P was 750 sixty days ago and is now trading at 811. Dividing 811 by 750 will yield the sixty day return of the index. This is the first term of the equation below. Recall that the variable leg has a one dollar term that must be removed by borrowing its present value. We can arbitrarily assume the appropriate present value factor of one dollar is 0.965 at the maturity of the swap which is one year and three hundred days from now. The index value less the present value of the dollar will be equal to the variable side, which in this example solves for 0.1113.

We can plug all of these values into the equation below. The solution would mark this swap to 0.0113 of every dollar of notional. This value is the difference between the variable side composed of the first two terms (0.1113) and the fixed side value that was expressed above (0.1). The variable side value is greater and thus the party receiving the equity leg will have a positive value and the fixed payer a negative value.

$$\frac{Index\ Value\ (Day\ 60)}{Index\ Value\ (\sout{Day\ 0}Start\ Date)} - PV\$1$$

$$- Fixed\ Payments \sum_{1}^{n} discount\ rates$$

One can also value a floating rate equity swap. Valuing a floating rate equity swap is much simpler because of the assumption that the floating rate side will be equal to one on payment dates and at maturity (Chance, 2003). Therefore the one dollar left over at the end that needed a present value loan to displace can now be used to pay the hypothetical principal on the floating rate side. Thus the one can be removed from the equation. The valuation is then simply the

difference between the present value of the variable side, which is just the change in the index, and the present value of the fixed side. The discount factor is the thirty day discount factor on day sixty because payment takes place at day ninety. Using a present value factor of 0.995 and a fixed payment of 0.015 the solution would look like this:

$$\left(\frac{811}{750}\right) - (1.015)(0.995) = 0.0714$$

These results suggest that the party receiving the variable side has a positive value on this swap of 0.0714 multiplied by the notional principal. Two equity index legs are the easiest to value. Just take the return on the index you are receiving and subtract the return on the index you are paying. This will give you the value of the swap at any time between payments. The values on each side will reset to zero after each payment.

Variations on Equity Swaps from the Perspective of an Asset Manager

To truly appreciate equity swaps and their many variations of ~~equity swaps~~ imagine that you are viewing them from the perspective of an asset manager. Suppose your mandate as a portfolio manager is to track the internal rate of return of the S&P 500. There is a variation on a swap that changes the notional principal by the payment amount on each payment date. As a result, entering as the equity leg receiver will match the manager's realized internal rate of return to that of that market (Kapner and Marshall, 1993).

Matching the returns of the market is great, but what about exceeding them? There is evidence to suggest that the returns on equity swaps can exceed

those of a cash portfolio. “Collectively, the initial transactions costs, the withholding taxes, the monopoly control in some markets, turnover taxes, custodial fees, and rebalancing costs can be substantial” (Kapner and Marshall, 2008). If avoiding these transaction costs allows an asset manager to enhance his/her returns, then an equity swap might be a worthwhile consideration.

What if you could provide your clients with the higher return of two indexes? An asset allocation swap will pay the greater return of two indexes in exchange for a higher swap coupon or front-end fee (Kapner and Marshall, 1993). You could also take thirty percent of your returns from one index, fifty from a second, and twenty from a third in what is referred to as a rainbow swap (Kapner and Marshall, 1993). This would likely be cheaper than effectively diversifying three portfolios in three different markets around the globe.

Another set of variations includes placing a cap on the rate one would have to pay if oneyou were paying the equity leg (Kapner and Marshall, 1993). An additional variation could be purchasing a diversified portfolio of bonds that pays a rate of return greater than the fixed coupon necessary to pay the fixed leg of the swap. As a result, assuming no defaults oneyou would receive the returns on the market plus a fixed spread.

In reality, asset managers would use equity swaps to lock in profits. For example, two years ago after the stock market experienced a tremendous run. tremendous run the market had experienced, Aa savvy manager with an index-like portfolio wnot wanting tould not want to pay significant capital gains taxes,. He or shebut wanting to would also want to hedge him/herself from the risk of a

down market. To accomplish these goals the manager would~~would~~ enter a fixed receiver equity swap. This effectively switches his/her position from an equity position to a fixed income position. To do this in the market place would require selling the shares in the fund, paying capital gains taxes, then researching and paying commissions on the purchase of a fixed income portfolio. One call to a swap dealer effectively eliminates what would otherwise be a very lengthy and ~~reasonably~~ costly process. This flexibility comes with the assumption of some credit risk,~~:~~ the risk that the counterparty~~,~~ usually a bank~~,~~ might default. Several banks did default in 2008. However,~~, but~~ most were purchased or bailed out. This~~which~~ kept them from defaulting on their obligations under swaps and other contracts.

