ANNEX III

ILLUSTRATIVE CONTRACT DESIGN FOR PHYSICAL DELIVERY

III.1 The Annex illustrates the determination of cheapest to delivery and certain nuances associated with the dynamics of it. To start with, the *cost of delivery* measures how much it costs a short to fulfill the commitment to deliver a bond through the futures contract. The shorts will minimize the cost of delivery by choosing the bond to deliver from the deliverable basket. The bond that minimizes the cost to deliver is called the cheapest to deliver (CTD). There are some alternate ways to arrive at the CTD and the alternative methods do not always result in the same CTD (specifically, if the price differential between the CTD is not large). However, in the absence of futures prices, we derive the CTD below on the basis of imputed forward prices. That suffices for the purpose at hand. In order to derive the CTD, we need to determine the conversion factor.

III.2 The design of bond futures purposely avoids a single underlying security. One reason for this is that if the underlying bond should lose liquidity, perhaps because it has been accumulated over time by buy and hold investors and institutions, then the futures contract would lose its liquidity as well. Another reason for avoiding a single underlying bond is the possibility of *squeeze*.

III.3 To illustrate the problem, let us assume that one bond were deliverable into the futures contract. Then a trader may profit by simultaneously purchasing a large fraction of that bond issue and a large number of contracts. As parties with short positions in the contract scramble to buy that bond to deliver or buy back the contracts they have sold, the trader can sell the holding of both bonds and contracts at prices well above their fair values. But by making shorts hesitant to take positions, the threat of a squeeze can prevent a contract from attracting volume and liquidity. The existence of a basket of securities effectively avoids the problems of a single deliverable *only if the cost of delivering the next to CTD is not that much higher than the cost of delivering the CTD*. Conversion factors reduce the differences in delivery costs across bonds by adjusting delivery prices for coupon rates. The conversion factor is the price of one unit of the bond at an yield of the notional coupon after rounding down its residual maturity on the first delivery date of the contract to nearest full quarters. The precise role of this conversion factor is discussed shortly.

III.4 In order to illustrate the features of the bond contract with regard to movement in the yield curve (through parallel shift) and notional coupon, we take the prices of the bonds as on 14 September, 2007.We restrict the deliverable basket to bonds with residual maturity between 7.5 and 15 years as on the first delivery date of the contract (the precise reason for doing this will be clear shortly) with outstanding amount of at least Rs 20,000 crores.

Notional Coupon	Parallel shift	Cheapest to deliver bond	Modified Duration	Difference with second smallest
			(years)	
8.00%	0	8.35% 2022	8.22	0.21
8.00%	-5	8.35% 2022	8.23	0.08
8.00%	-10	7.38% 2015 (conv)	5.71	0.05
8.00%	-50	7.38% 2015 (conv)	5.75	1.07
8.00%	5	8.35% 2022	8.2	0.28
8.00%	50	8.35% 2022	8.07	0.54

III.5 The following table illustrates the movements:

Notional Coupon	Parallel shift	Cheapest to deliver bond	Modified Duration	Difference with second smallest
			(years)	
6.00%	0	8.35% 2022	7	1.37
6.00%	-50	8.35% 2022	7.77	1.15
6.00%	-100	8.35% 2022	7.93	0.90
6.00%	50	8.35% 2022	7.46	1.56
6.00%	100	8.35% 2022	7.31	1.73
10.00%	0	7.38% 2015	5.88	2.50
10.00%	-50	7.38% 2015	5.92	2.84
10.00%	-100	7.38% 2015	5.96	3.12
10.00%	50	7.38% 2015	5.83	2.10
10.00%	100	7.38% 2015	5.79	1.74

III.6 Let us explain. With a static yield curve, 8.35% 2022 (the bond with the highest duration in the deliverable basket) is the CTD and the CTD is fairly stable for any upward shift in yield curve. With a parallel downward shift of 10 basis points or more, 7.38% 2015 (the bond with lowest duration in the deliverable basket) is the CTD. The reason for the above switch is not hard to fathom. As yield levels fall, the price of the bond with the lowest duration rises the least, hence the CTD. Similarly, as yield levels rise, the bond with the highest duration has the steepest fall in prices and hence the switch in CTD. It may be noted that as yields rise, the duration of the futures increase. Similarly as yields fall, the duration of the futures decrease. This feature is what is known in literature as negative convexity. So in effect, a bond future with deliverable basket is a negatively convex contract. The negative convexity feature is more pronounced in case the deliverable basket contains bonds with fairly divergent duration. Hence the choice of restricting the deliverable basket to bonds with residual maturities between 7.5 and 15 years. Also the farther the contract is to mature, the more pronounced the negative convexity feature is.

III.7 In order to illustrate the effect of notional coupon we illustrate the choice of CTD by shifting the notional coupon to 6% and 10%.

Notional Coupon	Parallel shift	Cheapest to deliver bond	Modified Duration (years)
6.00%	0	8.35% 2022	7.00
6.00%	-50	8.35% 2022	7.77
6.00%	-100	8.35% 2022	7.93
6.00%	50	8.35% 2022	7.46
6.00%	100	8.35% 2022	7.31
10.00%	0	7.38% 2015	5.88
10.00%	-50	7.38% 2015	5.92
10.00%	-100	7.38% 2015	5.96
10.00%	50	7.38% 2015	5.83
10.00%	100	7.38% 2015	5.79

III.8 We see that a choice of notional coupon away from the current levels make the bond futures, virtually single bond contract (i.e. contract with positive convexity) and hence with little role for the delivery basket.