

November 7, 1988

To: J. Macfarlane  
From: N. Abuaf and A. Karadewiz  
Subject: Finance Desk Credit Reserve Model

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We outline below the underpinnings of the Credit Reserve Model.

### Theory

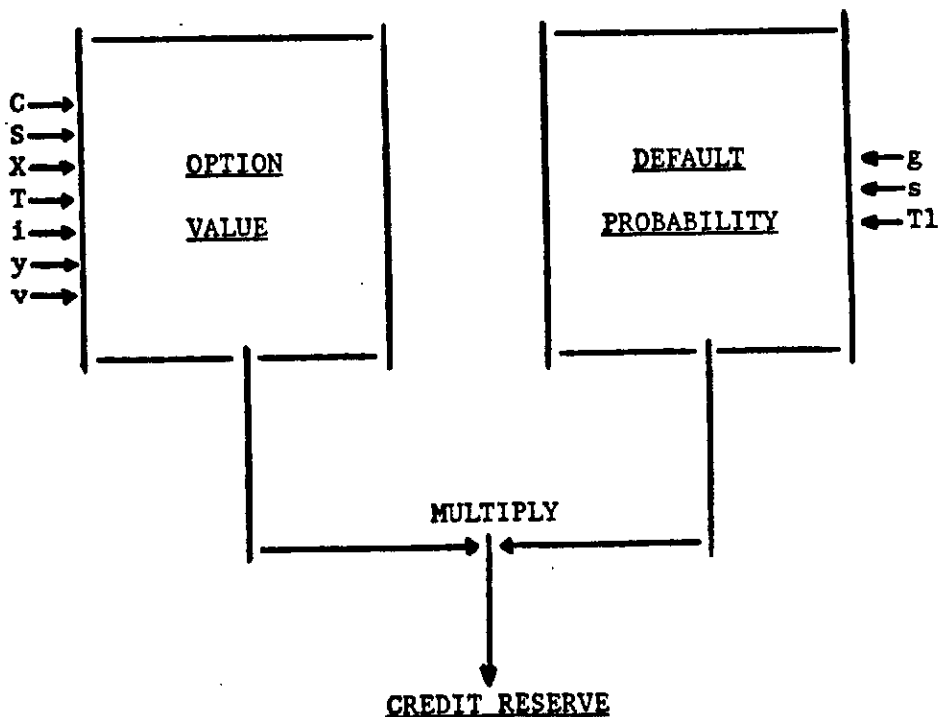
Our Credit Reserve/Risk Model consists of two building blocks. First, we compute the value of an option on the underlying transaction. Second, we calculate the probability of default of the relevant counterparty. Multiplication of the first and second values results in our credit reserve/credit-risk price estimate.

Intuitively, credit extension is similar to granting a counterparty an option to default on us, given the underlying transaction. The charge or reserve for this option equals its value times the probability of default of the counterparty. [To evaluate the option, we use a Black-Scholes type model. To assess the probability of default, we present value (modified) the counterparty credit spread (see attached proof).]

This exercise is similar to an actuarial reserving process that an insurance company undertakes. It differs from an actuarial reserving process in that if the counterparty does not default, the reserves are credited back. Consequently, if the counterparty does default, the losses are debited from current income rather than the reserve fund.

### Application

Below is a diagrammatic representation of the model:



We explain below the model variables:

- C.....Contract type. A call (put) option on rates if Salomon is long (short) the FRA. A call (put) option on the collateral if Salomon is borrowing (lending) money.
- S.....Underlying instrument price. Market interest rate for FRA's. One hundred for repos and reverses.
- X.....Exercise price. Contract interest rate for FRA's. One hundred minus haircut for repos and reverses (see table).
- T.....Time period within which counterparty has default option. Begin period for FRA's (7 days, 1 month, 2 months, ..., 24 months); mark-to-market tolerance for repos and reverses (1, 2, or 3 days).
- i.....Salomon marginal funding rate (LIBOR) corresponding to T for FRA's and T1 for repos and reverses.
- y.....Yield on collateral instrument. Not an input for FRA's. For repos and reverses the representative securities are: 1-year T-bill, 10-year T-note, 30-year T-bond, and the average of the current coupon GNMA's, FHLMC's and FNMA's. The above average plus 100 basis points for whole loans.
- v.....Volatility of underlying instrument. Historical interest-rate volatility on 1,2,...,12-month LIBOR for FRA's. For missing series (e.g. 10-, 11-month LIBOR), we proxy by linear interpolation. Currently, we have a one-year moving window. Since this includes the period right after the crash, these historical volatilities are higher than current implied volatilities. To reduce the estimated volatility, we can shorten the moving window. Unfortunately, we cannot use implied volatilities since these are only available for 3-month eurodollar futures contracts with varying maturities. For repos and reverses, we use the price volatilities of the instruments listed under input "y." For whole loans, we multiply the average GNMA, FHLMC, and FNMA volatility by 1.5. (See simulations for sensitivity of credit reserve to volatility.)
- g.....Government interest rate corresponding to T.
- s.....Credit spread of counterparty as given by BPA. A function of counterparty credit rating (AAA, AA, A, BBB). Individual user has an option to override as she wishes. (See simulations for sensitivity of credit reserve to spreads.)
- T1.....Time period from contract inception to maturity. For FRA's T1-T. For repos and reverses, T1 equals 1 day, 1-, 2-, or 3 months.