Commodity Swaps

Of the four types of swap classifications, the least is written on commodity swaps. It could be due to the relatively small market share, but it could also be due to their simplicity. It does not require any calculations to understand a basic commodity swap. Despite the lack of press, commodity swaps have perhaps the most interesting history of all of the swaps discussed thus far.

History of Commodity Swaps

Commodity swaps were first introduced in 1986 by Chase Manhattan Bank (Kapner and Marshall, 1993). There was an immediate interest in this instrument due to the fact that many commodity producers and consumers were already using hedging techniques. Commodity swaps offered long-term, multi-

period hedging agreements that did not exist in the futures market. However, just as growth in these swaps was beginning to accelerate the Commodity Futures Trading Commission questioned their legality. This effectively ceased trading activity in them until 1989 when the Commission reversed its decision and allowed the contracts to be used if they met certain requirements.

Many of these requirements were already established practices in the swaps market (Kapner and Marshall, 1993). There was one important restriction that was not an established swap practice. ~~and~~ ~~I~~it banned the use of a margin system that would guarantee performance. One could assume that a history of hedging commodity risk with futures had something to do with this restriction~~it~~. Under a margin system each party entering into a position posts funds to guarantee its performance. These funds are managed by a clearinghouse that stands as the counterparty to all transactions. As a result, no party hedging in the futures market had ever had payments due to them default because of the strength of the clearinghouse. However, this was not to be in the swaps market and dealers wishing to do trades now had to consider credit risk in their pricing. Some dealers limited their interactions to only those parties with the best credit (Kapner and Marshall, 1993).

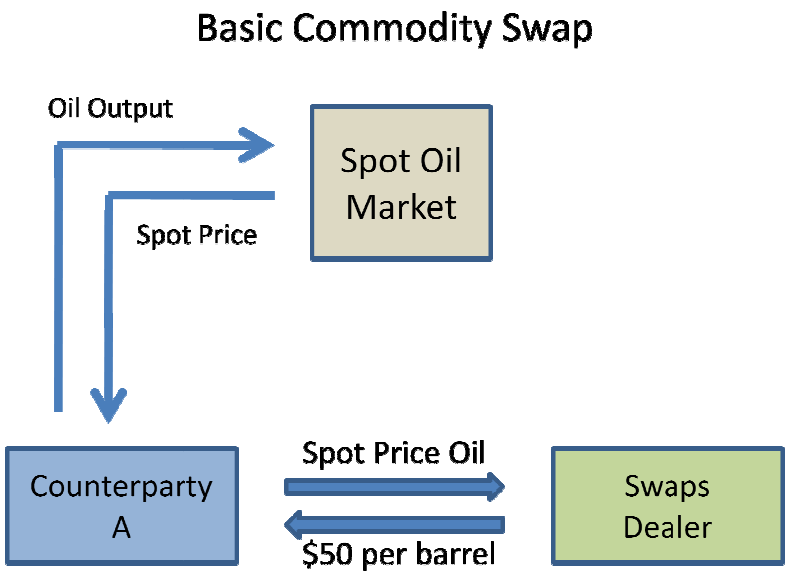
Commodity Swaps in the Context of Other Financial Securities

Like other swaps, "commodity swaps are in essence a series of forward contracts on a commodity with different maturity dates and the same delivery prices" (Hull, 1998). One thing to keep in mind with commodity swaps is that no notionals are exchanged (Kapner and Marshall, 1993). This is because all

exchanges of the underlying commodity, if any did take place, would be in the cash markets. The basic commodity swap structure is shown in Figure 1~~5~~7. This basic layout can be found in Kapner and Marshall (1993).

Basic Commodity Swap Structure

Figure 1~~5~~7



Uses of Commodity Swaps

~~T~~As an example, suppose~~o put some relevance in this example let us imagine an~~ oil producer with stable outputs every month is looking to fix the price it receives for the next ten years. To do this in the futures market it would have to enter into many different contracts. Furthermore, the futures contracts only go out a couple years. S~~and s~~o the producer would have to roll these contracts out every several years to cover its ten-year time window. Doing so leaves the company

open to price fluctuations. The swap fills this void by fixing the price for the next ten years. In exchange the company will pass on the spot prices it receives in the open market to the dealer.

