

Research Notes

The Value of a New Swap

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Summary

- The pricing of derivatives transactions is based on the theoretical concept of pricing at mid-market, that is, zero net present value at inception.
- In practice, the mid-market price is generally not the actual price transacted with a counterparty, but is instead a benchmark against which the actual price is set.
- If a dealer were to transact with a counterparty at the mid-market price, the dealer would neither recover its transaction costs such as credit spreads and hedging costs, nor would it earn a profit.
- The actual price agreed with the counterparty is therefore a bid or offer price that uses the mid-market price as a benchmark before adjusting for costs and risk, and the actual net present value to the dealer is not zero but a positive amount.

Introduction

A central concept of financial instrument pricing is that of zero net present value at inception; the concept is also known as mid-market pricing. Applied to a derivatives transaction, the concept means that the terms of the transaction are set so that the present value of expected cash flows to be paid by one party is equal to the present value of expected cash flows to be paid by the other. For an interest rate swap, for example, zero net present value means that the swap fixed rate is set so the present value of fixed rate cash flows equals the present value of expected floating rate cash flows. For a credit default swap, it means that the credit spread is set so the present value of expected spread payments equals the present value of expected default payments. And for an option, it means that the option premium paid at inception is equal to the present value of expected in-the-money cash flows. In all cases, once the market moves, net present value is no longer zero.

But in practice, originating and executing a transaction involves costs that must be covered by the dealer that arranges it. If the actual price of a transaction were set so net present value was zero, the dealer would not cover its costs of transacting and of serving more generally as a market maker, nor would it be compensated for the credit risk it takes in a bilateral transaction. It is therefore necessary to adjust the mid-market price to cover various costs and risks of

transacting as well as provide a return to the dealer that makes a market; this is true not only of derivatives but of market making for all financial instruments. The result is that the actual price agreed for the transaction is not the mid-market price, but typically either a bid price if the dealer is paying the fixed rate or an offer price if the dealer is receiving the fixed rate. And because the actual price is the bid or offer price, the net present value to the dealer will be a positive amount and not zero.¹

Because mid-market pricing is such a central concept, confusion sometimes arises from literal application of the concept to actual pricing. It is the purpose of this Note to describe in general terms the difference between the benchmark transaction price at which net present value of cash flows is zero and the actual price agreed with a counterparty. Using a hypothetical plain vanilla interest rate swap, the first section describes the concept of mid-market pricing at which net present value is zero at inception. The second section lists some of the costs incurred by a dealer in connection with a transaction. And the third section gives an example of how actual swap pricing adjusts the mid-market price to incorporate the costs of a transaction. The example is generic in nature and does not necessarily correspond to the details of any specific firm's practice.

Mid-market transaction pricing

Pricing and valuation, as the terms are used in financial markets, refer to two different aspects of the same process. Pricing refers to the process of setting the initial terms of a transaction, for example, the fixed rate on a plain vanilla interest rate swap. Valuation refers to determining the net present value of expected cash flows after the initial terms have been agreed and set. The following discussion will focus on pricing a swap transaction.

A plain vanilla interest rate swap involves one party paying a fixed rate to and receiving a floating rate, usually Euribor or Libor, from the other party. Pricing a vanilla swap begins with determining a benchmark fixed rate for a par swap, which is defined as an interest rate swap with a net present value of zero. This benchmark fixed rate is neither a bid price nor an offer price, but instead a *mid-market price* based on prices currently quoted in the market. This mid-market price is not itself a market price at which a transaction would be dealt.

Determination of the mid-market price involves calculating three interrelated yield curves. The first yield curve is the par curve, which is the set of fixed rates currently quoted for par swaps of various maturities. The par yield curve for interest rate swaps is also called the mid-market swap curve because, in practice, it is derived by averaging the bid and offer rates for each quoted maturity. A market participant considering entering into an interest rate swap would consult the par swap curve to determine the fixed rates currently being

¹“The small initial divergence from par is the dealer's profit on making the market.” *Bank One Corporation v. Commissioner of Internal Revenue*, 120 T.C. No. 11, May 2, 2003, p. 61.

quoted for various maturities.

