Method of Determining Settlement Prices of Options and Futures

Items	Descriptions	Remarks
I Purpose	・ The purpose of this document is to describe JSCC's procedures of futures and options contracts traded on Osaka Exchange (hereinafter referred to as "OSE") for setting settlement prices (the prices determined by JSCC, hereinafter referred to as "Settlement Prices etc.")	
II Overview 1. Procedures for setting Settlement Prices etc. for futures and options contracts		
(1) Settlement Prices etc. for JGB Futures	・ Settlement Prices etc. for each contract month of JGB Futures shall be set every trading day as follows:	
a. Settlement Prices for 10-year JGB Futures	A) Settlement Price of: - the Leading Contract Month; - a contract month which expires earlier than the Leading Contract Month; and - the second nearest contract month on the Last Trading Day of the nearest contract month.	When Intra-day Settlement Prices or Emergency Settlement Prices are set, the following order applies for each contract for each trading day:

Items	Descriptions	Remarks
	shall be set every trading day according to the following order: (a) Contract price at the close of the Afternoon Session by the Closing Auction (Itayose) method; (b) Last contract price in the ordinary auction trading sessions of a given trading day, excluding Strategy Trade contracts and the contracts concluded in the Night Session; and (c) Theoretical price calculated by the formula specified by JSCC (fractions less than the increment of a quote shall be rounded off to the nearest quote, or rounded up if there are two nearest quotes). B) Settlement prices of the contract months other than A) shall be set every trading day by adding / subtracting the latest Contract Spread Price* in the auction trading session, excluding the contracts concluded in the Night Session, on the relevant trading day from the Settlement Price of the Leading Contract Month; or * If no Contract Spread Price exists, the theoretical spread price shall be used as an alternative to the Contract Spread Price. C) Notwithstanding the provisions of A) and B), if JSCC deems it inappropriate to set Settlement Price(s) as prescribed in A) or B) taking into consideration the condition of contract prices and theoretical prices, JSCC shall set Settlement Price(s) as appropriate considering circumstances such as conditions of quotes placed in auction trading on that day.	a) Last contract price in the ordinary auction trading sessions (excluding the contracts concluded in the Night Session) at 11:02 am (in the case of Emergency Settlement Price calculation, at 1:00 pm) of the given contract (excluding Strategy Trade contracts); b) Price set by JSCC as appropriate considering circumstances such as conditions of quotes placed in auction trading on that day; or c) Settlement Price for the relevant contract month on the immediately preceding trading day. Contract Spread Price refers to a contract price of a Calendar Spread Trade, which is defined by OSE as a kind of Strategy Trades.

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b. Settlement Prices for 5-year JGB Futures and 20-year JGB Futures	A) Settlement Price of: - the Leading Contract Month; - a contract month which expires earlier than the Leading Contract Month; and - the second nearest contract month on the Last Trading Day of the nearest contract month shall be set every trading day according to the following order: (a) Contract price at the close of the Afternoon Session by the Closing Auction (Itayose) method; (b) Last contract price in the ordinary auction trading sessions after 14:50 of a given trading day ,excluding Strategy Trade contracts; (c) Price determined by JSCC based on mid price of the best quotes placed at 14:58 of a given trading day (taking the conditions where quotes have been constantly presented and the spread of such quotes into consideration); or (d) Price determined by JSCC by referring i) best bid or ask placed in a certain period before 14:58 (taking the conditions where quotes have been constantly presented into consideration), ii) last contract price* in the ordinary auction trading sessions (*excluding the Night Session) of a given trading day (*excluding Strategy Trade contracts), iii) price calculated by JSCC based on the underlying JGB price of a given trading day designated by JSCC and iv) theoretical price. B) Settlement prices of the contract months other than A) shall be set every trading day by adding /	Settlement Price on Last Trading Day of each contract month shall be determined in the same manner prescribed in (1) a. When Intra-day Settlement Prices or Emergency Settlement Prices are set, the same manner prescribed in "Remarks" column for (1) a applies.

