Expert Report of Darrell Duffie[1]

February 15, 2001

Confidential

UNITED STATES TAX COURT, Docket Nos. 5759-95 and 5956-97.

BANK ONE CORPORATION (SUCCESSOR IN INTEREST TO FIRST CHICAGO NBD CORPORATION, FORMERLY NBD BANCORP, INC., SUCCESSOR IN INTEREST TO FIRST CHICAGO CORPORATION) AND AFFILIATED CORPORATIONS,

Petitioner,

v.

COMMISSIONER OF INTERNAL REVENUE,

Respondent.

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Contents

1 Background

I have been asked to act as one of the Court's experts in this case. One of my duties is to prepare this report, which addresses a series a questions dealing mainly with the fair market values of the petitioner's swap portfolio. These questions are raised in several documents:

- Stipulation with respect to court appointed experts.
- Petitioner's proposed questions for court-appointed experts.
- Respondent's proposed questions for court's experts.

The questions asked in the Stipulation with respect to court appointed experts are:

a. The relative merits and deficiencies in the various expert reports and opinions of petitioner's and respondent's experts.

b. The generally accepted method or methodologies of the valuing the derivatives at issue in this case.

c. With respect to the mid-market method of valuation, what adjustments, if any, should be made in order to arrive at the "fair market value" of the derivative?

Sections 3 through 6 of my report deal with Questions (b) and (c). I respond to Question (a) in Sections 7 and 8. I respond to the questions posed to me by the petitioner and respondent in Sections 9 and 10, respectively.

2 Qualifications and Bases of Opinions

I am the James Irvin Miller Professor Finance at The Graduate School of Business, Stanford University. I have been a member of the finance faculty at Stanford since 1984. I teach, and do research on, the market valuation of securities and other assets, among other general subject areas. A significant portion of this teaching and research deals with the market valuation and management of credit risk. I attach a resumé that lists the articles and books that I have written, and other information relevant to this case, such

as consulting activities related to fixed-income pricing, derivative securities, risk management, and credit risk.

In each of our doctoral, executive, and MBA programs at Stanford, I teach courses that treat the measurement of credit exposure, the market valuation of credit risk, and adjustments for credit risk to the market valuation of swaps. For example, together with my Stanford colleague Professor Kenneth Singleton, I have developed, directed, and taught a series of executive courses with the title *Credit Risk Modeling for Financial Institutions*. These have drawn participants from major global commercial and investment banks. We also co-teach a closely related MBA course. We have been invited to present in-house variants of this course by several major global banks or investment banks. We have co-authored a textbook[2] with the same title. We have co-authored several journal articles on the topic of the market valuation of credit risk for fixed-income securities including swaps. One of these[3] deals with the empirical behavior of swap rates. This paper includes a model designed to capture the effects of both interest rates and credit risk on the market valuation of US interest rate swaps. This article deals primarily, however, with the valuation of swaps at their origination. In addition to my teaching and writing collaboration with Professor Singleton, I have authored or co-authored other articles on the topic of the market valuation of credit risk. In particular, an article[4] co-authored with another Stanford colleague, Professor Ming Huang, treats swap credit-risk adjustments for cases of counterparties with potentially unequal credit quality, whether or not at origination. Applications of the model that are specifically treated in the paper include the market value of credit risk in interest-rate and currency swaps. I have also treated these specific swap credit adjustments in both my teaching and my consulting work for dealers in swap markets.

In preparing this report, I have relied upon the knowledge and experience that I have gained through research, teaching, and interaction with market participants, including through consulting assignments. I have also relied on conversations with Mr. Barry Sziklay and on a number of documents that are listed at the end of this report.

[2]D. Duffie and K. Singleton, *Credit Risk Modeling for Financial Institutions*, forthcoming, Princeton University Press, 2001.

[3]D. Duffie and K. Singleton "An Econometric Model of the Term Structure of Interest Rate Swap Yields," *Journal of Finance*, Volume 52 (1997), pp. 1287–1321.

[4]D. Duffie and M. Huang "Swap Rates and Credit Quality," *Journal of Finance*, Volume 51 (1996), pp. 921–949.

3 Fair Market Value

When I speak below of "market value," I am speaking of "fair market value," meaning "the price at which the property [in question] would change hands between a willing buyer and a willing seller, neither being under any compulsion to buy and sell and both having reasonable knowledge of relevant facts." [See, for example, Bogdansky (1996), Section 2.01.]

There is perhaps some tension concerning how to (or whether to) apply this definition to the derivatives in question.

The market for plain-vanilla (that is, standard fixed-rate for floating rate) U.S. interest rate swaps between counterparties of relatively good credit quality is as deep and competitive as almost any other market, in my view. To a slightly lesser degree, the market for plain-vanilla currency swaps is also deep and liquid. Both of these instruments are varieties of over-the-counter (OTC) derivatives, which trade under standard contractual terms organized through the International Swaps and Derivatives Association (ISDA). The standardization and wide acceptance of ISDA OTC contracts makes them the basis for quick negotiation between active counterparties of the terms on each plain-vanilla swap.[5] This reliance on uniform and accepted contracts and easily understood terms allows counterparties to quickly "shop around" for competitive terms. For example, only the maturity and the fixed rate, two numbers, are sufficient to establish the contractual details of an ISDA plain-vanilla interest rate swap. Indeed, quick reference to electronic broker quotation services normally obviates the need to shop around, given the narrow bid-ask spread in this market. The appropriate range of terms for a large interest rate swap between high-quality counterparties are at least as transparent and easily determined, at a moment's notice, as would be the appropriate price for a comparably large position in even the most liquid equities traded on major U.S. stock exchanges. Indeed, because the degree of privately held information regarding market swap rates is typically much smaller than that held regarding equities, the common-knowledge-of-relevant-facts criterion for the fair-market-value standard would typically be more easily established for a swap transaction that for an equity trade.

The fact that trading is through bilateral negotiation, rather than in a

[5]More exotic swaps, which include special features regarding the timing of payments or non-standard formulas for the amounts of payments, may require additional time and effort to negotiate, largely because a market valuation appropriate for the terms must normally be analyzed by specially developed mathematical models.

centralized market, does not lessen the degree to which I hold the view that swap markets are competitive, and that the prices at which swaps trade may be broadly viewed as fair market values. The above definition of fair market value is consistent with bilateral trade between a willing buyer and seller that is away from a central marketplace.[6] In this particular market, bid and ask rates are widely reported, for example on broker screens. Relative to most asset markets, dealers are numerous and are aggressive in winning business. Evidence includes the large volumes of business by many dealers, and the nearness of bid and ask. In short, the use of quoted rates for the mid-market valuation of plain-vanilla interest-rate and currency swaps is no less reliable, in my view, than the use of market quotes, say at the closing price on a major stock exchange, for establishing the fair-market-valuation of equity positions.

As one moves away from a "plain-vanilla" active market in which reliable quotes are widely available, one must often estimate the price at which the hypothetical buyer and seller described above would trade. One method for this would be to present derivatives positions to actual dealers, asking for quotes. Given the very large number of positions held by those such as the petitioner, obtaining quotes for all such positions would be costly and impractical. In any case, quotes would vary slightly from dealer to dealer, and might not be obtained in the event of an actual trade. Instead, models are typically used for this purpose. Reasonable models may differ by amounts that are normally small, but that might be material (and even accumulate systematically across a large portfolio) in some cases. I do not view this as ruling out the use of models as reasonable for fair market valuation.

In practice, the mid-market valuation of swaps, with adjustments, is consistent with Bogdansky's description of fair market valuation by comparison with widely quoted assets via "formulas and ratios," with "adjustments." (See Bogdansky, 3.04[2].) I describe some of these procedures below.

Studies could be conducted that compare modeled marks to prices that are actually achieved, either through statistical inference from a sample of trades conducted in the normal course of business, or through a sample of quotes (or even trades) that are obtained specifically for such a comparison.

To my knowledge, for the types of derivatives addressed in this case, the

[6]In any case, theory tells us that the price at which trades would occur in a central competitive market at which demand and supply are crossed is well approximated by the bilaterally negotiated price in active markets. See, for example, "Valuation in Dynamic Bargaining Markets," by D. Duffie, N. Gârleanu, and L. Pedersen, Working Paper, Graduate School of Business, Stanford University, 2000.

generally accepted method for some time has been some variant of "mid-market with adjustments." I do not know when that method became commonplace. I first taught it at Stanford at the time of the appearance of the G30 Report "Derivatives Practices and Procedures." I have frequently discussed this approach with market participants since that time. Market participants have used some variant of this method, incorporating an adjustment of modeled mid-market values for credit risk, before the appearance of the G30 report. In my view, the basic idea of "mid-market with adjustments" is reasonable and practical.

