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Lecture Note 2.3: Still More Swaps

To conclude our tour of swaps, we will look at two more types of swap agreements that play a major role in financial engineeering. Even though these instruments at first look completely different from commodities swaps and interest rate swaps, we will see that there is common valuation idea behind all of them. This new idea will lead us to some deep insights.

Last, we will revisit our assumption of perfect counterparties, discuss what couterparty risk means in reality, and see how markets are evolving to cope with it.

Outline:

I. Return swaps.

II. Credit swaps.

III. About counterparty risk.

IV. Summary

I. Return Swaps.

- Last time we saw that interest rate swap valuation formulas are natural generalizations of the results we found for commodity swaps.
- Now I want to point out a *completely different* way that IRS can be valued as derivatives – by changing what we view as the underlying security.
- To start, re-write the first formula that we found for the value of a plain vanilla swap whose swap rate was set at s:

$$\begin{aligned} V(s) &= 1 - B_{0,T} - s \sum_{t=1}^{T} B_{0,t} \\ &= 1 - \left[s \cdot \sum_{t=1}^{T-1} B_{0,t} + (1+s) B_{0,T} \right]. \end{aligned}$$

- Notice that the last term (inside the brackets) is the value of a risk-free coupon bond, with coupon s, maturing at T.
- The first term (i.e. 1) is also the value of a bond: *it is the value of a risk-free floating-rate note (FRN) paying the t-bill rate.*
  - ▶ Why? No-arbitrage again.
  - ▶ If such a fund had a higher price that 1.0, short it and invest 1.0 in t-bills and have zero net cash flows at all future dates (plus money today). If it had a lower price...do the reverse.

- In other words, another way to look at our plain vanilla interest rate swap is as the exchange of cash-flows from investment in a FRN – or in a fund that just rolls-over T-bills – for those of a risk-free coupon bond.

- Most swaps do originate from one party wanting to off-set cash-flows from a coupon bond or a floating-rate note.

- When these underlying bonds really exist, we can view the swap as a *derivative of them*.

- This insight gives us **a third way of valuing swaps:** value the assets whose cash-flows are being exchanged.
  - The value of the swap must be the difference in the prices of the two underlying assets (or investments).
    - If it is not, then we can simply replicate the swap by buying one of the assets and selling the other.
    - (This assumes that both assets can be sold short.)
  - **No-arbitrage pricing applies if the two assets are traded** even if there are no forward prices for anything!

- Viewing swaps as derivatives of some underlying investment asset allows us to analyze a new class of products – **return swaps** – that are more complex than our original framework can handle.

- There are two common types of return swaps:

  Asset swap in which the payouts from two given investments are swapped for each other, with (risky) principal difference exchanged at the end.

  Total-return swap (TRS) in which the realized returns (including payouts) from the two investments are periodically exchanged, and the investments are re-calibrated to unit value.

- For example, consider this swap:
  - ▶ You pay me dividends and final liquidation value of £1 billion invested today in the FTSE 100 and held for one year.
  - ▶ I pay you dividends and final value of £1 billion invested in the Nikkei 225, converting the currency as necessary.

  Notice that the cash-flows here will be at unpredictable times that are not the same for the two sides.

- Also note, although we are maintaining the assumption that the obligations of the swap are certain to be performed by each counterparty, we are not assuming anything about the performance of the underlying investments.

- So the question is: how do we price this swap?
  - ▶ Should you pay me an extra fee? Should I pay you?
  - ▶ Does it depend on our forecasts for the Japanese and British economies – or their interest rates?

- Answer: No, no, and No! The swap has zero net value.
  - ▶ As we reasoned above, the value of the swap is the difference in the values today of the assets whose cash flows are being swapped.
  - ▶ Here both assets have the same value today (£1 billion).
- **Any swap of cash-flows from equal-value assets must be fair.**

- My example above was a typical 1-year asset swap.
- Now, if that swap is fair today, it will be fair in one year to enter another one just like it.
  - ▶ So committing today to do so then must also be fair.
- But that is exactly what a (2-year) TRS is.
  - ▶ A commitment to enter into a series of 1-year asset swaps.
  - ▶ (In practice, one would lump the dividends in with yearly payments; net two performances and just pay the difference.)
- **Conclusion:** TRS – with zero fee to either side – are always fair too!
- To be careful, we are saying the value of a total return swap is zero only at the rebalancing dates, where the principals are re-set.
  - ▶ At dates in between, the value is just the difference in returns since last rebalancing.