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	subtracting the latest Contract Spread Price* in the auction trading session, excluding the contracts concluded in the Night Session, on the relevant trading day from the Settlement Price of the Leading Contract Month; or * If no Contract Spread Price exists, the theoretical spread price shall be used as an alternative to the Contract Spread Price. C) Notwithstanding the provisions of A) and B), if JSCC deems it inappropriate to set Settlement Price(s) as prescribed in A) or B) taking into consideration the condition of contract prices and theoretical prices, JSCC shall set Settlement Price(s) as appropriate considering circumstances such as conditions of quotes placed in auction trading on that day.	
c. Settlement Prices for mini-10year JGB Futures	・ Settlement Price shall be the same as that of the Large-sized contract with the same contract month. However, if JSCC deems it inappropriate to set the Settlement Price in such a manner, JSCC shall set the Settlement Price in each case considering market conditions and other factors.	When Intra-day Settlement Prices or Emergency Settlement Prices are set the same manner prescribed in "Remarks" column for (1) a applies.
(2) Settlement Prices for Index Futures	・ Settlement Prices for each contract month of Index Futures shall be set every trading day as follows:	
a. Settlement Prices for Nikkei 225 Futures,	A) In cases where a contract, excluding Strategy Trade contracts, is concluded in the auction trading session between 3 p.m. and the close of a regular daytime auction trading session, Settlement Price	When Intra-day Settlement Prices are set, the phrase of "between 3 p.m. and

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TOPIX Futures and JPX-Nikkei Index 400 Futures	shall be the last contract price of the relevant contract month contract, excluding Strategy Trade contracts, in the auction trading session; or B) In cases other than A) or if JSCC deems it inappropriate to set the contract price(s) prescribed in A) as Settlement Price(s), the Settlement Price shall be the theoretical price calculated by the formula specified by JSCC (fractions less than the increment of a quote shall be rounded off to the nearest quote, or rounded up if there are two nearest quotes), or JSCC shall set Settlement Price(s) as appropriate considering circumstances such as conditions of quotes placed at the close of the auction trading session on that day.	the close of a regular daytime auction trading session" shall be replaced with "10:45 a.m. to 11:00 a.m." and when Emergency Settlement Prices are set the phrase shale be replaced with "0:45 p.m. to 1:00 p.m." (The same shall apply to (2) d. and e.). As to the Settlement Price for the 3rd and subsequent contract month contracts, the method described under A) on the left shall not apply, and Settlement Price will be determined according to the method described under B) on the left for the time being. (This shall not apply to Intra-day Settlement Price and Emergency Settlement Price) Notwithstanding the calculation methods described on the left in A) and B), in principal, the Settlement Prices

Items	Descriptions	Remarks
		on the last business day of March, June, September or December shall be the theoretical price calculated by the formula specified by JSCC (fractions less than the increment of a quote shall be rounded off to the nearest quote, or rounded up if there are two nearest quotes). (Excluding cases where Intra-day Settlement Prices or Emergency Settlement Prices are set. The same shall apply to (2) b.)
b. Settlement Prices for Nikkei 225 mini and mini-TOPIX Futures	A) For contract month of March, June, September and December, Settlement Prices shall be the Settlement Price of Large-sized contract month with the same Last Trading Day. However, if JSCC deems it inappropriate to set Settlement Prices in such a manner, JSCC shall set Settlement Prices in each case considering market conditions and other factors. B) For contract months other than A) above, Settlement Prices shall be determined in a same manner as (2) a.	

Items	Descriptions	Remarks
c. Settlement Prices for TOPIX Core 30 Futures, TOPIX Banks Index Futures, TSE REIT Index Futures , RN Prime Index Futures and TSE Mothers Index Futures	・ Settlement Price shall be the theoretical price calculated by the formula specified by JSCC (fractions less than the increment of a quote shall be rounded off to the nearest quote, or rounded up if there are two nearest quotes).	
d. Settlement Prices for Nikkei Stock Average Volatility Index Futures, Dow Jones Industrial Average Futures, TAIEX Futures and FTSE China 50 Index Futures	A) In cases where a contract, excluding Strategy Trade contracts, is concluded in the auction trading session between 3 p.m. and the close of a regular daytime auction trading session, Settlement Price shall be the last contract price, excluding Strategy Trade contracts, in the auction trading session; B) In cases where no contract price exists after the time specified in A) above, Settlement Price shall be mid price of the best bid and ask quotes placed on a given trading day or contract price; or C) Notwithstanding the provisions of A) and B), if JSCC deems it inappropriate to set Settlement Price(s) as prescribed in A) or B) taking into consideration of the condition of contract prices and quotes placed in auction trading on that day, JSCC shall set Settlement Price(s) as appropriate considering circumstances such as conditions of quotes placed in auction trading on that day.	