Enclosures: Haircuts table, output screens and sensitivity analysis, write-up on default probabilities and credit spreads.

October 20, 1988

Present Value of Credit Spreads and Default Probabilities

A One Period Model

Under risk-neutrality, returns from a risk-free bond equal expected returns from a risky bond:

$$(1+r_f) = (1-d_p)(1+r_i),$$

where  $r_f$  is the risk-free interest rate,  $r_i$  is the risky interest rate and  $d_p$  is the associated default probability.

Re-arranging terms:

$$d_p = (r_i - r_f) / (1 + r_i).$$

This implies that the default probability equals the present value of the credit spread, discounted at the risky rate.

This model can be applied to any practical situation provided that the interest rates are defined as if the world were one period. For example, we calculate default probability on a five-year forward contract by:

(1) converting risky and riskless annualized five-year interest rates into the corresponding five-year (i.e. periodic--non-annualized) five-year interest rates,

(2) computing the credit spread based on the periodic rates, and

(3) present valuing the credit spread by the periodic risky interest rate.

Niso Abuaf

x5-6530

HAIRCUTS

STREET

RETAIL

	STREET			RETAIL		
	1MO	2MO	3MO	1MO	2MO	3MO
BILLS RP	100.000	100.000	100.000	98.039	98.039	98.039
REV	100.000	100.000	100.000	98.039	98.039	98.039
NOTES RP	100.000	100.000	100.000	98.039	98.039	98.039
REV	100.000	100.000	100.000	98.039	98.039	98.039
BONDS RP	100.000	100.000	100.000	98.039	98.039	98.039
REV	100.000	100.000	100.000	98.039	98.039	98.039
GNMA RP	98.000	98.000	98.000	98.039	98.039	98.039
REV	98.000	98.000	98.000	98.039	98.039	98.039
WL RP	0.000	0.000	0.000	98.039	98.039	98.039
REV	0.000	0.000	0.000	98.039	98.039	98.039
SEC LEND	98.000	98.000	98.000	98.039	98.039	98.039

November 4, 1988

FINANCE DESK CREDIT RESERVE MODEL  
Interactive and Standard Screens for  
REPOS, REVERSES AND FRA'S  
Sensitivities to Volatilities and Credit Spreads  
Niso Abuaf and Aziz Karadeniz

**FINANCE DESK CREDIT RESERVE MODEL  
REPOS AND REVERSES  
(Credit Reserve in Basis Points)**

Customer's Credit Rating: AAA, AA, A, BBB : BBB

	Street			Retail			Security Lending					
	DTD	1MO	2MO	3MO	DTD	1MO	2MO	3MO	DTD	1MO	2MO	3MO
Bills RP	0.00	0.01	0.05	0.11	0.01	0.19	0.37	0.55	0.01	0.19	0.37	0.55
Rev	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Notes RP	0.00	0.03	0.10	0.22	0.01	0.19	0.37	0.55	0.01	0.19	0.37	0.55
Rev	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Bonds RP	0.00	0.04	0.15	0.32	0.01	0.19	0.37	0.55	0.01	0.19	0.37	0.55
Rev	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
GMAs RP	0.01	0.29	0.76	1.41	0.01	0.19	0.38	0.56	0.01	0.19	0.37	0.56
Rev	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Whole RP					0.01	0.19	0.38	0.57	0.01	0.19	0.38	0.57
Loans Rev					0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

F1: CALCULATE F2: SPREAD F3: EXIT

CREDIT RESERVE MODEL

FORWARD RATE AGREEMENTS

FRA BEGIN PERIOD: 7DYS=0, 1MO=1, 2MO=2, 4MO=4, . . . . ., 24MO=24 : 12  
 FRA END PERIOD: 1MO=1, 2MO=2, 3MO=3, 4MO=4, . . . . ., 36MO=36 : 18  
 CUSTOMER CREDIT RATING: AAA, AA, A, BBB . . . . .: BBB  
 SALOMON LONG = L; SALOMON SHORT = S . . . . .: L  
 CONTRACT RATE . . . . .: 8.62  
 MARKET RATE . . . . .:

CREDIT RESERVE PER MM IS \$ 3765.31

CREDIT RESERVE IN BASIS POINTS IS 75.31

F1: CALCULATE F2: CREDIT SPREADS F3: EXIT

Interactive Screen  
 Sensitivities to rate changes  
 and short vs. long positions.