- Also to be careful, the valuation conclusions for TRS assumes the underlyings investments are liquid, traded assets that can be sold short.
  - ▶ And the argument requires that we know that this will be true at future rebalancing dates as well.

- Return swaps are a very popular and useful tool for passive asset managers to alter their exposures without doing a lot of costly trading.

- Moreover, they offer interesting possibilities to active managers as well.

- **Example:** "alpha transfer."
  - ▶ Suppose you are an active manager in one market sector – say government bonds.
  - ▶ Suppose also that you are successful in "generating alpha" – meaning, consistently delivering returns greater than your sector's benchmark (e.g., beating the returns on, say, 10-year Treasury bonds).
    - ∗ Assume your fees are proportional to this alpha.
  - ▶ Then a large money-manager approaches you and tells you she will invest \$1 billion in your fund *if you can invest in the stock market and deliver alpha in excess of the S&P 500 returns.*

- Do you politely refuse because you have absolutely zero expertise in picking stocks?
  - **No!** You take the money!
  - Then....
  - ...do nothing different!
- You simply invest the client's money in your original fixed-income strategies and enter into a TRS where you recieve S&P 500 returns and pay the returns on 10-year Treasuries.
- Assuming you continue to deliver alpha with respect to that benchmark, you have now converted it into stock market alpha!
  - From the client's point of view, you are beating the S&P500.
  - It doesn't matter how you got there.
- The key to making this work: it had to be true that you could enter into the TRS *without having to pay a fee to do so.*

- As with all derivatives, return swaps can be also be used in situations where the no-arbitrage pricing conclusions do not apply because the underlying investments are not liquid, tradeable securities.
  - Examples could include private equity, real estate, or consumer loan portfolios.

II. Credit default swaps (a first look).

- What are they?
  - ▶ You pay me fixed fee $\$C$ until T;
  - ▶ I pay you nothing, unless a specified third party (call it Company X) goes bankrupt before T, in which case I pay you a lump-sum $\$L$.
  - ▶ Just an insurance policy.
    - ∗ Typically the fee is quoted as a percentage of the face value of some bond of company X.
    - ∗ And then the payout L is typically the loss-upon-default of that bond, i.e., face value minus recovery value.
- Later on in the course we'll study the pricing of credit risk in a lot more detail.
- For now, I just want to point out that these swaps can be viewed as another type of return swap: the exchange of cash-flows from particular portfolios.
- So, to the extent that we can trade the underlying portfolios, there's really no mystery to pricing them.

- Consider the following asset swap to time T.
  - You pay me the cash-flow from a portfolio that is long a coupon bond of company X maturing at T.
  - I pay you the cash-flow from a portfolio holding a riskless bond of the same maturity and principal.
  - Assume the coupon rates are such that the bonds are both worth par today.
  - At T we exchange the difference in market values of the two bonds.
  - Then, I've sold you credit insurance!
  - Why?
  - If company X never defaults, I get the net coupon difference between riskless and risky bonds, i.e. a fixed fee.
  - If X dies, then the terminal payoff you get is worth (roughly) the same as a CDS payoff: face value minus recovery value of the defaulted bond.

- So if credit swaps are a type of return swaps, we can apply what we just learned.

- First, the net value of the above swap is the difference in the time t prices of the two portfolios.
  - If the two bonds are both worth \$100 at the start, then the swap is fair.

- Thus the effective fee is the difference in the coupon rates.
  - And the coupon rates for bonds trading for par is the same thing as their yields-to-maturity (ytm).
  - And the *difference* between any bond's ytm and the ytm on a riskless bond of the same duration is, by definition, the *credit spread*.

- Conclusion: the fair credit default insurance fee should be the same as the risky entity's credit spread.

- We will revisit this conclusion later to discuss reasons why it might not exactly hold for credit default swap fees in real life.

III. Risky counterparties.

- Swaps can tie you to one counterparty for a (potentially) very long time. This makes the non-performance issue much more important for swaps than for forwards.

- Suppose you are valuing the promise of a risky counterparty to deliver a stream of some good (in exchange for your cash).
  - ▶ Even if forward contracts are available on the good to all dates, now that's not enough to allow valuation using no-arbitrage arguments.
  - ▶ A perfect hedge is no longer possible.
  - ▶ The issue is: your replicating portfolio will consist of contracts with *different* counterparties. They could default and the swap could default, but the two events are not likely to coincide.
  - ▶ So the default risk does not net out.