The issue of what adjustments to make, and how to make them, is debatable. I see no case for adjustments that lead to a modeled fair market value that is lower than what would be the dealer's bid price for the counterparty in question, were it available. The bid price is by definition one at which the dealer is willing to buy. If a trade is willingly made with knowledge of this bid price, then the seller would not accept a lower price than the bid price. Moreoever, if adjustments were always to arrive at what would be the bid price, the average effect would be an understatement of fair market value, for in many cases the dealer buys at a price in between its own bid and ask.

4 Mid-Market Valuation

This section treats mid-market valuation, before adjustments.

4.1 At-Market Interest Rate Swaps

An interest-rate swap is a periodic exchange of a fixed coupon rate by one counterparty in return for a floating-rate payment by the other counterparty, until the stated maturity. These payments are expressed as a fraction of the notional amount of the swap. The floating rate at any coupon date is, by contract, a particular market-quoted rate (LIBOR) for short-term loans that was set at the previous coupon date. The institutional features of this market are well described in the expert report of Smithson and Sullivan.

The fixed rate of the swap is normally set at the inception of the swap so that the two counterparties agree (in the sense of the above definition of fair market value) to the swap without any initial exchange of cash flows. This means that the initial market value of the swap must be zero. In this sense, the market value itself (zero) is a trivial matter. What is important

for purposes of mid-market valuation of other swaps is the fixed rate with the property that the initial price of the swap is zero.

In determining that "par" fixed rate, we will temporarily put aside as well the possibility of default by either counterparty. Without default, one can view the swap as an exchange of a fixed-rate bond for a floating-rate bond of the same maturity, both bonds being of face value equal to the notional amount of the swap. Absent consideration of default, the floating rate is by definition the rate, adjusted at each period, at which one can borrow the face value of the bond until maturity. In order for the swap to have an initial market value of zero, the fixed rate must also be the fixed rate at which one can borrow the face value until the stated maturity. In that case, the fixed and floating rate bonds being exchanged are each of market value equal to the notional amount of the swap, and can therefore be exchanged with no additional cash payments at inception. That particular fixed rate depends on the maturity of the swap, and is sometimes called the "par yield," or "at-market" swap rate.

I emphasize that we have yet to consider adjustments such as those for administrative costs and credit risk. We have also not addressed the valuation of swaps after inception. We will address the last of these issues first, and then the question of adjustments.

4.2 Mid-Market Revaluation

After the inception of a swap, market interest rates move, causing a mark-to-market profit or loss on the swap. In order to calculate the change in the market value of the swap between any two dates (before adjustments), it is enough to calculate the change in the market values of the fixed-rate and floating-rate bonds that are, in effect, being exchanged. To the fixed-rate receiver, the change in market value of the swap is the change in value of the fixed-rate bond, less the change in value of the floating-rate bond. (Again, this is before all considerations of adjustments and default risk.)

At each new coupon date, the floating-rate bond is equivalent to a new floating-rate bond, and so has a market value equal to its face value, after its coupon has been paid. For any date t, one knows that at the next coupon date, the floating-rate bond will have a market value V equal to its face value plus the amount of the coupon payment, which is known at date t, since the coupon payments are set at the previous coupon date. Thus, the market value of the floating-rate bond at date t is equal to the market value

of a loan whose maturity is the next coupon date, and whose principal is a known fixed amount V. We can therefore calculate the price of the floating-rate bond directly from the current short-term market interest rate for the maturity of the next coupon date. Later, I will discuss relevant information sources for this short-term interest rate.

The new market value of the fixed-rate bond may be computed by a standard discounted-cash-flow calculation from the new term structure of interest rates. It is important that we have a source from which to measure these new interest rates. Before consideration of administrative costs, dealer profits, and default risk, one may use the new at-market swap rates, for they reflect the current market interest rates at which the fair market values of new fixed-rate bonds are determined. These new swap rates are reported at all times from major vendors of financial data, and are normally based on dealer quotes. Major swap dealers could use alternatively rates based on those that they themselves are quoting. If the data are bid and ask rates, it is common to use the mid-point of the bid and ask rates for this purpose. While a detailed theoretical analysis could raise some issues about the use of the precise mid point, this is reasonable, and in any case the bid-ask spread is extremely narrow, shrinking in the late 1990s to a few basis points for conventional swaps, given the exceptional size and liquidity of this market. For shorter maturities, at which swap rates are not quoted, LIBOR rates are a reasonable proxy for the purpose of mid-market valuation. I shall have more to say about this when raising the question of default risk. For numerous reasons,[7] in my opinion one should *not* use the term structure of interest rates associated with U.S. Treasury instruments. For non-dollar currencies, government bond yields are also often unreliable for this purpose.

I would also draw caution regarding methods by which one may reconstruct the term structure of interest rates from futures prices in the LIBOR or Eurodollar futures market. It is known since the 1981 work of Cox, Ingersoll, and Ross[8] that interest-rate futures prices can be converted into the corresponding term structure of interest rates only after corrections for the re-settlement feature of futures contracts. These corrections are model based,

[7]These include the state tax exemption for Treasuries, the occasionally severe scarcity of Treasuries in repo markets, the superior liquidity and margin or collateral service values of Treasuries, and other reasons. See, D. Duffie "Special Repo Rates," *Journal of Finance*, Volume 51 (1996), pp. 493–526.

[8]See J. Cox, J. Ingersoll, and S. Ross "The Relation between Forward Prices and Futures Prices," *Journal of Financial Economics*, Volume 9 (1981), pages 321-346.

depend on volatility information, and can amount to more than the bid-ask spread in swap markets.[9] Futures rates are, however, a natural source of information provided the user makes the appropriate adjustments. The Devon system uses a particular combination of rates from different markets for this purpose. I have not verified whether they used these rates in an appropriate manner.

Now, in order to determine the discount factors for the discounted-cash-flow calculation mentioned above, one must somehow infer the discount factors for each swap payment date. The reported at-market swap rates (or other rates applied to this purpose) are not available for all possible maturity dates. Some interpolation is normally required in order to obtain discount factors for the particular cash-flow dates of the swap being marked. Interpolation methods, which are effectively curve-fitting algorithms, differ from bank to bank. (I have not reviewed the interpolation method used by the Devon System.) It is important to note that while different interpolation schemes are all directed at the same goal, they differ somewhat in implementation details. Such differences, while normally tiny in relative terms, could be material, if systematic, on large swap books. Once the interpolated discounts are determined, the remainder of the calculations for mid-market valuation of swaps are tedious (in light of the day-count conventions that must be scrupulously observed), but straightforward and not subject to interpretation. I have not verified whether the particular manner in which the Devon system arrived at mid-market valuations is accurate.

4.3 Default Risk and Reference LIBOR Rates

The market LIBOR rates used for purposes of setting the contractual swap floating-rate payments at each coupon date are obtained from a poll of rates offered on short-term loans by major high-quality banks to high-quality borrowers (roughly, those with AA credit ratings). As such, the floating-rate payments on the swap are not default-free rates, *even if both swap counterparties are themselves default free.* LIBOR short-term rates are often significantly higher than Treasury rates of the same maturity. The spread between the two has often been more that 100 basis points. As a result, at-market swap rates are, maturity by maturity, sometimes significantly more than the

[9]For example calculations, see M. Grinblatt and N. Jegadeesh, "The Relative Pricing of Eurodollar Futures and Forward Contracts," *Journal of Finance,* Volume 51 (1996), pages 1499-1522.

associated Treasury rates. This may raise some concern about the source of discount rates used to mark swaps to market, *even if both swap counterparties are default free.* As I have mentioned, Treasury rates are themselves unreliable for this purpose. Whether swap rates are reliable for this purpose is a somewhat subtle matter. It can be shown[10] that swap rates are effectively the bond yields that would apply to a hypothetical issuer whose credit quality will remain AA for the life of the swap. This hypothetical counterparty is said to be of "refreshed LIBOR quality." It is difficult to obtain true market long-term discount rates that are not at all contaminated by default risk, tax effects, or institutional factors. The incidence of default on short-term obligations by AA quality borrowers is exceptionally small. It is in any case consistent to use rates that include some effects of credit risk for the purpose of mid-market valuation. I believe that it is reasonable and natural to take at-market swap rates as a source of discount factors for mid-market vaulation before adjustments for counterparty default risk and other effects.

5 Value Adjustment for Default Risk

This section deals with credit adjustments to mid-market valuation. The idea is to compute the net market value of credit risk associated with the mid-market valuation (which is negligible for most interest rate swaps at origination), then compute the net market value of credit risk for valuation of the actual swap position, considering both counterparties' default risks. The net adjustment for credit is the difference of these two market values.

For example, consider a Yen-Dollar currency swap between counterparties A, the Yen receiver, and B. Suppose the mid-market valuation to such a swap to the yen receiver is 100. Suppose this mid-market valuation includes a market value of 2 for default risk to the hypothetical yen receiver, net of the market value of the default risk to the hypothetical yen payer. Suppose the actual swap between A and B has a net market value of default risk to A of 5. Then the credit-risk adjustment is a downward adjustment of 3, leaving a fair market value for A of 97.