CREDIT RESERVE MODEL

FORWARD RATE AGREEMENTS

FRA BEGIN PERIOD: 7DYS=0, 1MO=1, 2MO=2, 4MO=4, . . . . ., 24MO=24 : 12  
 FRA END PERIOD: 1MO=1, 2MO=2, 3MO=3, 4MO=4, . . . . ., 36MO=36 : 18  
 CUSTOMER CREDIT RATING: AAA, AA, A, BBB . . . . . : BBB  
 SALOMON LONG = L; SALOMON SHORT = S . . . . . : S  
 CONTRACT RATE . . . . . : 8.62  
 MARKET RATE . . . . . : 7.0

CREDIT RESERVE PER MM IS \$ 8950.90

CREDIT RESERVE IN BASIS POINTS IS 179.02

F1: CALCULATE F2: CREDIT SPREADS F3: EXIT

Interactive Screen  
 Sensitivities to rate changes  
 and short vs. long positions.



CREDIT RESERVE MODEL

FORWARD RATE AGREEMENTS

FRA BEGIN PERIOD: 7DYS=0, 1MO=1, 2MO=2, 4MO=4, . . . . . 24MO=24 : 12

FRA END PERIOD: 1MO=1, 2MO=2, 3MO=3, 4MO=4, . . . . . 36MO=36 : 18

CUSTOMER CREDIT RATING: AAA, AA, A, BBB . . . . . : BBB

SALOMON LONG = L; SALOMON SHORT = S . . . . . : S

CONTRACT RATE . . . . . : 8.62

MARKET RATE . . . . . : 10.0

CREDIT RESERVE PER MM IS \$ 1490.19

CREDIT RESERVE IN BASIS POINTS IS 29.80

F1: CALCULATE F2: CREDIT SPREADS F3: EXIT

Interactive Screen  
Sensitivities to rate changes and  
short vs. long positions.

CREDIT RESERVE MODEL

FORWARD RATE AGREEMENTS

FRA BEGIN PERIOD: 7DYS=0, 1MO=1, 2MO=2, 4MO=4, ..... 24MO=24 : 12

FRA END PERIOD: 1MO=1, 2MO=2, 3MO=3, 4MO=4, ..... 36MO=36 : 18

CUSTOMER CREDIT RATING: AAA, AA, A, BBB .....: BBB

SALOMON LONG = L: SALOMON SHORT = S .....: L

CONTRACT RATE .....: 8.62

MARKET RATE .....: 7.0

CREDIT RESERVE PER MM IS \$ 764.53

CREDIT RESERVE IN BASIS POINTS IS 15.29

F1: CALCULATE F2: CREDIT SPREADS F3: EXIT

Interactive Screen

Sensitized to rate changes  
and short vs. long positions.

CREDIT RESERVE MODEL

FORWARD RATE AGREEMENTS

FRA BEGIN PERIOD: 7DYS=0, 1MO=1, 2MO=2, 4MO=4, . . . . ., 24MO=24 : 12

FRA END PERIOD: 1MO=1, 2MO=2, 3MO=3, 4MO=4, . . . . ., 36MO=36 : 18

CUSTOMER CREDIT RATING: AAA, AA, A, BBB . . . . .: BBB

SALOMON LONG = L; SALOMON SHORT = S . . . . .: L

CONTRACT RATE . . . . .: 8.62

MARKET RATE . . . . .: 10.0

CREDIT RESERVE PER MM IS \$ 8463.76

CREDIT RESERVE IN BASIS POINTS IS 169.28

F1: CALCULATE F2: CREDIT SPREADS F3: EXIT

Interactive Screen

Sensitivities to rate changes  
and short vs. long positions.