- **Beware:** don't confuse two types of risk here:
  - ▶ The riskiness of the cash-flows being swapped versus the riskiness of the counterparty performing the swap.
  - ▶ For example, a BB-rated entity could promise to pay you the 10 year treasury bond return in a return swap.

- What actually happens when your counterparty (CP) defaults? Usually both parties will have agreed to be governed by a version of the ISDA Master Agreement (possibly with amendments).
  - ▶ Both sides stop exchanging cash-flows.
  - ▶ Counterparty goes into reorganization.
    - (**A**) If value of swap is positive (to CP), you – the non-defaulting party (NDP) – must pay the administrators that sum within 20 days of serving notice of default to the defaulting counterparty.
    - (**B**) If value is negative (i.e. favorable to you), your claim to that amount is classed with other business creditors, and, ultimately, you receive the same fractional value that they do.
    - (**C**) If you have multiple swaps *or other OTC derivatives* with CP, the obligations are supposed to be netted first to come up with one omnibus obligation.
      - ∗ This is called the "Safe Harbor" rule for OTC derivatives.
    - (**D**) Your Master Agreement may have contained provisions for each side collateralizing the swap value through time, possibly resulting in a senior claim.
  - ▶ Note: not clear what "value" is in (A). The ISDA standard is "replacement value" as determined by the market. But for whom?

Peregrine haunts Isda

The liquidators of Peregrine Investment Holdings – the Hong-Kong-based investment bank that collapsed in January 1998 – are to go court in London to clarify documentation relating to more than $1 billion of derivatives transactions. PricewaterhouseCoopers is seeking an interpretation of the Master Agreement produced by industry body the International Swaps and Derivatives Association, which threatens to delay the collection of more than $1.3 billion owed to Peregrine Fixed Income, a Peregrine subsidiary, on derivatives trades.

The outcome of the dispute turns on whether credit quality should influence the value assigned to an interest rate swap contract when one of the counterparties has defaulted. PWC will argue that the swap should be settled using a credit risk-free rate. An unnamed debtor, believed to be a non-financial sector Asian company, will argue that credit is a consideration. The debtor's credit quality has deteriorated since the swap was transacted, and it could therefore expect its debt to be slashed if successful in court.

PWC will use the court ruling to settle the rest of the claims. And creditors will be fervently hoping for a PWC victory. Anything else could cut potential recoveries.

If the court rules in favour of the debtor, the liquidators will be facing "a nightmare scenario", admits Simon Copley, Hong Kong-based partner with PWC's global risk management solutions division. In fact, the firm's calculations would be completely derailed. Copley says that even a small tweak in pricing could result in companies that believe they are owed money by Peregrine suddenly becoming debtors, and vice versa. "The ramifications could be hugely significant," says Copley. "It could even end up making Peregrine look technically solvent."

Copley claims that market participants agree with PWC's interpretation. "Maybe the words [in the Isda documentation] don't match up with what some people want; we believe our reading is the right one," he says.

Isda is keeping an eye on the situation. Quentin Hills, co-chairman of Isda's steering committee for Hong Kong and South-east Asia, maintains that the Master Agreement is operating as intended.

Isda's Master Agreement uses "replacement value" methodology in these situations. If one counterparty in a swap contract defaults, then Isda documentation assumes that the non-defaulting counterparty will need a replacement. The new swap will have to be transacted at current market prices, which will be determined by factors such as liquidity and credit quality, says Hills. The Master Agreement works on the principle that the replacement cost should be factored into the close-out value of the terminated swap, but Hills contends that credit factors alone should not dramatically affect this value.

Of the total $2 billion owed to Peregrine, PWC has separated the debtors into those that are able to pay, and those which are not. Top-rated international banks fall into the first category, and account for some $500 million of debt. The other $1.5 billion was transacted largely with entities in Indonesia (around $1.1 billion) and Thailand (around $300 million). Most of these cannot pay, says Copley. "We're talking to them now," he says. "We're trying to work something out."

PWC hopes to pay a first dividend to Peregrine creditors in August. By mid-June, Copley and his team had recovered 20%, roughly $400 million, of the money owed to Peregrine. This was mostly from bank debtors. Recoveries ahead of the first dividend payment are expected by Copley to range between $475 million and $775 million. Working from those figures, Copley says creditors can expect the dividend to be between 20% and 40% of the money owed to them. ■

Duncan Wood

- In 2002 ISDA changed its master agreement to specify a particular methodology for computing the "Close-out amount."
  - It still allows NDP to determine the value, and they are still allowed to use market quotes that take into account their own risk.
  - But their way of doing so has to be "commercially reasonable" – whatever that means!
- Also notice that if NDP is on the losing side of a swap he can BOTH stop paying required cash-flows AND delay – possibly forever – the close-out value simply by never issuing notice of default!
  - In the case of Lehman Brothers (2008), the bankruptcy court may have closed this loophole for now (in the U.S.) by allowing Lehman to sell its winning permission to non-defaulting third parties without getting permission for assignment from NDPs.
    - As a matter of interest, Lehman had about 930,000 swaps and other OTC contracts that had to be settled via the ISDA process with over 6,000 counterparties.