[10]See P. Colin-Dufresne and B. Solnik, "On The Term Structure of Default Premia in the Swap and LIBOR Markets," Working Paper, Graduate School of Industrial Administration, Carnegie-Mellon University, forthcoming, *Journal of Finance*; and D. Duffie and K. Singleton "An Econometric Model of the Term Structure of Interest Rate Swap Yields," *Journal of Finance*, Volume 52 (1997), pp. 1287–1321.

The mid-market valuations of swaps are based on hypothetical counterparties of AA quality, so the effects of default risk are essentially offsetting. They need not be precisely offsetting, as the fixed-rate payer has slightly different expected exposures than the floating-rate payer. For example, in an upward-sloping yield curve environment, we expect the exposure to the floating-rate receiver to grow over time, as the floating rate is expected to grow, in a sense that can be made precise. Even so, on a plain-vanilla US interest-rate swap swap between AA counterparties, for reasons explained below, the net market value of counterparty default risk associated with mid-market valuations is negligible.

This may not be the case for currency swaps that have an exchange of notionals at maturity, for which expected exposures can be substantial.

5.1 Default Risk: Swaps at Origination

The impact of counterparty default risk on the swap rate set at the inception of a swap is typically extremely small.

For example, consider a five-year plain-vanilla fixed-rate payer that issues corporate bonds at an interest rate that is 100 basis points higher than that paid by the fixed-rate receiver, reflecting the lower credit quality of the fixed-rate payer. The fixed rate paid on the swap is, roughly speaking, elevated by about 1 basis point from that of an alternative fixed-rate payer whose credit quality is the same as that of the floating-rate payer. That is, the swap rate correction for default risk is only about one hundredth of the bond rate correction for default risk. There is a simple explanation for this important difference between swaps and bonds. First, default on a bond means loss of a fraction (typically large) of the notional amount, whereas the swap contract does not call for payment of notionals at all, merely coupons. Second, at the default of a corporate bond, it is typical that all future coupon payments are lost. If a swap defaults, however, at most the *difference* between the fixed and floating rate payments are lost. This difference is on average rather small because the initial market value of the difference is zero.

In short, the correction from the mid-market valuation of an interest-rate swap at its inception is normally extremely small.

For currency swaps around the years 1990-1993, it was not unusual that the notional amounts of the two currencies would be exchanged at the maturity of the swap. The difference between the market values of these two notional payments could change dramatically over the life of the swap, the

threat of which presents significant credit exposure to each counterparty. The impact of differences in credit quality between the counterparties on the market value of credit risk is an order of magnitude larger for currency swaps than for interest swaps. For example, at origination, a difference of 100 basis points in the bond yields of the counterparties could imply a correction to the mid-market swap rate of roughly 10 basis points for a 5-year fixed-for-fixed currency swap, at typical levels of currency volatility. This is roughly ten times the corresponding adjustment for interest-rate swaps.

5.2 Risk Premia

In dealing with the market value of credit risk on a swap, we must discuss how one deals with the premia that investors demand for carrying risk.

For a risky investment, investors are prone to pay less than the expected payoff. For example, suppose a short-term bond paying 100,000 dollars will default with 30% probability, and in the event of default, half of the value is lost. The mean loss rate is therefore 15%, the product of the loss probability with the fraction lost given default. The pretitioner's modeling calls this mean loss rate the "loss factor." We will ignore the time value of money for this example, taking interest rates to be zero. Given the mean loss rate of 15%, the expected payoff of the bond is 85,000. Investors, however, would typically pay less than 85,000 for this defaultable bond. In order to give an investor an incentive to buy this risky bond rather than a default-free bond with the same expected payoff, the market price of the defaultable bond must be something less than its expected payoff, say 80,000. This means that for pricing and trading purposes, bond investors act as though they are neutral to risk, but assign a higher-than-actual mean loss rate of 20%. In this sense, 20% is called the "risk-neutral mean loss rate." The risk-neutral mean loss rate is a key input to bond pricing and other credit-risk pricing applications.

In practice, one could estimate the risk-neutral mean loss rate on a bond, or some other exposure such as a swap, from the prices of corporate bonds issued by the same or similar firms. Corporate bond prices reflect the probability of default in the same risk-neutral sense. Annualized risk-neutral mean loss rates, on average over the life of an exposure, are roughly the same as the portion of the bond yield that is due to credit risk. For example, suppose that a bond yield is 8%, but would have been 7.5% were it not for the risk of its default. Then the average risk-neutral mean loss rate is roughly 50 basis points. One should not estimate the yield spread associated with credit

risk by taking the difference between the corporate bond yield and the yield of a treasury bond of the same maturity, say 7%, for the treasury yield is depressed from corporate bond yields by other important factors, notably the state tax exemption for US. Treasury coupon income, and the superior liquidity of treasuries.

Recently, default swaps, a class of credit derivatives, have become a source of information of risk-neutral mean loss rates. A default swap obligates the counterparty buying default protection to pay the default-swap rate at periodic coupon dates until maturity or default of the underlying "insured" bond or loan, whichever arrives first. If and when default arrives first, the seller of protection pays the buyer of protection the difference between the face value and the market value of the underlying bond or loan.[11] The default swap rate for a particular corporate bond is approximately equal to the average risk-neutral mean loss rate on the underlying bond.

Over-the-counter (OTC) derivatives such as swaps may have systematically different fractions lost at default than corporate bonds, although there is not much evidence available on this point. More generally, there is sparse information, even today, bearing on risk-neutral mean loss rates for OTC derivatives. For this purpose, one must normally draw information from market data on comparable securities, and use reasonable modeling assumptions.

While the risk neutral mean-loss rate is similar to the "loss factor" that plays a role in the petitioner's model, I found no mention of adjustments to the petitioner's loss factors for risk premia. The impact of risk premia would be systematic, and could be relatively significant.

5.3 Mean Exposure Times Mean Loss Rate

This method for swap credit adjustments computes the market value of credit risk by adding up the (risk-neutral) discounted mean default losses, coupon period by coupon by period, over the life of the swap. Several simplifying assumptions are required for this to be appropriate.[12]

We ignore until Section 5.6 the case of two-sided default risk, but we can (in principle) treat any derivative security or portfolio of derivative securities.

[11] For details and variants, see D. Duffie, "Credit Swap Valuation," *Financial Analyst's Journal*, January-February, 1999, pp. 73-87.

[12] See, for example, D. Duffie and K. Singleton, *Credit Risk Modeling for Financial Institutions*, forthcoming, Princeton University Press, 2001.

The total market value $V(t)$ of default risk at coupon date t is calculated as follows.

1. Calculate $E(t)$, the risk-neutral expected exposure (that is, the average of exposures weighted by their risk-neutral probabilities, over all possible scenarios). This is the risk-neutral expected mid-market value that would be lost with default at that coupon date, with no recovery, with all applicable netting agreements in force, and net of all collateral. This exposure measure $E(t)$ is easily calculated directly from interest-rate option pricing models, by methods that are well recognized by derivatives specialists at major dealers.

2. Calculate the risk-neutral mean default loss rate $L(t)$ associated with the period between coupon date t and the previous coupon date.

3. Obtain $C(t)$, the price of a default-free zero-coupon bond of the same maturity date t.

4. Calculate $V(t) = E(t) \times L(t) \times C(t)$, the discounted[13] risk-neutral expected loss associated with default risk at coupon date t.

The risk-neutral expected exposure $E(t)$ on a US dollar interest-rate swap may in some cases be significantly larger than the expected exposure uncorrected for risk premia.[14]

This mean-loss approach, while calling for some assumptions, is a reasonable approach for most practical cases. The risk-neutral expected exposures can be obtained by (possibly tedious) Monte Carlo calculations using the dealer's derivative pricing models. The risk-neutral mean loss rate $L(t)$ can be reasonably modeled from default-swap rates, or from credit yield spreads of bonds of a credit quality similar to that of the counterparty, relative to

[13]This calculation is approximate, for it ignores certain correlation effects. A more accurate approach would be to calculate the expected exposure $E(t)$ under the so-called "forward measure," which corrects for the effects of correlation between exposures determining $E(t)$ and short-term interest rates determining $C(t)$. For details on forward-measure calculations, see, for example, John Hull, *Options, Futures, and Other Derivative Securities,* Prentice-Hall, Englewood Cliffs, New Jersey, Fourth Edition, 2000.

[14]For an example calculation, see D. Duffie and K. Singleton, *Credit Risk Modeling for Financial Institutions*, forthcoming, Princeton University Press, 2001.

the yield spread of a AAA bond.[15] This approach is somewhat improved and generalized with the simulation model described in Section 5.6.