The second yield curve is known as the zero coupon curve or spot curve, and is related through arbitrage to the par yield curve. The zero coupon yield curve is a set of rates paid on instruments that accumulate interest until maturity, with no intermediate cash flows. For interest rate swaps, zero coupon rates have traditionally been used to discount expected cash flows.²

The third yield curve is the forward curve, and is derived from the zero coupon yield curve. The forward yield curve consists of the future values of zero coupon rates that are implied by current zero coupon rates. For interest rate swaps, forward rates are used as proxies to estimate expected floating rate cash flows for future dates. This calculation is based on the unbiased expectations hypothesis, an economic theory that asserts that forward prices are unbiased predictors of future spot prices.

Table 1 shows how the three yield curves fit together in order to price a hypothetical five-year USD interest rate swap in which one receives the fixed rate on a notional amount of \$10 million. Assuming annual cash flows for simplicity, Column B is a hypothetical par yield curve from which the zero coupon and forward curves in Columns C and D are derived. For a five-year swap, the benchmark fixed rate for the swap will be the five-year par swap rate of 4.0 percent (Column B). The floating rate cash flows (Column E) other than the first one are unknown, so they are estimated based on forward rates for the appropriate dates (Column D). Finally, zero coupon rates are used to discount the cash flows (Column C).³ The present values of the fixed-rate and floating-rate cash flows are exactly offsetting, so the net present value of the swap is zero (Columns F and I).

**Table 1:
Mid-market
yield curves and
expected cash
flows at origination**

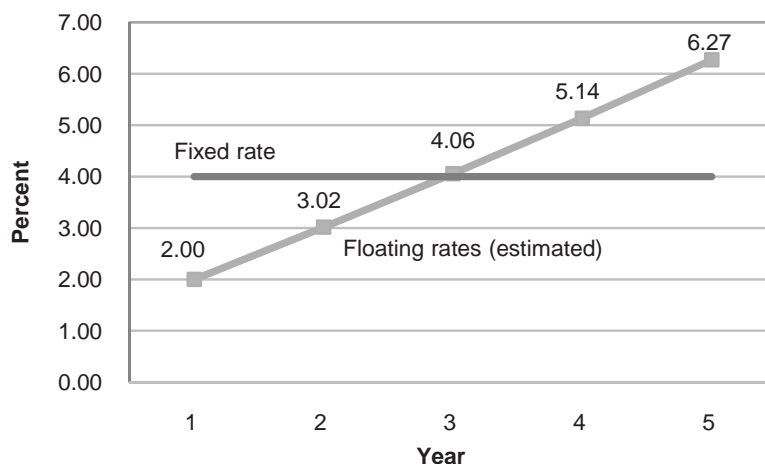
A	B	C	D	E	F	G	H	I
Year	Par	Zero	Forward	Floating payment (est.)	PV (Floating)	Fixed rate	Fixed payment	PV (Fixed)
1	2.00	2.00	2.00	(\$200,000)	(\$196,078)	4.00	\$400,000	\$392,157
2	2.50	2.51	3.02	(301,508)	(286,944)	4.00	400,000	380,679
3	3.00	3.02	4.06	(405,625)	(370,984)	4.00	400,000	365,840
4	3.50	3.55	5.14	(513,618)	(446,806)	4.00	400,000	347,967
5	4.00	4.08	6.27	(627,012)	(513,267)	4.00	400,000	327,437
					(\$1,814,080)			\$1,814,080
				Net PV	\$0			

² For a discussion of recent issues regarding the choice of discount rates, see Christopher Whittall, “Dealing with Funding on Uncollateralized Swaps,” *Risk*, July 2010.

³ The example abstracts from the issue of determining the appropriate discount rate.

Chart 1 (below) illustrates graphically the relationship between the fixed rate and floating rate cash flows. The fixed rate on a par swap is effectively a weighted average of estimated floating rates. The areas under the two curves, in present value terms, should be equal. The result is that the net present value of expected cash flows is zero.