Example of default losses

- You do a 10-year swap paying T-bills (annual) for 6% fixed on \$100m. Then rates jump.

New interest rate flat term-structure:	3%	4.5%	6%	9%	12%
Value of swap:	+\$24.6m	+\$11.9m	0	-\$19.3m	-\$33.9m
... if CP defaults:	0	0	0	-\$19.3m	-\$33.9m

(Recall formula: $V = 1.06 \sum_{t=1}^{10} B_{0,t} - \sum_{t=0}^{9} B_{0,t}$.)

- Counterparty risk only arises from times when *both* the counterparty fails *and* you are a winner on your side of the trade.
- Your *extra* loss when counterparty defaults is zero if swap has gone against you. But the size of any loss is unknown at initiation (depends on rates at the time, remaining life, etc).
- The "insurance" you would need to buy to make the swap riskless would be more complicated than a lump-sum payoff.
  - ▶ Need something like an option, something like default insurance.
  - ▶ To truly have a no-arbitrage value for our position, this is the insurance we would have to price.
  - ▶ The cost of such insurance would then depend on the correlation between the counterparty's credit risk and the underlying variable(s) in your swap.

- Most major dealers now attempt to price such risk and incorporate a "credit value adjustment" into prices they charge customers.
  - ▶ They then have to run special CVA trading operations to dynamically adjust the size of their default insurance as underlying values move.
    - ∗ There are lots of jobs in this area at the moment!
  - ▶ Note the importance of the safe harbor (netting) rules here: a particular customer trade may actually lower a firm's overall exposure to that customer if it off-sets existing positions.
    - ∗ This could produce a negative CVA. If there were no netting, every trade would incur a positive CVA.

- **Question:** What happens if two parties, A and B, are both risky? Do the credit risks cancel? What is the "fair" swap rate?
  - ▶ Let s be the default insurance/option cost (for both parties).
  - ▶ Let S be the risk-free swap rate (against T-bills,say).
  - ▶ A will only pay $S - s$ against floating to take B's credit.
  - ▶ B needs $S + s$ fixed in order to pay floating to A.
- If they just trade at the mid-point rate, neither side receives enough to purchase a replicating portfolio for his/her obligations. So no swap is "fair" as we have defined it.
  - ▶ How can they trade?

- This example shows the economic logic of putting a riskless intermediary in between the two parties.

- As mentioned last time, governments are increasingly imposing central clearing on swaps markets.
  - SwapClear and the CME group are currently the two biggest operations providing central clearing to large market participants.
  - Smaller players then have to have one of these larger banks act as their "prime broker" and have their transactions cleared via them.

  And for non-cleared bilateral deals, as of last year, almost all financial institutions now must arrange for daily margining by a third party.

IV. Lecture Summary.

- We looked at swaps in a new way today: as the difference in cash-flows (or returns) between two pre-specified securities or portfolios.

- When the two portfolios consist of tradeable (shortable) assets, no-arbitrage pricing applies even where forwards and futures don't exist and can't be replicated.

- Any two payment streams can be swapped:
  - ▶ if we can value each, we can value the swap;
  - ▶ if each is the cash-flow from an investment whose value today is \$1, the value of the swap must be 0;
- Return swaps, interest rate swaps, and even some types of credit default swaps can be priced like this.

- Counterparty default risk is really a *joint* risk that your counterparty defaults *at a time when you are a net winner on the swap.*

- Pricing a swap in which your counterparty is risky requires you to value a dynamic default risk strategy whose size varies with contract mark-to-market value.

- Quantifying the resulting extra cost of hedging/replication is still an evolving science.

- With luck, central counterparties will save us from some of the headaches!

Lecture Note 2.3: Summary of Notation

Symbol	Page	Meaning
C,L	*p9*	*annual fee and payout on credit default swap on entity* X
S	*p18*	*interest rate swap rate for riskless counterparties based on riskless floating rate*
s	*p18*	*cost of purchasing right to replace a swap if original risky counterparty defaults*