We also need a procedure by which to determine the portion of the mid-market valuation that is due to credit risk. For interest rate swaps, there is effectively no impact of counterparty credit risk on the broker-reported par swap rates, so the portion of mid-market valuation associated with default risk on another swap, whether or not at origination, is effectively zero. For currency swaps, I expect the same story to apply, but I have not done a study of this. For certain other forms of derivatives that have not been considered in this case, such as options, all of the exposure is to one counterparty only (unless the position is collateralized), and mid-market valuations would therefore reflect some material impact of default risk.

5.4 The Sorenson-Bollier Method

By 1990, credit-risk adjustments for interest-rate swaps had been developed at Salomon Brothers by E. Sorenson and T. Bollier.[16] Their work was available publicly around 1991, and finally appeared in the *Financial Analysts Journal*[17] in 1994. I will discuss a variant of the Sorenson-Bollier approach in which one counterparty is free of default risk, and the other is not. The method is based on certain other simplifying assumptions that are reasonably made in most cases. Later, I will discuss a model based on less restrictive assumptions.

We will compute the market value $V(t)$ of any losses associated with potential default at a particular future coupon date t. The mid-market credit adjustment is then the total of $V(t)$ over all coupon dates. We will assume that the defaultable counterparty is the fixed-rate payer. An almost identical algorithm applies in the opposite case of a defaultable floating-rate payer. This model can be viewed as a special case of the previous approach that is designed specifically for a single uncollateralized swap.

[15] That is, if the counterparty's bonds trade at a yield spread relative to like-maturity treasury securities of 150 basis points, and a AAA bond trades at a yield spread over treasury rates of 50 basis points, then the portion of the counterparty's yield spread that is attributable to credit risk is approximately 100 basis, ignoring differences in liquidity between the counterparty's bonds and the AAA bond. If the bonds are callable, adjustments for the values of the call options are appropriate.

[16] This is as related to me by Thierry Bollier.

[17] May-June 1994, pp. 23–33.

1. Calculate $A(t)$, the market value today of an option to receive, on the future coupon date t of concern, the mid-market valuation for the same fixed-for-floating swap. The option will be exercised only if the swap has a positive mid-market valuation at that future coupon date. One may think of $A(t)$ as the current market value of the future default loss that would occur at time t if one were certain that default would occur on that future coupon date t, and if there were to be no recovery value at default. (In practice, such an option can be priced from the dealer's models for pricing options on swaps, which are called "swaptions.")

2. Using the risk-neutral mean excess loss rate $L(t)$ described earlier, calculate the resulting credit adjustment for this coupon date as $V(t) = L(t) \times A(t)$.

5.5 The Petitioner's Approach

The petitioner's approach during the period in question was similar to the mean-exposure-times-mean-loss approach, with notable exceptions:

- There may have been no correction for risk premia.

- The risk-neutral expected exposure $E(t)$ was replaced with a confidence-level measure of exposure, calculated as follows. Let $M(t)$ be the level of exposure on the swap, uncorrected for netting, that is only exceeded at time t with 20% probability, that is, the 80% confidence level.[18] The exposure measure used by the petitioner is the maximum M of $M(t)$ over all times t during the life of the position.

- The credit adjustment applied at the orgination of the swap was not adjusted as time passed, except for accounting-based accrual effects, with changes in market conditions. Thus, the petitioner's credit adjustments were typically "stale."

The confidence-level exposure measure M defined above is significantly larger than the expected exposure. This is true because:

1. An 80% confidence level $M(t)$ for a swap's exposure at some future time t is much larger than the mean exposure $E(t)$ for that same time.

[18] From testimony, it appears that the 95% confidence level was used during certain periods.

2. The petitioner used the maximum M of the 80% confidence levels over the life of the position, which is larger than the corresponding 80% confidence level $M(t)$ at each future time t, except for the time t at which the maximum level was achieved. The difference is particularly large near the origination and maturity dates of interest rate swaps, when the exposure (by any measure) is close to zero.

3. The petitioner's exposure measure did not allow for the effects of netting agreements. To the extent that netting agreements were in place and enforceable with some probability, they would reduce the effective exposure.

Each of these three effects is large and systematic.

I am not sure of the extent to which the petitioner's measure of exposure or loss factors were corrected for risk premia. (I didn't find mention of this in the portions of the record that I covered.) If, for example, the Hsieh Model used to simulate the petitioner's exposure was a model that was appropriate for simulating interest rates for the purpose of derivatives valuation, then the exposure measures were already corrected for risk premia. To the extent that there were not risk-premium adjustments in calculating exposures or loss factors, there is an associated under-statement of the credit-risk adjustment. I cannot tell whether the potential under-statement associated with any failure to allow for risk premia would have been large enough to offset the over-statements associated with the use of high-confidence exposure measures, and the failure to account for netting.

In any case, I see no strong reason to multiply the petitioner's confidence-level measure of exposure by a loss factor. The result of this multiplication is not based on any conceptual foundation for market valuation with which I am familiar.

There does not seem to have been any effort to calculate the impact of the default risk of the petitioner itself. It would seem, then, that even at the origination of a swap with a counterparty of equal or better quality than the petitioner, had the petitioner calculated by its method the credit-risk adjustment on the swap, it would have inappropriately applied a downward credit adjustment from the mid-market valuation, which is obviously inappropriate.

5.6 General Derivative Pricing Approach

A more generally applicable algorithm for credit-risk adjustment is as follows. This algorithm relies on Monte Carlo simulation methods that are now commonly available. It allows for default risk from both counterparties, for general types of derivatives and other positions such as loans and options, for netting and collateral agreements, and even for correlation between the default risk and changes in underlying market prices and interest rates. All simulation described here is of the "risk-neutral" or "pricing" variety, by which expected discounted cash flows represent market values, through a model in which adverse events are simulated with "risk-neutral" probabilities that are elevated from actual probabilities so as to account for market risk premia. Such risk-neutral simulation has been a standard method for derivative pricing since 1980 or earlier.

This algorithm calculates the market value V_B of all future potential losses to a particular Party A, through default by a given counterparty B. The algorithm can likewise be used to calculate the market value V_A of losses to counterparty B through default by counterparty A. The difference $V_B - V_A$ is subtracted from the default-free value in order to obtain the net market value of the default losses to party A.

The algorithm is described in simple terms, and not in a complete and computationally efficient manner.

1. Initiate a new independently simulated scenario.

2. Simulate, for this scenario, date by date, the net exposure of Counterparty A to default by Counterparty B. At each date, this gives the market value that would be lost if B were to default at that date, with no recovery, with all applicable netting agreements in force, and net of all collateral. The enforceability of netting can also be simulated if uncertain.

3. Simulate, date by date, whether or not B defaults at that date, and whether A defaults at that date.[19]

4. If, at a given date, Counterparty B defaults and Counterparty A has not already defaulted, then simulate the fraction of the net exposure,

[19] Alternative methods for default simulation became relatively common in the late 1990s, although there is still considerable variation in implementation across dealers. During the period 1990-93, such methods were not commonly used in banks.

as obtained in Step 2, that is lost. This determines the losses to A in this scenario.

5. Simulate the path of short-term interest rates.

6. Discount to present market value, using compounded short-term interest rates, the losses to Counterparty A.

7. Return to Step 1, unless a sufficiently large number[20] of independently simulated scenarios have already been generated.

8. Average the results of Step 6, over all independently generated scenarios. This average is the estimate of the market value of default losses to counterparty A due to default by counterparty B.

The total market value of the default risk to Counterparty A is equal to $V_B - V_A$, the market value of default losses to Counterparty A due to default by Counterparty B, as above, net of the market value V_A of the losses to Counterparty B due to default by Counterparty A. This difference $V_B - V_A$ can be positive or negative.

5.7 General Remarks on Credit Adjustments

There is some scope for differences among reasonable models for the computation of the market value of default losses, even among models that have identical conceptual foundations and intent. Such differences can arise from reasonable but different inputs (such as risk-neutral mean loss rates), and also from different model structures. This is one of the more challenging types of financial calculations that banks do, and an active area of current research and development. Standards are still in a state of flux today. Modeling approaches were much less well settled in the early 1990s.

6 Other Adjustments

This section discusses other adjustments to mid-market valuation.

[20] Typically, some thousands or tens of thousands of scenarios are used, depending on the technique, in order to capture the effect of the law of large numbers, under which the average becomes arbitrarily close to the true expectation.

6.1 Administrative Costs

With regard to administrative costs, one must first distinguish between marginal and average costs. (General overhead, for example, is not a marginal cost.) To the extent that there are marginal costs, they would reduce the present value of the cash flows associated with acquiring the swap, and therefore change the prices at which counterparties would willingly trade. I would be more inclined in estimating these costs to build a model that estimates a reasonable bid-ask spread, and that allocates some portion of the difference between bid and ask to administrative costs and dealer margins. An attempt to carefully measure and allocate to individual swaps the actual costs incurred in administrating a swap portfolio seems to me an expensive and error-prone exercise, but my expertise does not extend to cost accounting.

