CME SPAN®

Standard Portfolio Analysis of Risk®

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CME SPAN® - Standard Portfolio Analysis of Risk

- Developed in 1988 by Chicago Mercantile Exchange Inc. to effectively assess risk on an overall portfolio basis.
- SPAN is a market simulation based Value At Risk system which has been reviewed and approved by market regulators and participants world wide.
- SPAN is the official Performance Bond mechanism of 54 exchanges and clearing organizations world-wide, making it the global standard for portfolio margining.
- SPAN's risk based margin requirements allows for effective margin coverage while preserving efficient use of capital.
- SPAN assesses risk for a wide variety of financial instruments including: futures, options, physicals, equities, or any combination.

CME SPAN® - Objectives

- SPAN assesses the risk of a portfolio by calculating the maximum likely loss that could be suffered by the portfolio based on parameters set by the margin-setting authority, usually an exchange or clearing organization.
- The core of SPAN risk analysis is to simulate potential market moves and calculate the profit or loss on individual contracts given the market moves.

SPAN风险分析的核心是模拟潜在的市场波动，并在市场波动的情况下计算单个合约的盈亏。

- Exchanges may determine any number of market scenarios to be included in the SPAN analysis.

交易所可以确定任何数量的市场情景，以包括在SPAN分析中。

- Most SPAN exchanges and clearing organizations use 16 scenarios.

CME SPAN® - Methodology

- SPAN groups together financial instruments with the same underlying for analysis.
- For example, Futures on an Equity Index and Options on the Equity Index would be grouped together for analysis.
- Each product is referred to as a Combined Commodity.
- SPAN uses parameters set by the exchange or clearing organization to evaluate a portfolio with the following two step analysis:
  - Step 1: SPAN first analyzes the risk of each Combined Commodity in isolation from other Combined Commodities.
  - Step 2: SPAN then seeks risk reducing offsets between Combined Commodities.

Scan Risk Arrays

CME SPAN® - Scan Risk

- The core of SPAN risk analysis to simulate potential market moves and calculate the profit or loss on individual contracts.
- Exchanges or clearing organizations may determine any number of market scenarios to be included in SPAN analysis.
- Most SPAN exchanges or clearing organizations use 16 scenarios.
- The 16 scenarios are referred to as SPAN Risk Arrays.

CME SPAN® - Scan Risk Arrays

- SPAN Risk Arrays represent a contract's hypothetical gain/loss under a specific set of market conditions from a set point in time to a specific point in time in the future.
- Risk Arrays typically consist of 16 profit/loss scenarios for each contract.
- Each Risk Array scenario is comprised of a different market simulation, moving the underlying price up or down and/or moving volatility up or down.
- The risk array representing the maximum likely loss becomes the Scan Risk for the portfolio.

CME SPAN® - Scan Risk Arrays

- Below is an example of the 16 Scan Risk Arrays used by CME

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Scenario	Underlying Price Change as % of Price Scan Range	Volatility Move
1	UNCHANGED	UP
2	UNCHANGED	DOWN
3	UP 33%	UP
4	UP 33%	DOWN
5	DOWN 33%	UP
6	DOWN 33%	DOWN
7	UP 67%	UP
8	UP 67%	DOWN
9	DOWN 67%	UP
10	DOWN 67%	DOWN
11	UP 100%	UP
12	UP 100%	DOWN
13	DOWN 100%	UP
14	DOWN 100%	DOWN
15	UP 300%	UP
16	Down 300%	UP

CME SPAN® - Scan Risk Example

- The next slide demonstrates the Scanning Risk calculation for an S&P 500 portfolio:
  - ➢Long 1 MAR 2019 SP Future (price is 2,790) 期货买方，价格为2790
  - ➢Short 1 MAR 2019 SP 2825 Call Option (implied volatility is 16%) 看涨期权卖方，价格为2825
- The Price Scan Range is $30,000 or 120 points (CVF for SP 500 is $250, $30,000/$250 = 120 points) 问题：一个point是什么意思？CVF是什么意思？
- The Volatility Scan Range for SP 500 is 35%