The swap dealer would most likely enter into the reverse of this swap with a customer looking to fix the price it pays for oil and receive the spot price in order to hedge itself. The above discussion is sufficient to give the reader a basic understanding of commodity swaps. It is difficult to find a great deal more than this coverage~~written~~ in an introductory swaps book.

Pricing Commodity Swaps

Commodity swaps can be priced in a manner similar to interest rate swaps, except one would use a strip of commodity futures instead of interest rate futures. An important difference for commodity swaps from other swaps is that both price and volume are important to determining the fixed payment. Therefore one must multiply the fixed price per unit by the number of units to get the total fixed payment. This method allows for customizing the swap for the amounts that customers need. For example, if a company has seasonal demand for a commodity, allowing the volumes to match the customer needs makes the swap an effective hedge.

The above method works for shorter term swaps where there is an active futures market to use as a price determinant. However, for the longer dated swaps the users of swaps and swap dealers must rely on sophisticated models to predict the price of a given commodity over the tenor of a swap. These models include supply and demand projections, GDP growth, capacity issues, industry analyses,

and many other variables to predict the price movements of the underlying commodity. Obviously not every party will agree what the exact price of a swap should be because they are all using different models. Despite this characteristic~~T~~ the long tenor market will function ~~despite this~~. Similar to other markets, if one counterparty using its model feels that the offered price of the fixed leg is too low it would take the fixed side on the other hand~~, while~~ if another counterparty's model says the price is too high it would take the variable side. Therefore market forces driven by different expectations will be responsible for pricing longer tenor swaps.

Extendable and Cancellable Swaps

Of particular relevance to commodity swaps are extendable and cancellable swaps. An extendable swap occurs when a counterparty has the option to extend the tenor of an existing swap. A cancellable swap is when a counterparty has the option to cancel an existing swap. Both swaps require a premium to be paid by the counterparty with the option. The premium paid usually takes the form of a higher payment.

An example will illustrate the value of an extendable swap. Let us assume that at the maturity of a swap one of the counterparties has the option to extend the swap. Suppose this counterparty has a positive mark on the swap because it is currently paying a lower fixed price than the market variable price it is receiving. It would be to the counterparty's benefit to extend the swap and continue this profitable transaction. Thus the extendable swap feature adds value to the counterparty. For the other counterparty that is paying the market price and

receiving a lower fixed price the option to cancel would have value. Both types of swaps allow gains and losses to either be cut short or extended into the future.

Conclusion

Swaps play an important role in the modern financial system both as a hedge and as a tool for lowering borrowing costs. Due to their rapid growth, many people are still unaware that the swap market has become ~~is~~ one of the biggest derivative markets in the world. It is important for individuals looking to understand the complex financial issues taking place today to have a basic understanding of the swaps market.

Swaps connect global financial markets and help distribute risk effectively throughout the financial system. This can be to the benefit or detriment of certain market participants. The financial crisis of the last year might cause regulators to examine the degree of exposure of ~~how exposed~~ banks and other financial institutions ~~may be~~ to one another and how that should be expressed in their financial statements. We may see more transparency in financial statements regarding swap and other derivative positions.

Swaps could potentially grow in scope in the future. Swaps are highly effective instruments that are currently used only on a large scale. There is potential for the swap market to be scaled down and/or expanded into other areas that will help it continue its rapid rate of growth. As more financiers and managers become aware of swaps and their many uses the market is likely to continue to expand. Perhaps someday one might find swaps alongside stocks and

bonds in a basic finance primer. Although t~~T~~he specific future of swaps is uncertain, the evidence indicates~~but what is known is~~ that swaps are here to stay and that they will continue to play a vital role in future financial markets.

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Summary

The swaps market is currently one of the largest financial derivative markets in the world. With more than the $400 trillion in stated contract value worldwide it is difficult to overemphasize the importance of swaps in today's modern financial system. What is a swap? Quite simply a swap is an agreement to exchange cash flows in the future. Sometimes these cash flows are fixed between the two parties. O~~and o~~ther times they are based on an observable index such as the stock market or the price of a commodity. Swaps are used by banks, government agencies, and corporations to manage risk or lower costs.