Items	Descriptions	Remarks
e. Nikkei 225 Dividend Index Futures, TOPIX Dividend Index Futures and TOPIX Core30 Dividend Index Futures	A) In cases where a contract, excluding Strategy Trade contracts, is concluded in the auction trading session between 3 p.m. and the close of a regular daytime auction trading session, Settlement Price shall be the last contract price, excluding Strategy Trade contracts, in the auction trading session; B) In cases where no contract price exists after the time specified in A) above, Settlement Price shall be mid price of the best bid and ask quotes placed in that specified time; or C) In cases other than A) or B), Settlement Price shall be the last contract price (excluding Strategy Trade contracts and contracts concluded in the Night Session) in cases where a contract is concluded in the auction trading session before 3 p.m., and where no contract price exists in the auction trading session on a given trading day, Settlement Price shall be the price determined according to the following order set as (a) or (b), depending on type of contract month, : (a) Settlement Price of the Leading Contract Month as determined by JSCC and the nearest contract month shall be the Settlement Price on the immediately preceding trading day for a given contract month; or (b) For contract month other than a) above, Settlement Price shall be determined as follows; Settlement Price on the immediately preceding day for a given contract month	Notwithstanding the calculation methods described on the left in B) and C), when Intra-day Settlement Prices or Emergency Settlement Prices are set, Settlement Price shall be the latest mid price of the best bid and ask quotes placed on a given trading day; provided however, if no mid price exists, Settlement Price shall be the Settlement Price on the immediately preceding trading day.

Items	Descriptions	Remarks
	+ (the Settlement Price of the Leading Contract Month as prescribed in (a) - the Settlement Price of that Leading Contract Month on the immediately preceding day). D) Notwithstanding the provisions of A) to C), if JSCC deems it inappropriate to set Settlement Price(s) as prescribed in A) to C) taking into consideration of the condition of contract prices and quotes placed in auction trading on that day, JSCC shall set Settlement Price(s) as appropriate considering circumstances such as conditions of quotes placed in auction trading on that day.	
(3) Settlement Prices for Options contracts	・ Settlement Price of each contract month of Options contracts shall be set every trading day (every business day for Options on Individual Securities) as follows:	
a. Settlement Prices for Nikkei 225 Options	A) In cases where a contract, excluding Strategy Trade contracts, is concluded in the auction trading session between 3 p.m. and the close of a regular daytime auction trading session, Settlement Price shall be the last contract price, excluding Strategy Trade contracts, in the auction trading session; or B) In cases other than A), Settlement Price shall be the theoretical price calculated by the formula specified by JSCC (fractions less than the increment of a quote shall be rounded up to the nearest quote). ・ Notwithstanding the provisions of the above A) and B), if JSCC deems it necessary, JSCC may change	When Intra-day Settlement Prices or Emergency Settlement Prices are set, Settlement Prices shall be the theoretical price calculated by the formula specified by JSCC. As to the formula used to obtain the theoretical price under B) on the left, the latest underlying index shall be used

Items	Descriptions	Remarks
	Settlement Price which is deemed appropriate.	as the value deemed appropriate by JSCC. Notwithstanding the provisions of the left in A) and B), Settlement Price s on the last business day of March, June, September or December shall be the theoretical price calculated by the formula specified by JSCC (fractions less than the increment of a quote shall be rounded up to the nearest quote).
b. Settlement Prices for Options on Individual Securities, Options on JGB Futures, TOPIX Options, JPX-Nikkei Index 400 Options, TOPIX Banks Index Options and TSE REIT	・ Settlement Price shall be the theoretical price calculated by the formula specified by JSCC (fractions less than the increment of a quote shall be rounded up to the nearest quote.)	

Items	Descriptions	Remarks
Index Options. 2. Formulas for calculating theoretical prices of Futures and Options (1) Formulas for calculating theoretical prices of JGB Futures	・ For all deliverable bonds of JGB Futures, theoretical prices shall be calculated using the following formulas: ➢ Theoretical price = (Deliverable bond price − Cost of carry) / Conversion factor ➢ Cost of carry = [Coupon rate − $\frac{\text{Short-term interest rate} \times (\text{Deliverable bond price} + \text{Accrued interest})}{100}$] × t_1 / 365 ➢ Accrued interest = Face value (JPY100) × Coupon rate (%) / 100 × t_2 / 365 The symbols used in the above equations shall be defined as follows: t_1 : the number of days between the delivery date for the cash bond transaction and the physical settlement date for the Futures contract (either the start date or end date shall be included); t_2: the number of days between the previous interest payment date and the delivery date for the cash bond transaction (either the start date or end date shall be included); Short term interest rate: the 3-month Tokyo Repo Rate released by the Bank of Japan on one business day before the date of theoretical price calculation;	Among the theoretical prices of all deliverable bonds for each contract month of JGB Futures, the cheapest theoretical price shall be adopted as the theoretical price of the relevant contract month.