CME SPAN® - Scan Risk Example

下表中负数代表盈利，正数代表亏损

Scenario	SP Underlying Price Move	Volatility Move	SP Future Gain/Loss	SP Option Gain/Loss	Portfolio Gain/Loss
1	UNCHANGED	UP	$0	$1,994	$1,994
2	UNCHANGED	DOWN	$0	-$1,517	-$1,517
3	UP 33%	UP	-$9,999	$6,291	-$3,708
4	UP 33%	DOWN	-$9,999	$2,178	-$7,821
5	DOWN 33%	UP	$9,999	-$714	$9,285
6	DOWN 33%	DOWN	$9,999	-$2,876	$7,123
7	UP 67%	UP	-$20,001	$12,281	-$7,720
8	UP 67%	DOWN	-$20,001	$8,818	-$11,183
9	DOWN 67%	UP	$20,001	-$2,183	$17,818
10	DOWN 67%	DOWN	$20,001	-$3,179	$16,822
11	UP 100%	UP	-$30,000	$19,772	-$10,228
12	UP 100%	DOWN	-$30,000	$17,607	-$12,393
13	DOWN 100%	UP	$30,000	-$2,857	$27,143
14	DOWN 100%	DOWN	$30,000	-$3,218	$26,782
15	UP 300%	UP	-$29,700	$25,503	-$4,197
16	Down 300%	UP	$29,700	-$1,063	$28,637
				Largest Potential Loss = SPAN Risk	**$28,637**

个人理解：
波动率上升，价格更有可能涨到行权价之上。根据BS公式，期权价格上涨，作为看涨期权卖家，如果平仓，就需要付出更多成本买入期权。意味着亏损。

资产价格上涨，叠加波动率上涨，那么作为看涨期权卖家，就会亏损。

通过这个图可以看出，SPAN评估风险是基于整个portfolio，而非单个投资项。

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CME SPAN® - Scan Risk Extreme Scenarios

- Deep out-of-the-money short options may pose significant risk, as unusually large price changes may result in unexpectedly large losses, particularly as expiration nears.
例子：现货价格100，行权价为200的看涨期权，就是深度OTM期权。作为short的一方，即卖方，即卖出行权价为200的看涨期权。
如果现价100，行权价200，都有人买，意味着市场对该资产是看涨的，且上涨幅度有可能很大，即价格变动可能很大，
如果涨到500，那么期权卖方就亏损严重。
- SPAN accounts for this risk by including Extreme Scenarios in the Risk Arrays.
- Extreme Scenarios may be used to simulate a significant market move designed to shock deep out-of-the-money options.
- Extreme Scenarios are determined by the Exchange or Clearing Organization.
是否把极端市场行情纳入考虑取决于交易所或者清算所
- CME uses a market move equal to 3x Price Scan Range and 1x Vol Scan for a given product. The resulting gain or loss is then multiplied by 33% to determine the potential exposure.
这段说的是CME对极端市场行情的计算方法

CME SPAN® - Composite Delta Scenarios

问题：还是没有理解composite delta场景是什么意思？具体在计算max loss中有什么用？

delta的加权平均值

- Composite Delta is derived as the weighted average of the deltas, where the weights are associated with each underlying price scan point.
- Below is an example of the 7 Delta Points used by CME:

指的是7种价格变化场景

Scenario	Underlying Price Change as % of Price Scan Range	Probability Weight
1	UNCHANGED	0.27
3	UP 33%	0.217
5	DOWN 33%	0.217
7	UP 67%	0.11
9	DOWN 67%	0.11
11	UP 100%	0.037
13	DOWN 100%	0.037

SPAN® Analysis

Spread Types & Formations

Short Option Minimum & Delivery Add-On Charge
Net Option Value

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CME SPAN® - Spread Types & Formation

商品组合内的跨月价差风险

- **Intra-Commodity Spread**: Evaluate the basis risk between contract periods with different expirations within the same product. Spreads are prioritized by lowest charge.