Swaps originated in the exchange control environment of the late 1970's. At the time, restrictions on the movement of currency into and out of the Euro zone made financing international subsidiaries difficult. A parallel loan market emerged, followed by a back-to-back loan market to get around these restrictions. Both of these methods could be seen in corporate financial statements and harmed the appearance of important financial ratios. Swaps came to be used as a means of exchanging the cash flows from loans in a way that could be recorded off the financial statements. Swaps were able to accomplish this because each cash flow is considered a contingent sale or purchase. T~~and are t~~hus they are not subject to the same reporting requirements as loans.

The swap market's growth truly began to accelerate after a notable and well publicized swap transaction between the World Bank and IBM in 1981. As the market grew, standardization replaced individually structured and negotiated swaps contracts. This uniformity sped up transactions and allowed trades to occur

more easily. Individual swaps contracts can be customized to meet the needs of the users. The reason for this is swaps are not traded on an exchange like stocks, but rather through a network of brokers and dealers. This style of trading is known as over-the-counter and allows customers to get a swap that fits their needs.

Interest rate swaps are by far the most commonly used swaps. Banks and corporate treasury offices use them to manage the risks on loans. A plain-vanilla interest rate swap is one of the simplest types of swaps. As an example, say New York State borrows $1 billion at a fixed rate of five percent to expand the thruway. The alternative would have been for the state to take out an adjustable rate loan, where the interest rate moves with the market. Perhaps a few years later the adjustable rate is very low, much like it is today with the government working to lower interest rates. New York State is still paying a fixed five percent interest rate when the adjustable rate might be two percent. The state, looking to lower its interest cost, could take out an adjustable rate loan to get a lower interest rate and use it to pay off the fixed rate loan.~~,~~ This move, though,~~but this~~ would require paying significant~~lots of~~ closing fees to the bank. As an alternative, the state can approach a swap dealer and enter a swap to pay the adjustable rate and receive a fixed rate. In this case, the state would customize the swap so it receives five percent to cover the interest cost on its loan. Using a swap is more efficient for the state because instead of paying off one loan and creating another, the state just makes an agreement with a dealer to exchange the cash flows in the future.

Currency swaps occur when a party is looking to borrow in another currency or eliminate the risk of exchange rates changing. A basic currency swap can be viewed as a situation where two parties using different currencies each borrow in their home currency and then exchange the principals borrowed. Each then makes payments to the other in the currency they received until the end of the swap and then at the end of the swap agreement they exchange back the money for their home currency. This type of swap is used by businesses looking to invest abroad. For example, suppose that~~if~~ Wal-Mart wants to build new stores in India, ~~,~~instead of having to find a bank to borrow rupees from in India, it can just swap dollars it already has for the rupees it needs.

Equity swaps allow for money managers to move cheaply into and out of the stock market. An index fund is one where the fund holds all of the shares in that index. For example, the S&P 500 index is the 500 largest companies in the US. For a manager to buy all 500 stocks would require paying a great deal in commissions. Once the manager has all of those shares he/she would be very unlikely to jump in and out of those shares. However, the shares in the index will move up and down. A manager concerned about the shares in the index going down might wish to sell the shares and invest the money in safe bonds that pay a fixed rate of interest. However, this would require paying commissions to sell the shares and buy the bonds. Alternatively, the manager could enter into a swap to pay the returns on the S&P 500 and receive a fixed rate of interest. The swap is a much cheaper and more efficient solution than transacting all of those stocks and bonds.

Commodity swaps have a rich history since their legality was questioned for several years after their introduction. Eventually the market did take hold and commodity swaps fill an important gap in a commodity hedger's tool kit. Businesses need commodities like oil, corn, and rubber to assemble the products that they sell. Dramatic price increases in commodities can result in businesses losing money. As a result, businesses try to hedge or fix the price that they will pay for a commodity. Most other derivatives used for this purpose, such as futures contracts, only go out to a maximum of five years. Commodity swaps can be dated out as long as twenty or thirty years. For example, a company can arrange to pay a fixed rate for corn for the next twenty years in exchange for receiving the variable market price of corn, which it then uses to go out in the market and purchase corn.

Different swap classes number in the hundreds and payments can be based on anything from rainfall to electricity costs. Swaps have proven to be a very efficient tool for sharing risk and lowering costs. The tremendous growth this market has had should only continue as more market participants become aware of their benefits and new swap types are created. Though the regulatory environment is likely to change, swaps will continue to play an important role in financial markets of the future.

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