The issue of hedging costs is somewhat subtle. For example, depending on the remainder of the bank's portfolio, certain derivatives, because they reduce overall risk, actually reduce the incentives for and costs of hedges. In theory, the portion of the administrative-cost adjustment associated with hedging should be negative in such cases. Moreover, even when a swap creates a larger incentive to hedge, the incentive to hedge is based on the marginal increase in risk for the dealer's portfolio, which is generally smaller than the risk of the swap when treated as a stand-alone position, because of diversification.

6.2 Liquidity Adjustments

I think the case for a liquidity adjustment is relatively strong in some cases. Mid-market pricing from models based on the prices of benchmark instruments that are liquid overstates the pricing of assets that are exotic, or infrequently traded assets, or have a limited set of potential buyers. Such assets should be marked down for their illiquidity. At this point, I am not aware of sound and implementable approaches for liquidity adjustments, although this is an active research area.

6.3 Dealer Margins

If a dealer is asked for a swap quote and trade occurs at the dealer's quote, there would often be a dealer margin, unless for example the dealer is willing to forego profits or even subsidize the trade for relationship reasons. Because

mid-market valuations are based on rates midway between bid and ask, they do not fully reflect dealer margins. An adjustment to the dealer's valuation from the mid-market valuation may therefore be appropriate on certain swaps, for example on trades initiated at the request of certain end users. Some of the dealer margin reflects a cost of capital and use of the broader resources of the dealer, such as the amount of total risk that the dealer can absorb at its current capitalization. This does not mean that this portion of the dealer margin should be neglected. The adjustments to mid-market valuation for dealer margin should be designed to construct the price at which the trades would occur, under the fair-market-value standard, *including whatever elements of dealer profit and compensation for use of funding and for bearing risk that would have been present in that price.* Again, I would be more inclined to estimate any appropriate adjustments indirectly from bid-ask spread data than from a direct attempt to measure profits and the cost to the bank of bearing risk. Capturing the marginal impact of a new swap on the total risk of the dealer is difficult because risk is multi-dimensional, and involves complex diversification issues across the dealer's book. For example, a swap increases total portfolio risk at the 10% confidence level, the 20% confidence level, and so on, in a manner that depends on all of the other positions held by the dealer. Even if one were able to obtain good marginal risk measures, the market valuation of the costs of bearing these risks is also a difficult exercise, and traders do not to my knowledge attempt to explicitly incorporate dealer margins when negotiating trades in active swap markets.

Once an initial adjustment for dealer margin has been made at the origination of the swap, there is normally no expectation that the dealer will be asked by the counterparty to offset the swap,[21] so marks to market would not usually include further adjustments for dealer margins.[22]

[21] If there were offsets, dealer margins could be incorported accordingly.

[22] For example, on a hypothetical 2-year swap with an end user, ignoring all adjustments from mid-market other than for dealer margin, suppose that the actual initially agreed price (and thus, the fair market value) is zero. Suppose the initial mid-market valuation is 100, reflecting a dealer margin of 100. Suppose, further, that marks to market are made annually, and that there are mid-market valuations of -120 and $+130$ at the end of the first and second years of the swap, respectively. These would also be the respective fair market values, assuming no prospect of offset before maturity. If the dealer margin were to be treated as a (delayed) adjustment to the mid-market valuation that occurs at the end of the first year, the resulting sequence of measured "values" would be 0 at origination, $100 - 120 = -20$ at the end of the first year, and $+130$ at the end of the second year.

7 Petitioner's Expert Report

With some exceptions discussed below, I found the petitioner's expert report, by Dr. Charles Smithson and Mr. Robert Sullivan, to be authoritative and accurate. It is extremely well documented with historical and institutional details. I agree with the essence, if not the fine details, of this report, with the following exceptions.

7.1 Exposure Measurement

The petitioner used a downward credit-risk adjustment, swap by swap, which was a loss factor multiplied by the lifetime maximum of the 80% confidence level of exposure.

I have already discussed the deficiencies of this measure. I believe the use of this approach by the petitioner during 1990-93 period can be partly defended by the claim that practices at that time varied, and that models were generally less sophisticated then than they are now.

The petitioner's experts defended the absence of netting effects in the petitioner's adjustments for a number of reasons given on pages 50-54 of their report. The most persuasive of these is that that netting effects were difficult to compute at that time. The argument that the applicability of netting in the courts was doubtful is not convincing. Excluding netting from mid-market adjustments is equivalent to pricing under the assumption that netting would have absolutely no chance of being legally enforceable. Market participants at that time placed significant stress on the use of netting agreements, presumably because they viewed the likelihood of enforcement to be sufficiently high to justify their efforts.

I also do not think the experts provided a sufficiently critical assessment of how the petitioner's practice of multiplication of its loss factors by the 80% confidence levels of exposures would somehow provide a reasonable approximation for the actual costs associated with credit risk. The 80% confidence levels, maximal over the life of the position, were much larger than expected exposures. The credit adjustment of the petitioner's model is therefore significantly larger than expected credit losses. There seems to be an implicit presumption by the experts that the amount by which the petitioner's credit adjustment exceeds the expected credit losses is somehow an approximation of a charge to reflect the cost of the use of the capital of the petitioner. (See, the displayed formula at the top of page 39 of their report.) No justification

is offered for this presumption, and I myself see no good reason for it.

Market risk premia are not sufficiently considered.

7.2 Loss Factors for Counterparties Rated 1

The petitioner's expert report discusses the loss factors that were applied by the petitioner to counterparties whom they rated "1," which would apparently be rated AA or better in most cases by Standard and Poors. Broker swap quotes are normally based on LIBOR-quality counterparties. Unless the swap rates used by the Devon system were unusual, the petitioner's mid-market valuations from Devon were therefore already based on counterparties of no higher quality than those rated "1" by the petitioner. Therefore, no credit-risk adjustments would have been appropriate in this case for swaps at origination.

I do not find the unqualified arguments for the opposing view that are given on page 49 of the expert report to be at all convincing. In particular, as opposed to the message that seems to be conveyed here, broker quotes of at-market swap rates *do indeed* take account of the potential downgrade of a swap's counterparties during the life of the swap, and the Devon system, if using those quotes to obtain mid-market values, does account for those potential downgrades. (Whether it correctly accounts for them is another matter.)

Even for counterparties rated "1," a swap credit-risk adjustment would be appropriate if changes in interest rates have caused the market value of the swap for the petitioner to become positive. Mid-market quotes for at-market swaps reflect much smaller credit risk adjustments than those appropriate for "in-the-money" swaps. For example, when receving fixed on a 5-year plain-vanilla US interest rate swap, an at-market swap-rate credit correction of 1 basis point implies a swap-rate correction of 4 basis points for swaps whose fixed rate is 100 basis points higher than the at-market rate. This means a credit-risk adjustment in market value that is roughly 4 times as big.[23]

In summary, credit risk adjustments for AA counterparties are sometimes justified, but not at inception and not (as far as I can see) for the reasons outlined in this expert report.

[23]See D. Duffie and M. Huang "Swap Rates and Credit Quality," *Journal of Finance*, Volume 51 (1996), pp. 921–949.

7.3 Adjustments for Higher-Rated Counterparties

The petitioner's experts argue (page 50) that credit adjustments are appropriate even if a counterparty's credit quality is rated higher than that of the petitioner. As I shall later explain, there are cases in which this is correct, that is, in which a downward adjustment from mid-market value is appropriate. There are also, however, cases in which an *upward* adjustment in market value is appropriate! This can be true whether or not the counterparty is of higher quality than the petitioner. In general, the higher the relative quality of the counterparty, the greater is the fair market value of a given derivative to the dealer (an obvious point).

The petitioner's experts seem to base their analysis of this issue on the premise that only the credit quality of the dealer's counterparty should be considered when making a credit-risk adjustment, and that the credit quality of the dealer itself is irrelevant. This is incorrect, and demonstrably so.

For example, consider the case of interest-rate swaps, with two possible dealers, Gilt and Silver, and an outside counterparty, Z, that wishes to pay the floating rate. We will ignore all adjustments except for credit. Suppose the outside counterparty Z is rated AA, that Gilt is rated AA, and that Silver is rated BBB. Suppose Z calls Gilt and asks for the fixed rate R to be paid by Gilt that would be set so that there is no initial exchange of cash, meaning that the fair market value of this swap between Z and Gilt is zero.

Now, suppose Z calls the lower-quality dealer Silver in order to obtain an interest rate swap under which Z pays floating and Silver pays the same fixed rate R. They negotiate a price P for this swap (under the same standard of willing buyer and seller used in the definition of "fair market value") to be paid by Silver to Z. The price P is *greater than zero* because Z was willing to receive a price of zero under the same contractual terms when trading with the higher-quality dealer Gilt. He would be unwilling to trade at a price of zero with Silver, but rather would demand some higher price as compensation for bearing the comparably higher credit risk of Silver. This means an *upward* adjustment in the market value of the swap to Silver, relative to the price of zero obtained by Gilt. This refutes the claim that Silver's own credit quality should play no role in the fair market values at which it trades.