**Chart 1:
Estimated cash flows
for a par swap priced
at 4.00%**



Market making and the costs of a swap transaction

Although the fixed rate of 4.0 percent in Table 1 and Chart 1 is a benchmark mid-market rate, it is unlikely to be the fixed rate actually paid by either of the parties. But even though market participants do not actually transact at the mid-market rate, it is nonetheless useful because it is an objective, transparent rate that might be used as a basis for actual pricing; indeed, market participants can infer mid-market rates for vanilla swaps from the bid and offer prices posted on Bloomberg, Reuters, and other data services. The following section will consider the various costs associated with a plain vanilla swap in which a dealer is one of the counterparties and how those costs can be incorporated into the terms of the swap.

Over-the-counter derivatives markets function by means of the intermediation services provided by swap dealers; the service they provide is known as market making. As market makers, swap dealers stand ready to act as a counterparty to transactions with other market participants. Market makers provide liquidity to the market, and virtually all swap transactions involve a dealer as counterparty. But market making involves costs, and dealers that make markets must be compensated for incurring these costs.

The following is a list of some of the costs associated with vanilla swap transactions executed by dealers. The cost classification is generic in nature, and does not necessarily correspond exactly to practices at any individual firm; costs will vary from firm to firm because of differences in assumptions, portfolio exposure and strategies, and internal cost structures. The list is by no means exhaustive: more complex, non-vanilla transactions, for example, would involve additional costs resulting from features specific to those transactions.

Hedging costs. When a dealer acts as market maker, it takes on risks from some market participants and then hedges the risks by offsetting them with other clients or in other markets. The costs of hedging fall into two categories. The first category is mid-market hedging costs, which reflect the cash flows on the instruments used to offset the risks of the transaction. In the above interest rate swap, the mid-market pricing reflects the assumption that the expected cash flows are hedged by a strip of forward rate agreements or interest rate futures, whichever offers the most effective hedge over the life of the swap.

But a second category of hedging cost, the dealer's market making cost, reflects the bid-offer spread in the inter-dealer market; this cost is not included in the mid-market price and must therefore be added. If a dealer receives the fixed rate, for example, it might hedge the swap by entering into a swap in the interdealer market on which it pays fixed; the fixed rate paid by the dealer in this case will be another dealer's offer price. A common way to incorporate this bid-offer cost is to take one half of the inter-dealer bid-offer spread and add it to the mid-market rate. So if the interdealer bid-offer spread is two basis points, the dealer would use one basis point as its market making cost.⁴

Cost of credit. Over-the-counter derivatives involve the risk of counterparty default, and a financial institution expects to be compensated for taking on this risk. One way to do so is to set aside a credit reserve for the transaction; another is an internal charge by the credit business to the swap business unit. Reserves and credit charges will both be a function of the creditworthiness of the counterparty and of other aspects such as whether the counterparty has pledged collateral. If liquid credit default swaps are traded for the counterparty, the creditworthiness of the counterparty might be assessed using the CDS spread for that counterparty. The credit adjustment will typically reflect the ability of the dealer to mitigate the credit risk through, for example, netting, collateral, third party guarantees, and central counterparty clearing.

Administrative and other costs. In acting as a market maker, a dealer incurs various administrative costs, including systems costs, operational and processing costs, and other allocated costs. Further, complex and less liquid transactions are likely to involve reserving against model risks and unhedgeable risks.

Profit margin. Dealers typically include some measure of required profit margin, which economists describe as an implicit cost of a transaction because it represents a minimum return necessary to justify taking on the risks of entering the transaction. One possible measure is required return on capital, which is the net income necessary to cover the cost of allocated capital. Another measure is gross profit margin, which must also cover administrative costs.

⁴ Some dealers make the simplifying assumption that they can trade out of a hedge at mid-market and therefore do not include an inter-dealer market making cost entry.

Pricing to cover transaction costs

Origination. The marketing function at a dealer has primary responsibility for the origination process, and needs to be compensated for the work performed and value added. Origination costs will be particularly significant for innovative or highly customized transactions.

Given that mid-market pricing provides only a benchmark for pricing, how do dealers incorporate transactions costs into pricing of an actual transaction? One way would be to charge an up-front fee to cover anticipated costs and then to transact at the mid-market rate. This has not been typical market practice, however, largely because most of the costs, particularly hedging, credit, and administration, will take place over the life of the transaction. Instead, normal practice is to adjust the mid-market price for the costs of a transaction, although adjustments differ across firms to the extent cost accounting practices differ.