Daily Standard Table

		CREDIT RESERVE IN BASIS POINTS FOR FORWARD RATE AGREEMENTS											
		CONTRACT TYPE (FRA BEGIN PERIOD / FRA END PERIOD)											
		0/3	1/4	2/5	3/6	4/7	0/6	1/7	2/8	3/9	6/12		
CUSTOMER'S	AAA	0.1	0.9	2.5	4.5	7.0	0.1	0.9	2.7	4.9	13.5		
	AA	0.1	1.1	3.1	5.7	8.7	0.1	1.1	3.3	6.0	16.8		
CREDIT	A	0.1	1.3	3.6	6.6	10.2	0.1	1.3	3.9	7.1	19.7		
RATING	BBB	0.2	1.8	5.3	9.6	14.8	0.2	1.9	5.6	10.3	28.6		

F3: EXIT

# Sensitivity Analysis

CREDIT RESERVE IN BASIS POINTS FOR FORWARD RATE AGREEMENTS

CUSTOMER'S CREDIT RATING	CONTRACT TYPE (FRA BEGIN PERIOD / FRA END PERIOD)									
	0/3	1/4	2/5	3/6	4/7	0/6	1/7	2/8	3/9	6/12
AAA	0.1	0.7	2.1	3.9	6.0	0.1	0.7	2.1	3.9	10.9
AA	0.1	0.7	2.1	3.9	6.0	0.1	0.7	2.1	3.9	10.9
A	0.1	0.7	2.1	3.9	6.0	0.1	0.7	2.1	3.9	10.9
BBB	0.1	0.7	2.1	3.9	6.0	0.1	0.7	2.1	3.9	10.9

F3: EXIT

VOLATILITY = 10%  
SPREAD = 100BP

# Sensitivity Analysis

CREDIT RESERVE IN BASIS POINTS FOR FORWARD RATE AGREEMENTS

CUSTOMER'S CREDIT RATING	CONTRACT TYPE (FRA BEGIN PERIOD / FRA END PERIOD)										
	0/3	1/4	2/5	3/6	4/7	0/6	1/7	2/8	3/9	6/12	
AAA	0.1	0.8	2.4	4.3	6.6	0.1	0.8	2.4	4.3	12.0	
AA	0.1	0.8	2.4	4.3	6.6	0.1	0.8	2.4	4.3	12.0	
A	0.1	0.8	2.4	4.3	6.6	0.1	0.8	2.4	4.3	12.0	
BBB	0.1	0.8	2.4	4.3	6.6	0.1	0.8	2.4	4.3	12.0	

F3: EXIT

VOLATILITY = 11%  
SPREAD = 100BP

*Sensitivity Analysis*

CREDIT RESERVE IN BASIS POINTS FOR FORWARD RATE AGREEMENTS

CUSTOMER'S CREDIT RATING	CONTRACT TYPE (FRA BEGIN PERIOD / FRA END PERIOD)									
	0/3	1/4	2/5	3/6	4/7	0/6	1/7	2/8	3/9	6/12
AAA	0.1	0.9	2.6	4.7	7.2	0.1	0.9	2.6	4.7	13.1
AA	0.1	0.9	2.6	4.7	7.2	0.1	0.9	2.6	4.7	13.1
A	0.1	0.9	2.6	4.7	7.2	0.1	0.9	2.6	4.7	13.1
BBB	0.1	0.9	2.6	4.7	7.2	0.1	0.9	2.6	4.7	13.1

F3: EXIT

VOLATILITY = 12%  
SPREAD = 100BP

*Sensitivity Analysis*

CREDIT RESERVE IN BASIS POINTS FOR FORWARD RATE AGREEMENTS												
CUSTOMER'S CREDIT RATING	CONTRACT TYPE (FRA BEGIN PERIOD / FRA END PERIOD)											
	0/3	1/4	2/5	3/6	4/7	0/6	1/7	2/8	3/9	6/12		
AAA	0.1	1.0	2.8	5.1	7.8	0.1	1.0	2.8	5.1	14.2		
AA	0.1	1.0	2.8	5.1	7.8	0.1	1.0	2.8	5.1	14.2		
A	0.1	1.0	2.8	5.1	7.8	0.1	1.0	2.8	5.1	14.2		
BBB	0.1	1.0	2.8	5.1	7.8	0.1	1.0	2.8	5.1	14.2		

F3: EXIT

VOLATILITY = 13%  
SPREAD = 100BP



*Sensitivity Analysis*

CREDIT RESERVE IN BASIS POINTS FOR FORWARD RATE AGREEMENTS

CUSTOMER'S CREDIT RATING	CONTRACT TYPE (FRA BEGIN PERIOD / FRA END PERIOD)									
	0/3	1/4	2/5	3/6	4/7	0/6	1/7	2/8	3/9	6/12
AAA	0.1	1.0	3.0	5.5	8.4	0.1	1.0	3.0	5.5	15.3
AA	0.1	1.0	3.0	5.5	8.4	0.1	1.0	3.0	5.5	15.3
A	0.1	1.0	3.0	5.5	8.4	0.1	1.0	3.0	5.5	15.3
BBB	0.1	1.0	3.0	5.5	8.4	0.1	1.0	3.0	5.5	15.3