评估同一产品不同期限合约间的基差风险。价差按最低收费排序。问题：什么叫“价差按最低收费排序”？

- **Inter-Commodity Spread**: Evaluate credit available for offsetting positions in related instruments. Spreads are prioritized by greatest total savings.

评估可用于抵消相关金融工具头寸的信用。
价差的优先顺序是最大的总节省。
关键词是商品间的“抵消”

- SPAN forms Intra-Commodity Spreads before Inter-Commodity Spreads. 先计算商品内，再计算商品间
- **Super Inter-Commodity Spread**: Allows Inter-Commodity Spreads to be evaluated before Intra-Commodity Spreads. 这是另一种选择，先计算商品间，再计算商品内
- **Inter-Exchange Spread Credit**: Allows spreads to be formed for portfolios containing products listed on multiple Exchanges, as defined by the Exchange.
  - ➢The formation of Inter-Exchange Spreads is similar to process of forming Inter-Commodity Spreads, however each Exchange can only provide a credit for its own products.

允许为包含在多个交易所上市的产品的投资组合形成基差，由交易所定义。

CME SPAN® - Intra-Commodity Spread Risk

- Since futures prices do not correlate exactly across contract months, a gain in one month may not exactly offset losses in another month. 由于期货价格在合约月份之间并不完全相关，一个月的收益可能无法完全抵消另一个月的损失。例如，现货价格1000，买入1月期货，价格900，卖出2月期货，价格900，那么收益和亏损完全抵消。但假设买入1月期货，价格900，赚100，卖出2月期货价格，价格800，亏200，那么亏损就比收益多100.
- An Intra-Commodity Spread Charge can be set in SPAN to cover the risk of calendar spread positions. 可以在SPAN中设置商品内基差费用，以覆盖日历基差头寸的风险。
- The Intra-Commodity Spread Charge can be tailored for contract pairs or specified groups of contracts.
- There is no limit to the number of contract legs that can be specified in an Intra-Commodity Spread, also known as tiered intra-commodity spreading.
- The Intra-Commodity Spread Charge can also be tailored to specific calendar months.
- For example, a March versus April calendar spread can have a different charge rate than a March versus September calendar spread. This is also known as series specific intra-commodity spreading.
- The next slide shows an example of an Intra-commodity Spread for a portfolio with 1 long Mar 2019 Eurodollar and 1 short April 2019 Eurodollar.

CME SPAN® - Intra-Commodity Spread Example

- The Intra-Commodity Spread Charge for Mar 2019 vs. Apr 2019 is $70. 3月的是多头，4月的是空头
- Since the gains on Mar ED exactly offset the losses on Apr ED, the Scan Risk is $0.
- Therefore, the Intra-Commodity Spread charge of $70 becomes SPAN Risk.

Scenario	ED Underlying Price Move	Volatility Move	Mar ED Gain/Loss	Apr ED Gain/Loss	Portfolio Gain/Loss
1	UNCHANGED	UP	$0	$0	$0
2	UNCHANGED	DOWN	$0	$0	$0
3	UP 33%	UP	-$60	$60	$0
4	UP 33%	DOWN	-$60	$60	$0
5	DOWN 33%	UP	$60	-$60	$0
6	DOWN 33%	DOWN	$60	-$60	$0
7	UP 67%	UP	-$120	$120	$0
8	UP 67%	DOWN	-$120	$120	$0
9	DOWN 67%	UP	$120	-$120	$0
10	DOWN 67%	DOWN	$120	-$120	$0
11	UP 100%	UP	-$180	$180	$0
12	UP 100%	DOWN	-$180	$180	$0
13	DOWN 100%	UP	$180	-$180	$0
14	DOWN 100%	DOWN	$180	-$180	$0
15	UP 300%	UP	-$178	$178	$0
16	Down 300%	UP	$178	-$178	$0

CME SPAN® - Inter-Commodity Spread Risk

重点是商品间价格高度相关

- To recognize the risk reducing aspects of portfolios containing off-setting positions in highly correlated instruments, SPAN forms Inter-Commodity Spreads.