The following is a stylized version of how transaction pricing works in practice. As a general matter, a dealer expects to transact at one level with clients and at another with other dealers; the difference is analogous to a retailer's buying goods from a supplier at a wholesale price and selling the goods to customers at a retail price. Bid and offer prices posted by data providers such as Bloomberg and Reuters represent the wholesale prices transacted between dealers. In order to arrive at an interest rate swap rate for a non-dealer client, transaction costs typically are added to the mid-market fixed rate if the dealer is the fixed rate receiver and subtracted from the mid-market fixed rate if the dealer is the fixed-rate payer. The result is the bid-offer spread that is quoted to a particular counterparty; the spread incorporates both general market costs such as inter-dealer bid-offer spreads and processing costs as well as counterparty-specific costs such as credit and origination.

In order to quantify the value added by a transaction, the dealer calculates a gross transaction value, which is the net present value of actual cash flows compared with the benchmark mid-market value. More precisely, gross transaction value is equal to the difference between (1) the net present value of the transaction using the actual bid or offer fixed rate agreed with the counterparty but discounted using mid-market rates, and (2) the net present value of the transaction assuming it is priced at mid-market. Since (2) is generally equal to zero, the value added is normally equal to (1). This gross transaction value can then be partially offset by cost provisions such as credit charges and hedging costs.

At some firms, this amount is known as initial net present value (INPV), although INPV can also be defined as gross transaction value minus the credit charge and hedging costs. The INPV of a swap is in effect an estimate, booked at the time of origination according to each bank's policies, of net revenues expected over the life of the swap. A swap that is difficult to hedge, for example, will have relatively high provisions for hedging costs, resulting in a reduction of the amount of net revenues booked. By estimating expected net revenues at origination, the INPV makes it possible to allocate the value to various functions:

the credit charge to the credit business, bid-offer to the trading business, and at some firms the residual INPV is allocated to the origination function. Once the allocation has been made, it is the responsibility of the trading desk to preserve the residual INPV through hedging and portfolio management. Because INPV after cost allocation is an estimate, it may or may not be realized during the life of the transaction and could even result in a loss for the dealer.

Table 2 continues the example in Table 1 and assumes that, although the mid-market fixed rate is 4.00 percent, the counterparty actually pays a fixed (offer) rate of 4.1 percent. Discounting the expected cash flows at mid-market rates gives a gross transaction value of \$45,352. Next, the bid-offer charge is based on an inter-dealer bid-offer spread of 3 basis points. The bid-offer charge is obtained by multiplying half the bid-offer spread by the value of a one basis point change in rates, commonly known as the present value of a basis point (PVBP).⁵ Using the same model used to calculate the numbers in Table 1, the PVBP is approximately \$4,535 so the bid-offer charge is \$6,803. Finally, the \$3,000 figure is an illustrative figure that represents the credit charges estimated by the dealer; in practice, credit charge methodologies vary from firm to firm. In order to calculate INPV, the hedging and credit charges are subtracted from gross transaction value. The remaining \$35,549 is available to compensate the dealer for the costs and risks involved in transacting the swap.

Table 2:
Sample net present value adjustment for a new swap

Gross transaction value	\$ 45,352
Bid-offer	6,803
Credit	3,000
INPV	\$ 35,549

Conclusion

Swap dealers are in the business of making markets, that is, quoting bid and offer prices at which they stand ready to transact. The function of market makers is to provide liquidity to the market, and in the process provide a social benefit. But acting as a market maker involves costs, which the dealer recovers by means of bid-offer spreads.

The pricing of a derivatives transaction begins with determination of a benchmark mid-market price at which net present value is zero at the inception of a transaction. But if the dealer were actually to transact at the mid-market price, it would incur transaction costs but would not cover them, nor would it earn a return to compensate it for acting as market maker. The actual price transacted with the client is therefore not the mid-market price but a bid or offer price at which the dealer realizes a positive estimated net present value. The mid-market price is instead a starting point for setting the actual price at which the transaction will be executed.

⁵ Another common term is discounted value of a basis point or DV01.

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