The petitioner's expert analysis suggests that Silver should make a *downward* credit adjustment in market value (from zero) associated with the potential default of counterparty Z, disregarding its own lower credit quality. Again, this is incorrect. The petitioner's experts rely on the argument that if

the low-quality dealer Silver were to attempt to "sell" (that is, assign its position in) its swap with Z to the higher-quality dealer Gilt, then Gilt "would not be influenced to pay more or less" because of Silver's credit rating, because, if it purchased this swap from Silver, it would not be extending credit to Silver. (See the first pargraph of Section V.C.2. of the petitioner's expert report.) There is a logical fallacy here. Silver had already been receiving, in terms of expected credit exposure, an effective extension of credit from Z, which was worth P to Silver, net of the value of the effective credit it had offered Z. If Silver were to ask Gilt to assume its position in the swap, it would demand P in return for the net loss in market value on the extension of credit by Z. Then, before completing the deal with Silver, Gilt would turn to counterparty Z and ask for an upfront payment of P in return for relieving Z of its net exposure to Silver, in the event that the re-assignment of the swap from Silver to Gilt were to occur. Since Z would indeed benefit from this net reduction in credit risk that is worth P, Z would agree to pay P to Gilt, contingent on the re-assignment. All three parties would then consummate the trade. Gilt would now be paying a fixed rate R to Z on a fixed-for-floating swap, and have gotten into this contract for a net price of 0. This is of course the same price (zero) at which Gilt and Z would have signed the swap contract in the first place. Of course, there is some doubt in practice whether all three counterparties would take the trouble to make such contingent assignment arrangements, and indeed in it is unusual to see swap assignments where there is a material difference in the credit qualities of the assignor and assignee. This does not lessen the "moral of the story," which is that Silver's own credit quality does indeed play a role in determining the market value of its swap with Z.

Now, going back to the swap between Z and the low-quality dealer Silver, suppose that interest rates fall dramatically, and the swap has moved so far into the money (of positive value) to Silver, that Silver now has an expected exposure to Z that is so large as to cause an expected loss from default by Z that is much larger than the expected loss to Z from default by Silver, resulting in a new[24] credit adjustment in Silver's market value that is downward.

That is, the same swap between the same two counterparties can have an upward adjustment for credit risk in some cases, and a downward credit

[24]The petitioner's model calculated its exposure measures only at the inception of swaps, and did not re-calculate them on an ongoing basis.

adjustment in other cases, regardless of the relative quality of the counterparties. At the inception of a swap with no initial exchange of cash flows, however, a dealer of lower credit quality than its counterparty should not apply a downward credit adjustment relative to a mid-market valuation. If anything, the adjustment should from mid-market should be upward.[25]

I have not learned of cases in which major dealers have actually made upward credit adjustments from the mid-market valuation of interest-rate swaps associated with the fact that their own credit quality is lower than that of their counterparty. Dealers are normally of high quality in any case. When dealers (and other firms) issue bonds, however, they sell them to investors at a price that reflects their own credit quality. The lower their quality, the lower the price at which they are willing to issue their bonds, relative to those issued by higher-quality firms. The same principle applies to derivatives.

7.4 Marginal or Average Administrative Costs

The petitioner's experts seem to suggest that the total administrative costs of a swap portfolio should be used when estimating the administrative cost adjustment for a particular swap. In principle, only marginal costs should be considered, because of the usual argument in economics that the price at which a buyer willingly acquires an asset reflects the marginal, that is, incremental, impact of the asset on the costs of the buyer for holding or managing the asset.

For example, consider a swap dealer who is, net across all Dollar-Yen currency swaps currently held, paying Dollars and receiving Yen. In other words, he is "long Yen." Suppose the dealer is partially un-hedged and is asked by a counterparty to consider buying a swap to receive Dollars and pay Yen, reducing his exposure to currency risk. This trade would lower the dealer's risk and relieve some of the dealer's incentive to hedge. This dealer is therefore willing to pay more for the swap than he would if short Yen. If the dealer were to average his hedging costs across his previously held portfolio and apply that average cost to the swap in question as a downward administrative cost adjustment from the mid-market valuation, then he would be understating the fair market value of that particular swap.

[25]There is some related empirical work, also cited in John Parsons' report, by T. Sun, S. Sundaresan, and C. Wang, *Journal of Financial Economics*, vol. 34 (1993), pp 77-99, titled "Interest Rate Swaps: An Empirical Investigation."

Whether the burden of estimating marginal, rather than average, portfolio administrative costs is appropriate is beyond my expertise.

8 Respondent's Expert Reports

The report by the respondent's expert Professor Patricia O'Brien appears to deal with accounting issues that go beyond my expertise. I will not comment here on Professor O'Brien's report.

With some exceptions discussed below, I found the respondent's expert report by Dr. John Parsons, to be authoritative and accurate. I am especially sympathetic with Parsons' view that adjustments for purposes of obtaining market value should not "err on the side of conservatism" (page 44).

In general, I agree with this report, with the following exceptions.

8.1 Loss Rates

I find little hard substantiation for Parsons' claim (page 43) that "the probability of default and of loss in the event of default is much less for swaps than for traditional loans." Parsons points to a study showing an average default rate of 0.41% (measured in terms of notional amount, not number of loans) of swaps. This rate is actually substantially larger than the incidence of default on corporate bonds rated AAA, AA, A, and in some cases even BBB. In order to conclude that swaps have a lower default rate than comparable-quality credit instruments of other types such as loans and bonds, a much more systematic study would need to be done, and one that controlled for credit quality. I would not claim that Parsons' conclusion is demonstrably incorrect, only that it is not well established.

As for the probability of loss given default, one must be careful. With swaps, there is no loss in the event that the position represents a claim of the counterparty against the dealer, which means indeed that the probability of loss in the event of default is lower for swaps than for, say, loans. The petitioner's methodology, however, applied its loss rate to the swap's exposure, not the notional amount of the swap, therefore correctly allowing for scenarios in which there was no exposure. (The petitioner's exposure measure was problematic, but that is a separate issue.) Therefore, the point that Parsons makes about the lower probability of loss given default for swaps, while correct, is irrelevant in this regard, and somewhat misleading.

In addition, I was not as troubled as Parsons that the petitioner used its own historical loss experience in order to estimate loss rates. I have no strong reason to believe that this historical measure is misleading. I would probably not have done exactly as the petitioner did on this score, but with the knowledge I have at this point, I think that their approach to estimating expected loss rates was not unreasonable at that time.

The petitioner's loss rates were not to my knowledge adjusted for risk premia. This may have been the case for the exposure measure as well. Dr. Parsons seems to have inappropriately sidestepped the issue of risk premia, which would tend to reduce fair market values for swaps on which the petitioner has a net expected exposure to a lower quality counterparty.

8.2 Market Benchmark for Administrative Costs

Dr. Parsons seems to state (page 60) that there is no market benchmark for administrative cost adjustments. In my view, the bid-ask spread might be a reasonable source of market information.

Consider, for example, plain-vanilla interest-rate swaps. I would guess that there is little private information in this market that would be held by the petitioner's counterparties that would cause the petitioner to widen spreads in order to avoid getting "picked off." My guess is therefore that the majority of the difference between mid-market and the bid side of the market can be allocated to dealer margins and administrative costs. Dealer margins can perhaps be estimated. In any case, it seems that this 'mid-to-bid' spread provides a reasonable upper bound (at least in current swap markets) on administrative costs. While bid and ask rates (and therefore prices) are not available on every position, they are available on a representative sample of positions from which administrative costs might be estimated.

9 Petitioner's Questions

This section responds to the petitioner's questions.

9.1 Precision of Fair Market Value in 1990-93

Question: Were the valuation tools available in 1900-1993 capable of arriving at a single precise fair market value for petitioner's swaps, or were those tools

only capable of arriving at a range of reasonable fair market values?

In 1990-1993, and even with the improved modeling available in 2001, there would be a range of reasonable values that a dealer might choose as its fair market value. For example, it is difficult to estimate the loss factors that are used in credit risk adjustments, and reasonable models will differ. I presume that different but reasonable cost accounting procedures would arrive at different administrative cost adjustments. Liquidity adjustments are difficult to estimate.

9.2 Zero Value at Origination

Question: Does a swap agreement have a fair market value of zero at origination if the price and terms are determined competitively.

I am not sure of what is intended by the term "competitively." I will interpret this term as meaning consistent with the conditions that are provided in the standard definition of "fair market value." In that case, most swaps at origination involve no initial cash flows, and therefore have a fair market value of zero. There are certain swaps, such as "off-market swaps," that involve an initial payment by one of the counterparties to the other. In such cases, of course, the fair market value is not zero.

9.3 Adjusted Value: More Accurate or Not?

Question: Did petitioner's methodology (mid-market value less credit and administrative adjustments) provide a more accurate estimate of fair market value than would the mid-market value without adjustments?