F3: EXIT

VOLATILITY = 14%  
SPREAD = 100BP

*Sensitivity Analysis*

CREDIT RESERVE IN BASIS POINTS FOR FORWARD RATE AGREEMENTS

CUSTOMER'S CREDIT RATING	CONTRACT TYPE (FRA BEGIN PERIOD / FRA END PERIOD)									
	0/3	1/4	2/5	3/6	4/7	0/6	1/7	2/8	3/9	6/12
AAA	0.1	1.1	3.2	5.8	8.9	0.1	1.1	3.2	5.8	16.2
AA	0.1	1.1	3.2	5.8	8.9	0.1	1.1	3.2	5.8	16.2
A	0.1	1.1	3.2	5.8	8.9	0.1	1.1	3.2	5.8	16.2
BBB	0.1	1.1	3.2	5.8	8.9	0.1	1.1	3.2	5.8	16.2

F3: EXIT

VOLATILITY = 15%  
SPREAD = 100BP

*Sensitivity Analysis*

CREDIT RESERVE IN BASIS POINTS FOR FORWARD RATE AGREEMENTS

CUSTOMER'S CREDIT RATING	CONTRACT TYPE (FRA BEGIN PERIOD / FRA END PERIOD)									
	0/3	1/4	2/5	3/6	4/7	0/6	1/7	2/8	3/9	6/12
AAA	0.1	1.2	3.4	6.2	9.5	0.1	1.2	3.4	6.2	17.3
AA	0.1	1.2	3.4	6.2	9.5	0.1	1.2	3.4	6.2	17.3
A	0.1	1.2	3.4	6.2	9.5	0.1	1.2	3.4	6.2	17.3
BBB	0.1	1.2	3.4	6.2	9.5	0.1	1.2	3.4	6.2	17.3

F3: EXIT

VOLATILITY = 16%  
SPREAD = 100BP

*Sensitivity Analysis*

CREDIT RESERVE IN BASIS POINTS FOR FORWARD RATE AGREEMENTS

CUSTOMER'S CREDIT RATING	CONTRACT TYPE (FRA BEGIN PERIOD / FRA END PERIOD)									
	0/3	1/4	2/5	3/6	4/7	0/6	1/7	2/8	3/9	6/12
AAA	0.1	1.2	3.6	6.6	10.1	0.1	1.2	3.6	6.6	18.4
AA	0.1	1.2	3.6	6.6	10.1	0.1	1.2	3.6	6.6	18.4
A	0.1	1.2	3.6	6.6	10.1	0.1	1.2	3.6	6.6	18.4
BBB	0.1	1.2	3.6	6.6	10.1	0.1	1.2	3.6	6.6	18.4

F3: EXIT

VOLATILITY = 17%  
SPREAD = 100BP

*Sensitivity Analysis*

CREDIT RESERVE IN BASIS POINTS FOR FORWARD RATE AGREEMENTS

CUSTOMER'S CREDIT RATING	CONTRACT TYPE (FRA BEGIN PERIOD / FRA END PERIOD)									
	0/3	1/4	2/5	3/6	4/7	0/6	1/7	2/8	3/9	6/12
AAA	0.1	1.3	3.8	7.0	10.7	0.1	1.3	3.8	7.0	19.4
AA	0.1	1.3	3.8	7.0	10.7	0.1	1.3	3.8	7.0	19.4
A	0.1	1.3	3.8	7.0	10.7	0.1	1.3	3.8	7.0	19.4
BBB	0.1	1.3	3.8	7.0	10.7	0.1	1.3	3.8	7.0	19.4

F3: EXIT

VOLATILITY = 18%  
SPREAD = 100BP

*Sensitivity Analysis*

CREDIT RESERVE IN BASIS POINTS FOR FORWARD RATE AGREEMENTS

CUSTOMER'S CREDIT RATING	CONTRACT TYPE (FRA BEGIN PERIOD / FRA END PERIOD)									
	0/3	1/4	2/5	3/6	4/7	0/6	1/7	2/8	3/9	6/12
AAA	0.2	1.4	4.0	7.4	11.3	0.2	1.4	4.0	7.4	20.5
AA	0.2	1.4	4.0	7.4	11.3	0.2	1.4	4.0	7.4	20.5
A	0.2	1.4	4.0	7.4	11.3	0.2	1.4	4.0	7.4	20.5
BBB	0.2	1.4	4.0	7.4	11.3	0.2	1.4	4.0	7.4	20.5