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	Deliverable bond price: the average price of reference statistical prices for over-the-counter bond transactions, published by Japan Securities Dealers Association on the date of theoretical price calculation; and (Rounding of fractions) : The theoretical prices of the Futures contract shall be rounded off to two decimal places.	
	・ Theoretical spread prices for JGB Futures shall be calculated using the following formula: ➢ Theoretical spread price = Theoretical price of a near contract month - Theoretical price of a more distant contract month	The theoretical spread price shall be calculated every trading day and used for calculating Settlement Prices on the following trading day.
(2) Formula for calculating theoretical prices of Index Futures	・ Theoretical prices of each contract month of Index Futures shall be calculated using the following formula: ➢ Theoretical price = $Se^{(r-\delta)T}$ The symbols used in the above equation shall be defined as follows: S: the latest underlying index price (when calculating the settlement price, the last underlying index price of the day); e: the base of a natural logarithm; r: interest rate;	

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(3) Formulas for calculating theoretical prices of Options on Individual Securities	δ: the expected dividend yield specified by JSCC among the expected dividend yields or the expected distribution yields related to the underlying index; and T: the number of days between the following day and the business day following the Last Trading Day of the Futures contract / 365. ・ Theoretical prices of each contract month of Options on Individual Securities shall be calculated using the following formulas: ➢ The theoretical price of a put option $=-S'N(-d_1)+Ke^{-rT}N(-d_2)$ ➢ The theoretical price of a call option $=S'N(d_1)-Ke^{-rT}N(d_2)$ where, $S'=S-\sum_{i=1}^{n} D_i e^{-rt_i}$ $d_1=\{\ln(S'/K)+(r+\sigma^2/2)T\}/\sigma\sqrt{T}$ $d_2=d_1-\sigma\sqrt{T}$ The symbols used in the above equations shall be defined as follows: S: the latest contract price of the underlying security traded on the Financial Instruments Exchange designated by OSE (when calculating Settlement Price, the last contract price of the underlying security traded on the Exchange on the day);	

Items	Descriptions	Remarks
	e: the base of a natural logarithm; D_i: the expected dividends for the *i*-th period for the underlying security; T: the number of days between the following day and the exercise day / 365; t_i: the number of days between the following day and the ex-dividend day for Di / 365; r: interest rate; N(x): cumulative probability density function of standard normal distribution; K: exercise price; Ln: natural logarithm; and σ : volatility.	Expected dividends shall be based on the summary of financial statements and other documents disclosed by the issuer of the underlying security. Volatility shall be the implied volatility of the issue (i.e. the value calculated backwards based on the theoretical price calculation formulas, referring the latest mid price of the best quotes placed in the auction trading or the contract price; the same shall apply to (4) and (5).
(4) Formulas for calculating theoretical prices of Options on	・ Theoretical prices of each contract month of Options on JGB Futures shall be calculated using the following formulas: ➢ The theoretical price of a put Option on JGB Futures	

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JGB Futures	$= e^{-rT}\ [\ EN(-d_2) - SN(-d_1)\ ]$ ➢ The theoretical price of a call Option on JGB Futures $= e^{-rT}\ [\ SN(d_1) - EN(d_2)\ ]$ where, $d_1 = \ln(S/E) / (\sigma\sqrt{T}) + 0.5\sigma\sqrt{T}$ $d_2 = d_1 - \sigma\sqrt{T}$ The symbols used in the above equations shall be defined as follows: e: the base of a natural logarithm; r: interest rate; T: the number of days between the following day and the option expiration date / 365; E: exercise price; N(x): cumulative probability density function of standard normal distribution; S: the settlement price of the underlying contract month contract on a given trading day; ln : natural logarithm; and σ : volatility.	
(5) Formula for calculating theoretical prices of Index Options	・ Theoretical prices of each contract month of Index Options shall be calculated using the following formulas: ➢ The theoretical price of an index put option $= -Se^{-\delta T}N(-d_1) + Ke^{-rT}N(-d_2)$	

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	➢ The theoretical price of an index call option $= Se^{-\delta T}N(d_1) - Ke^{-rT}N(d_2)$ where, $d_1 = \{\ln(S/K) + (r - \delta + \sigma^2/2)T\} / \sigma\sqrt{T}$ $d_2 = d_1 - \sigma\sqrt{T}$ The symbols used in the above equations shall be defined as follows: S: the value specified by JSCC among the value related to the underlying index; e: the base of a natural logarithm; δ: the expected dividend yield specified by JSCC among the expected dividend yields or the expected distribution yields related to the underlying index,; T: the number of days between the following day and the exercise day / 365; r: interest rate; N(x): cumulative probability density function of standard normal distribution; K: exercise price; ln: natural logarithm; and σ: volatility.	The expected dividend yield shall be the same as that mentioned in (2).

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