The adjusted value is more accurate, provided the adjustments themselves are correctly calculated. As I have said, I have concerns about the correctness of the petitioner's adjustments. If, for example, the total adjustment to mid-market value that is applied in practice to a swap is more than double the size of the correct total adjustment, then we know as a matter of simple algebra that the adjusted mid-market valuation, as implemented, is less accurate than the unadjusted mid-market value. I have not done the analysis necessary to judge whether this was the case on average, or not.

9.4 Too Big, Too Small, or About Right?

Question: Did petitioner's adjustments to mid-market value, taken as a whole, result in an overstatment, an understatement, or a reasonable approximation of the fair market value of its swap portfolio?

As to whether these adjustments resulted in the end in an under-statement of fair market values of their swap portfolios or not, I myself could not decide to a certainty. I have expressed my concerns about the inaccuracies. I am particularly concerned with the systematic effects of:

1. The use of a lifetime-maximum 80% confidence limit exposure measure as the exposure measure that is multiplied by mean loss rates.
2. The failure to account for netting.
3. The failure to make a credit adjustment for the counterparty's credit risk *relative to* the petitioner's own credit risk.

Each of these causes under-statements of fair market values that are likely to accumulate across the portfolio and to be material. I have already discussed the effects of risk premia, which move in the opposite direction. It would be slightly speculative of me to conclude that the net effects of all inaccuracies resulted in an under-statement.

The appearance of the word "reasonable" in this question carries weight. In light of it, I consider how costly it might have been at the time in question for the petitioner to develop more accurate adjustments. The petitioner did apparently use these same adjustments when reporting their financial results, and for other non-tax business purposes (Brief for Petitioner, page 16).

9.5 Amortization of Credit Adjustments

Question: Did petitioner's procedure of amortizing the initially-determined credit adjustments on a straight-line basis, rather than periodically recalculating the adjustment over the life of each swap, result in a systematic overstatement of the value of petitioner's swaps?

To me, the nub of the question is not the straight-line method of amortization, but rather the failure to re-calculate the credit-risk adjustment by

any method that incorporated the effects of changes in credit quality of both the petitioner and its counterparties, changes in expected future exposures, and changes in market swap rates. This certainly made the "stale" adjustments inaccurate with the passage of time, and could have resulted in either an under-statement or an over-statement. Some of the effects, for example changes in credit quality, would have been systematic. I have not done the detailed numerical analysis that would be necessary to answer this question.

9.6 Credit Adjustments and Mid-Market Valuation Errors

Question: If the petitioner's credit adjustments were smaller than the margin of error inherent in determining the mid-market value, would it be proper to conclude that petitioner's credit adjustments did not result in an over-statement of fair market value?

The answer, based on logic alone, is "No." Suppose, for example, that the estimated mid-market value of a swap is 100, that the margin of error of this mid-market valuation is plus-or-minus 10, and that the credit risk adjustment is a downward adjustment of 5, an example consistent with the terms of the question. Suppose, for sake of this hypothetical, that the credit risk adjustment is correctly calculated, and that there are no other adjustments. This means that the modeled fair market value is $100 - 5 = 95$, while the correct fair market value (if it could be discovered) is somewhere between $90 - 5 = 85$ and $110 - 5 = 105$. Thus, the result of 95 may have been an over-statement (for example if the fair market value were in fact 85), and it may not have. One cannot conclude either way, and the answer has nothing to do with the particulars of this case.

10 Respondent's Questions

This section responds to the respondent's questions.

10.1 Definition of Fair Market Value

Question: When answering the questions posed by the Court, how are you defining fair market value? If you define fair market value using a willing buyer/willing seller standard, explain what assumptions you make in applying the standard.

I am using the standard definition of "fair market value," that is, "the price at which the property would change hands between a willing buyer and a willing seller, neither being under any compulsion to buy and sell and both having reasonable knowledge of relevant facts." As for assumptions in applying the standard in this case, I am assuming that the petitioner and its swap counterparties, in conducting their trades, are willing to trade, under no compulsion to buy or sell, and have reasonable knowledge of the relevant facts. The relevant facts are the precise terms of the swap contract, current market information (for example screen quotes on comparable swaps) that could be used to determine mid-market values, and reasonable knowledge of each other's credit risk. Each counterparty would also need to know its own administrative costs. I am also assuming that the publicly reported broker quotes available to each counterparty themselves reasonably reflect fair market values.

10.2 Verification and Accuracy of Adjustments

Question: If you opine in response to paragraph 1.1(c) of the Expert Stipulation that adjustments should be made to mid-market swap values to arrive at fair market values, how would you test or verify that the recommended adjustments arrive at fair market values, that the recommended adjustments are more accurate estimates of the fair market values than the unadjusted mid-market values, and that the collective impact of the adjustments does not reduce the mid-market values below fair market values?

It is not uncommon in the banking industry to present positions for which marks to market are required to third-party dealers for dealer quotes. For these various proposed tests, this could be done with a sample of the petitioner's swaps. One would presumably choose a third-party dealer whose characteristics (especially administrative cost structure and credit quality)

are similar to those of the petitioner. Statistical methods based on the data for the sample of swaps could then be used to test the various hypotheses posed in this question.

10.3 Adjustments Recognized in the Marketplace?

Question: Whether petitioner's adjustments, both in amounts as claimed, and in the methodology prescribed by the petitioner, are adjustments to mid-market values recognized in the marketplace during the years at issue for the following purposes:

a. pricing swaps at inception;

b. setting the termination price of swaps;

c. risk managing swaps; and

d. valuing swaps.

In addition, please state your opinion as to how the amounts of these adjustments, if recognized in the marketplace, are determined in the marketplace during the years at issue.

Various purposes to which these adjustments may be applied are listed in the question. Other than adjustments of the termination prices of swaps, of which I have no information, I will address these purposes simultaneously. The notion of mid-market adjustments for credit was recognized. I have no reason to believe that the particular implementations (computational procedures or amounts) of these adjustments adopted by the petitioner were recognized. As for administrative costs, and how these adjustments were determined in this marketplace during the years in question, I do not have the survey data necessary to answer.

10.4 Are Buy-out Prices Fair Market Values?

Question: If petitioner valued swap buy-out transactions at the unadjusted mid-market values computed by its Devon Derivative System ("Devon") would

that evidence that the unadjusted mid-market values as computed by Devon are the fair market values of the swap and, if not, why not?

Assuming swap buy-out prices are those arrived at by a willing buyer and seller, operating under the terms of the fair-market-value standard, they would be fair market values by definition, whether or not at Devon-system-based mid-market valuations. I am presuming the question addresses the fair market valuation of swaps in cases of buy-outs only. It would not be reasonable to infer that if mid-market valuations are fair market values in buy-out settings, then they are fair market values in all settings.

Buy-outs are extremely rare. Buy-outs can occur when one party or the other is under some special incentive or compulsion to offset a particular swap, due for example to a re-organization, a liquidation, or with financial distress of either counterparty. If counterparty A is approached with a request by counterparty B for the buy-out of a swap, counterparty A has some degree of monopoly power, for the existing swap is specifically with counterparty A, and can only be eliminated with the agreement of counterparty A.

The answer to this question is, "not necessarily." I would need to know more about the specifics in order to provide a better answer.

10.5 Market Practice on Credit Risk

Question: During the years at issue, 1990 through 1993, whether participants in the marketplace quoted bid and ask prices based on the credit risk of the counterparty (e.g. different bid rates for a AAA counterparty or a AA counterparty) or dealt with credit risk by rationing the amount of exposure to specific counterparties and through credit enhancements and credit triggers.

During this period, some market participants quoted bid and ask prices based on the credit risk of the counterparty. It would be unusual to make any adjustments for bid and ask as counterparty quality varied between AAA and AA, because the appropriate adjustment for such a small variation in credit quality is normally negligible. For wider variations in credit quality, adjustments were indeed made.

During this period, an important part of credit risk management by market participants was to ration exposure to specific counterparties, and through credit enhancements. This practice was extremely widespread.

10.6 End-User Versus Inter-Dealer Rates

Question: Whether the bid and ask rates quoted to dealers differ from the rates quoted to end-users and whether the effective spread in the inter-dealer market differs from the effective spread charged to end-users.

I have no empirical data to present on this issue. Theory suggests that inter-dealer bid-ask spreads would often be tighter that those quoted to most outside end-users. Some end users, for example GE Capital, AIG, or Fannie Mae, would presumably be sufficiently large and sophisticated to obtain roughly the same rates offered in the inter-dealer markets. Sometimes end users are offered attractive rates in order to develop future business. So there could be exceptions to the general rule.

10.7 Inter-Dealer Profits

Question: Whether dealers generally enter into swaps with other dealers without making any profit, or whether the profit is just less than the profit on swaps with end-users.