F3: EXIT

VOLATILITY = 19%  
SPREAD = 100BP

*Sensitivity Analysis*

CREDIT RESERVE IN BASIS POINTS FOR FORWARD RATE AGREEMENTS

CUSTOMER'S CREDIT RATING	CONTRACT TYPE (FRA BEGIN PERIOD / FRA END PERIOD)									
	0/3	1/4	2/5	3/6	4/7	0/6	1/7	2/8	3/9	6/12
AAA	0.2	1.5	4.2	7.8	11.9	0.2	1.5	4.2	7.8	21.6
AA	0.2	1.5	4.2	7.8	11.9	0.2	1.5	4.2	7.8	21.6
A	0.2	1.5	4.2	7.8	11.9	0.2	1.5	4.2	7.8	21.6
BBB	0.2	1.5	4.2	7.8	11.9	0.2	1.5	4.2	7.8	21.6

F3: EXIT

VOLATILITY = 20%  
SPREAD = 100BP

*Sensitivity Analysis*

CREDIT RESERVE IN BASIS POINTS FOR FORWARD RATE AGREEMENTS

CUSTOMER'S CREDIT RATING	CONTRACT TYPE (FRA BEGIN PERIOD / FRA END PERIOD)									
	0/3	1/4	2/5	3/6	4/7	0/6	1/7	2/8	3/9	6/12
AAA	0.2	1.5	4.5	8.2	12.5	0.2	1.5	4.5	8.2	22.7
AA	0.2	1.5	4.5	8.2	12.5	0.2	1.5	4.5	8.2	22.7
A	0.2	1.5	4.5	8.2	12.5	0.2	1.5	4.5	8.2	22.7
BBB	0.2	1.5	4.5	8.2	12.5	0.2	1.5	4.5	8.2	22.7

F3: EXIT

VOLATILITY = 21%  
SPREAD = 100BP



*Sensitivity Analysis*

CREDIT RESERVE IN BASIS POINTS FOR FORWARD RATE AGREEMENTS

CUSTOMER'S CREDIT RATING	CONTRACT TYPE (FRA BEGIN PERIOD / FRA END PERIOD)											
	0/3	1/4	2/5	3/6	4/7	0/6	1/7	2/8	3/9	6/12		
AAA	0.2	1.6	4.7	8.5	13.1	0.2	1.6	4.7	8.5	23.8		
AA	0.2	1.6	4.7	8.5	13.1	0.2	1.6	4.7	8.5	23.8		
A	0.2	1.6	4.7	8.5	13.1	0.2	1.6	4.7	8.5	23.8		
BBB	0.2	1.6	4.7	8.5	13.1	0.2	1.6	4.7	8.5	23.8		

F3: EXIT

VOLATILITY = 22%  
SPREAD = 100BP

# Sensitivity Analysis

CREDIT RESERVE IN BASIS POINTS FOR FORWARD RATE AGREEMENTS

CUSTOMER'S CREDIT RATING	CONTRACT TYPE (FRA BEGIN PERIOD / FRA END PERIOD)									
	0/3	1/4	2/5	3/6	4/7	0/6	1/7	2/8	3/9	6/12
AAA	0.2	1.7	4.9	8.9	13.7	0.2	1.7	4.9	8.9	25.0
AA	0.2	1.7	4.9	8.9	13.7	0.2	1.7	4.9	8.9	25.0
A	0.2	1.7	4.9	8.9	13.7	0.2	1.7	4.9	8.9	25.0
BBB	0.2	1.7	4.9	8.9	13.7	0.2	1.7	4.9	8.9	25.0

F3: EXIT

VOLATILITY = 23%  
SPREAD = 100BP

*Sensitivity Analysis*

CREDIT RESERVE IN BASIS POINTS FOR FORWARD RATE AGREEMENTS

CUSTOMER'S CREDIT RATING	CONTRACT TYPE (FRA BEGIN PERIOD / FRA END PERIOD)									
	0/3	1/4	2/5	3/6	4/7	0/6	1/7	2/8	3/9	6/12
AAA	0.2	1.8	5.1	9.3	14.3	0.2	1.8	5.1	9.3	26.0
AA	0.2	1.8	5.1	9.3	14.3	0.2	1.8	5.1	9.3	26.0
A	0.2	1.8	5.1	9.3	14.3	0.2	1.8	5.1	9.3	26.0
BBB	0.2	1.8	5.1	9.3	14.3	0.2	1.8	5.1	9.3	26.0

F3: EXIT

VOLATILITY = 24%  
SPREAD = 100BP

*Sensitivity Analysis*

CREDIT RESERVE IN BASIS POINTS FOR FORWARD RATE AGREEMENTS

CUSTOMER'S CREDIT RATING	CONTRACT TYPE (FRA BEGIN PERIOD / FRA END PERIOD)									
	0/3	1/4	2/5	3/6	4/7	0/6	1/7	2/8	3/9	6/12
AAA	0.2	1.8	5.3	9.7	14.9	0.2	1.8	5.3	9.7	27.1
AA	0.2	1.8	5.3	9.7	14.9	0.2	1.8	5.3	9.7	27.1
A	0.2	1.8	5.3	9.7	14.9	0.2	1.8	5.3	9.7	27.1
BBB	0.2	1.8	5.3	9.7	14.9	0.2	1.8	5.3	9.7	27.1