Inter-dealer trades are motivated by gain, in the form of direct profit or something else. They are not done as favors. There are reasons to trade other than immediate profit on the position, for example, order-flow information or relationship building. As to whether there are positive deal profits as well, I have no direct data on this particular market, but inter-dealer profits do exist on many markets.

10.8 Two Adjustments, or More Than Two?

Question: Whether petitioner is actually taking all, or at least more than two, or the adjustments described in the Group of Thirty Report considering:

(a) The testimony relative to the treatment of the cost of capital (Tr. 353-354, 382-383);

(b) The testimony relative to the treatment of funding costs (Tr. 340-341);

(c) The testimony relative to the treatment of costs of hedging outstanding swaps to maturity (Tr. 606, 609);

(d) The testimony relative to the treatment of the costs of quantitative personnel to work on the development of new risk management techniques for managing outstanding swaps (Tr. 264); and

(e) The testimony relative to the credit risk carve-out adjustments and administrative expense adjustments.

To summarize, the question asks "whether petitioner is actually taking all, or at least more than two, of the adjustments described in the Group of Thirty Report," and lists some portions of testimony. I will rely on this testimony as though it is correct.

There seems no dispute that there were adjustments for credit risk and for "administrative costs." Additional adjustments cited in the Group of Theory Report (page 10) are "close-out adjustments" and "investing and funding adjustments." The former of these deals with "the cost of eliminating their market risk." The latter is related to the cost of funding and investing cash flow mis-matches. By 'eliminating market risk,' it appears that The Group of Thirty is referring to hedging. The petitioner included hedging costs under the category of "administrative costs." There seems to be a semantic issue about whether hedging is an administrative cost or not. The language in the Group of Thirty Report suggests that it viewed hedging costs as distinct from administrative costs, for otherwise hedging costs would be counted twice, and I presume that The Group of Thirty did not intend to have them counted twice. Given this presumption, the petitioner is indeed making at least three of the mid-market adjustments listed by the Group of Thirty.

Line 5 of page 340 of the testimony cited in the question refers to an "adjustment" that appears to be for funding swaps whose market values are positive. This adjustment is not a credit risk adjustment, nor an administrative cost adjustment, nor a hedging cost adjustment. I am not certain whether this "adjustment" was actually made to the mid-market values of the petitioner's swaps, as the testimony is not clear in this regard. It is not clear to me that this is the type of "funding" adjustment for cash flows that appears in the Group of Thirty Report.

With the qualifications that I have given, it follows that at least three, and perhaps at least four, of the adjustments described in the Group of Thirty Report were made.

10.9 Considerations for Credit Adjustments

Question: Whether the credit enhancements, the ISDA agreements and the schedules to the ISDA agreements referenced in the Fourth Stipulation of Facts and admitted into evidence, as well as public debt ratings of the counterparties, the relationship of the counterparties to the petitioner and offsetting swaps, should be considered in evaluating whether petitioner's credit risk adjustments to its mid-market values arrived at the fair market value of the swaps at issue and, if not, why not.

I will assume that the ISDA agreements, and schedules that are cited in this question, which I have not studied in detail, provide the terms of the swap contracts. I am also assuming that the relationships between petitioner and counterparty that are stated in the question could potentially include parent-subsidiardy or other affiliate relationships. Under this stipulation, yes, all of these issues listed in the question should be considered in evaluating whether the petitioner's credit risk adjustments arrived at the fair market value of the swaps at issue.

10.10 Size of Accruals in One Instance

Question: Assuming arguendo that the $76,972,957 on Ex. 128-P, Bates stamped page 033574 (first page of the exhibit) is the unadjusted mid-market value of the petitioner's swaps as of December 20, 1993 (Tr. 1309, 1557), would it be reasonable and/or typical for accruals of periodic payments as of December 20, 1993 to amount to $75,064,957 of a $76,972,9567 value for the swaps?

I have not done the analysis necessary to address this question. I am not, in any case, an expert on accounting issues, nor experienced enough with these accruals to judge what might be typical.

10.11 "Maximum" or Expected Exposure

Question: Assuming arguendo that an adjustment for credit risk should be applied to the mid-market value, and assuming arguendo that this adjustment should be made by applying a loss factor to a measure of exposure,

should one use a maximum or an expected credit exposure in determining the adjustment? Did petitioner use a maximum or an expected credit exposure in its credit risk adjustment?

I addressed this issue in detail earlier in my report. The careful answer to the first question is: "neither." There is no conceptual basis of which I am aware for the use of the "maximum" exposure measure used by the petitioner, which seems arbitrary. The correct calculation would use the expected exposure, once adjusted for risk premia. This is sometimes called the "risk-neutral" expected exposure. This is the same as the expected exposure when computed by Monte Carlo simulation, using the simulated scenarios generated by a derivative pricing model.

10.12 Bi-Lateral Credit Risk

Question: Should a credit risk adjustment to the mid-market value reflect the credit quality of both parties to the swap transaction?

Yes, the credit risk adjustment should reflect the credit quality of both parties to the swap transaction, as I have argued in more detail earlier in my report.

11 Documents Relied Upon

The documents upon which I have relied in preparing this report are:

1. John Bogdansky, *Federal Tax Valuation*, Boston: Warrren, Gorham, and Lamont, 1996.

2. P. Colin-Dufresne and B. Solnik, "On The Term Structure of Default Premia in the Swap and LIBOR Markets," Working Paper, Graduate School of Industrial Administration, Carnegie-Mellon University. forthcoming, *Journal of Finance*.

3. J. Cox, J. Ingersoll, and S. Ross "The Relation between Forward Prices and Futures Prices," *Journal of Financial Economics*, Volume 9 (1981), pages 321-346.

4. D. Duffie, "Credit Swap Valuation," *Financial Analyst's Journal*, January-February, 1999, pp. 73-87.

5. D. Duffie "Special Repo Rates," *Journal of Finance*, Volume 51 (1996), pp. 493–526.

6. D. Duffie, N. Gârleanu, and L. Pedersen, "Valuation in Dynamic Bargaining Markets," Working Paper, Graduate School of Business, Stanford University, 2000, downloadable at http://www.stanford.edu/∼duffie/.

7. D. Duffie and M. Huang "Swap Rates and Credit Quality," *Journal of Finance*, Volume 51 (1996), pp. 921–949.

8. D. Duffie and K. Singleton "An Econometric Model of the Term Structure of Interest Rate Swap Yields," *Journal of Finance*, Volume 52 (1997), pp. 1287–1321.

9. D. Duffie and K. Singleton, *Credit Risk Modeling for Financial Institutions*, forthcoming, Princeton University Press, 2001.

10. Financial Accounting Standards Board, "Statement of Financial Accounting Standards Number 107, Disclosures about Fair Value of Financial Instruments," December, 1991.

11. M. Grinblatt and N. Jegadeesh, "The Relative Pricing of Eurodollar Futures and Forward Contracts," *Journal of Finance*, Volume 51 (1996), pages 1499-1522.

12. Group of Thirty, *Derivatives: Practices and Principles* (1993).

13. J. Hull, *Options, Futures, and Other Derivative Securities,* Prentice-Hall, Englewood Cliffs, New Jersey, Fourth Edition, 2000.

14. R. Litzenberger, "Swaps: Plain and Fanciful," *Journal of Finance*, Volume 47 (1992), pages 831-850.

15. E. Sorenson and T. Bollier,"Pricing Swap Default Risk," *Financial Analysts Journal*, May-June 1994, pp. 23–33.

16. T. Sun, S. Sundaresan, and C. Wang, "Interest Rate Swaps: An Empirical Investigation," *Journal of Financial Economics*, Volume 34 (1993), pp 77-99,

17. Letter of Mr. Saul Rosen, Salomon Brothers, to Mr. Karl Walli, Internal Revenue Service, December 6, 1991, reproduced in *Tax Notes Today,* December 17, 1991.

18. The expert report of Dr. Clifford Smith and Mr. Robert Sullivan.

19. The expert report of Professor Patricia O'Brien.

20. The expert report of Dr. John Parsons.

21. Portions of trial testimony and depositions, including testimony by Ms. Mary Jawor, Mr. Emerson Negel, and Ms. Darcie Lamond.

22. Pretrial Brief of *Amici Curiae,* The American Bankers Association, Institute of International Bankers, International Swaps and Derivatives Association, Inc., New York Clearing House Association L.L.C., Securities Industry Association, and Wall Street Tax Association, October 12, 2000.

23. First Stipulation of Facts, October 30, 2000.

24. Fourth Stipulation of Facts.

25. Brief for petitioner.

26. Respondent's pre-trial proposed findings of fact.

27. Respondent's trial memorandum.

28. Pre-trial brief for respondent.

29. Petitioner's proposed findings of fact.

30. Stipulation with respect to court appointed experts.

31. Petitioner's proposed questions for court-appointed experts.

32. Respondent's proposed questions for court's experts.

33. Respondent's Supplemental Filing Regarding Proposed Questions for Court's Experts.