F3: EXIT

VOLATILITY = 25%  
SPREAD = 100BP

# Sensitivity Analysis

CREDIT RESERVE IN BASIS POINTS FOR FORWARD RATE AGREEMENTS

CUSTOMER'S CREDIT RATING	CONTRACT TYPE (FRA BEGIN PERIOD / FRA END PERIOD)									
	0/3	1/4	2/5	3/6	4/7	0/6	1/7	2/8	3/9	6/12
AAA	0.1	0.6	1.6	2.9	4.5	0.1	0.6	1.6	2.9	8.2
AA	0.1	0.6	1.6	2.9	4.5	0.1	0.6	1.6	2.9	8.2
A	0.1	0.6	1.6	2.9	4.5	0.1	0.6	1.6	2.9	8.2
BBB	0.1	0.6	1.6	2.9	4.5	0.1	0.6	1.6	2.9	8.2

F3: EXIT

VOLATILITY = 15%  
SPREAD = 50BP



*Sensitivity Analysis*

CREDIT RESERVE IN BASIS POINTS FOR FORWARD RATE AGREEMENTS

CUSTOMER'S CREDIT RATING	CONTRACT TYPE (FRA BEGIN PERIOD / FRA END PERIOD)									
	0/3	1/4	2/5	3/6	4/7	0/6	1/7	2/8	3/9	6/12
AAA	0.1	0.8	2.3	4.1	6.3	0.1	0.8	2.3	4.1	11.4
AA	0.1	0.8	2.3	4.1	6.3	0.1	0.8	2.3	4.1	11.4
A	0.1	0.8	2.3	4.1	6.3	0.1	0.8	2.3	4.1	11.4
BBB	0.1	0.8	2.3	4.1	6.3	0.1	0.8	2.3	4.1	11.4

F3: EXIT

VOLATILITY = 15%  
SPREAD = 70BP

*Sensitivity Analysis*

CREDIT RESERVE IN BASIS POINTS FOR FORWARD RATE AGREEMENTS

CONTRACT TYPE  
(FRA BEGIN PERIOD / FRA END PERIOD)

	0/3	1/4	2/5	3/6	4/7	0/6	1/7	2/8	3/9	6/12
CUSTOMER'S	AAA	0.1	0.9	2.6	4.7	7.2	0.1	0.9	2.6	4.7
	AA	0.1	0.9	2.6	4.7	7.2	0.1	0.9	2.6	4.7
CREDIT	A	0.1	0.9	2.6	4.7	7.2	0.1	0.9	2.6	4.7
RATING	BBB	0.1	0.9	2.6	4.7	7.2	0.1	0.9	2.6	4.7

F3: EXIT

VOLATILITY = 15%  
SPREAD = 80BP



*Sensitivity Analysis*

CREDIT RESERVE IN BASIS POINTS FOR FORWARD RATE AGREEMENTS

CUSTOMER'S CREDIT RATING	CONTRACT TYPE (FRA BEGIN PERIOD / FRA END PERIOD)									
	0/3	1/4	2/5	3/6	4/7	0/6	1/7	2/8	3/9	6/12
AAA	0.1	1.0	2.9	5.3	8.1	0.1	1.0	2.9	5.3	14.7
AA	0.1	1.0	2.9	5.3	8.1	0.1	1.0	2.9	5.3	14.7
A	0.1	1.0	2.9	5.3	8.1	0.1	1.0	2.9	5.3	14.7
BBB	0.1	1.0	2.9	5.3	8.1	0.1	1.0	2.9	5.3	14.7

F3: EXIT

VOLATILITY = 15%  
SPREAD = 90 BP

*Sensitivity Analysis*

CREDIT RESERVE IN BASIS POINTS FOR FORWARD RATE AGREEMENTS

CUSTOMER'S CREDIT RATING	CONTRACT TYPE (FRA BEGIN PERIOD / FRA END PERIOD)									
	0/3	1/4	2/5	3/6	4/7	0/6	1/7	2/8	3/9	6/12
AAA	0.1	1.1	3.2	5.9	9.0	0.1	1.1	3.2	5.9	16.3
AA	0.1	1.1	3.2	5.9	9.0	0.1	1.1	3.2	5.9	16.3
A	0.1	1.1	3.2	5.9	9.0	0.1	1.1	3.2	5.9	16.3
BBB	0.1	1.1	3.2	5.9	9.0	0.1	1.1	3.2	5.9	16.3

F3: EXIT

VOLATILITY = 15%  
SPREAD = 100BP

*Sensitivity Analysis*

CREDIT RESERVE IN BASIS POINTS FOR FORWARD RATE AGREEMENTS

CUSTOMER'S CREDIT RATING	CONTRACT TYPE (FRA BEGIN PERIOD / FRA END PERIOD)										
	0/3	1/4	2/5	3/6	4/7	0/6	1/7	2/8	3/9	6/12	
AAA	0.1	1.2	3.5	6.5	9.9	0.1	1.2	3.5	6.5	17.9	
AA	0.1	1.2	3.5	6.5	9.9	0.1	1.2	3.5	6.5	17.9	
A	0.1	1.2	3.5	6.5	9.9	0.1	1.2	3.5	6.5	17.9	
BBB	0.1	1.2	3.5	6.5	9.9	0.1	1.2	3.5	6.5	17.9	

F3: EXIT

VOLATILITY = 15%  
SPREAD = 110BP

# Sensitivity Analysis

CREDIT RESERVE IN BASIS POINTS FOR FORWARD RATE AGREEMENTS

CUSTOMER'S	CREDIT	RATING	CONTRACT TYPE (FRA BEGIN PERIOD / FRA END PERIOD)									
			0/3	1/4	2/5	3/6	4/7	0/6	1/7	2/8	3/9	6/12
AAA	0.1		1.3	3.9	7.0	10.8	0.1	1.3	3.9	7.0	19.5	
AA	0.1		1.3	3.9	7.0	10.8	0.1	1.3	3.9	7.0	19.5	
A	0.1		1.3	3.9	7.0	10.8	0.1	1.3	3.9	7.0	19.5	
BBB	0.1		1.3	3.9	7.0	10.8	0.1	1.3	3.9	7.0	19.5	

F3: EXIT

VOLATILITY = 15%  
SPREAD = 120BP

# Sensitivity Analysis

CREDIT RESERVE IN BASIS POINTS FOR FORWARD RATE AGREEMENTS

CUSTOMER'S CREDIT RATING	CONTRACT TYPE (FRA BEGIN PERIOD / FRA END PERIOD)									
	0/3	1/4	2/5	3/6	4/7	0/6	1/7	2/8	3/9	6/12
AAA	0.2	1.4	4.2	7.6	11.7	0.2	1.4	4.2	7.6	21.1
AA	0.2	1.4	4.2	7.6	11.7	0.2	1.4	4.2	7.6	21.1
A	0.2	1.4	4.2	7.6	11.7	0.2	1.4	4.2	7.6	21.1
BBB	0.2	1.4	4.2	7.6	11.7	0.2	1.4	4.2	7.6	21.1

F3: EXIT

VOLATILITY = 15%  
SPREAD = 130BP

*Sensitivity Analysis*

CREDIT RESERVE IN BASIS POINTS FOR FORWARD RATE AGREEMENTS

CUSTOMER'S CREDIT RATING	CONTRACT TYPE (FRA BEGIN PERIOD / FRA END PERIOD)									
	0/3	1/4	2/5	3/6	4/7	0/6	1/7	2/8	3/9	6/12
AAA	0.2	1.6	4.5	8.2	12.6	0.2	1.6	4.5	6.2	22.7
AA	0.2	1.6	4.5	8.2	12.6	0.2	1.6	4.5	8.2	22.7
A	0.2	1.6	4.5	8.2	12.6	0.2	1.6	4.5	8.2	22.7
BBB	0.2	1.6	4.5	8.2	12.6	0.2	1.6	4.5	8.2	22.7

F3: EXIT

VOLATILITY = 15%  
SPREAD = 140BP

# Sensitivity Analysis

CREDIT RESERVE IN BASIS POINTS FOR FORWARD RATE AGREEMENTS

CUSTOMER'S CREDIT RATING	CONTRACT TYPE (FRA BEGIN PERIOD / FRA END PERIOD)									
	0/3	1/4	2/5	3/6	4/7	0/6	1/7	2/8	3/9	6/12
AAA	0.2	1.7	4.8	8.8	13.4	0.2	1.7	4.8	8.8	24.4
AA	0.2	1.7	4.8	8.8	13.4	0.2	1.7	4.8	8.8	24.4
A	0.2	1.7	4.8	8.8	13.4	0.2	1.7	4.8	8.8	24.4
BBB	0.2	1.7	4.8	8.8	13.4	0.2	1.7	4.8	8.8	24.4

F3: EXIT

VOLATILITY = 15%  
SPREAD = 150BP