为了识别包含高度相关工具的抵消头寸的投资组合的风险降低方面，SPAN形成了商品间价差。

- Inter-Commodity Spreads produce credits which reduce the overall performance bond or margin requirement.
- The universe of recognized spreads, rates, and priority are determined by the Exchange.
- Below is an example of 1 Long SP future and 5 Short Nasdaq futures. The recognized spread ratio is 1 SP vs. 5 NQ and the spread credit is 75%

spread credit是什么意思？个人理解是相反方向上资产价格的相关性，值越大，相关性越高。

Combined Commodity	Position	Outright PB Requirement	Recognized Spread Credit	SPAN Requirement
		此处PB是什么的缩写？		
SP	Long 1	$30,000		
NQ	Short 5	$7,600 x 5 = $38,000		
Total		$68,000	X 75% = $51,000	$17,000

计算步骤：
1.分别计算出long和short的头寸的价值，即相反方向头寸的价值
2.把相反方向头寸的价值相加，得到portfolio的总价值，68000
3.用总价值乘上spread credit,得到可以抵扣的价值，51000
4.总价值-可以抵扣的价值=需要的保证金价值

CME SPAN® - Inter-Commodity Delta Based Spreading

这个还没看懂

- Delta Based Spreading is performed after the Scan Risk or Scanning process.
- One result of the Scanning process for each Combined Commodity is a Net Delta position, which is an estimate of market exposure that has not been offset within the Combined Commodity, which is available to be offset between Combined Commodities.
- Each exchange defines a table of recognized Inter-Commodity Spread formations and the margin credit to apply for such formations.
- SPAN takes the Inter-commodity spread table and seeks out the defined spread formations, giving margin credit for each spread formed.
- A Delta based spread may contain any number of spread legs. Any remaining deltas are margined at the outright rate.

CME SPAN® - Delta Based Spread Example

- Long 50 Soybean (S) futures & Short 50 Corn (C) futures

Spread Position	**Product**	**Position**	**Outright PB Requirement**	**Spread Ratio**	**Spread Credit**
	S	50	$1,750	1	60%
	C	-50	$700	2	
Spread Credit	**Product**	**Position**	**Outright PB Requirement**	**Position x Outright PB**	**Spread Credit**
	S	25	$1,750	$43,750	$78,750 x .60 = $47,250
	C	50	$700	$35,000	
Remaining Delta	**Product**	**Position**	**Outright PB Requirement**	**Position x Outright PB**	
	S	25	$1,750	$43,750	
	C	0	$700	$0	
Delta-Based Total Requirement	**Remaining Delta PB Requirement**	**Spread Req (40%)**	**Total PB Requirement**		
	$43,750	$31,500	**$75,250**		

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CME SPAN® - Inter-Commodity Scanning Based Spreading

这是另一种方式

- Another method of recognizing offsetting positions between Combined Commodities is Scanning Based Spreading.
- Scanning Based Spreading allows Combined Commodities which are part of the spread to go through SPAN's 16 scenarios simultaneously, ensuring they are subject to the same worst case loss scenario and that offsetting futures and options delta positions between them automatically offset.

基于扫描的基差允许作为基差一部分的组合商品同时经历SPAN的16种情况，确保它们受到相同的最坏情况损失情况的影响，并自动抵消它们之间的期货和期权delta头寸。问题：不是很懂。

- In recognizing that the correlations between Combined Commodities may not be perfect, the gains in the Scanning process may be limited by a gain allowance factor set by the exchange.

认识到组合商品之间的相关性可能并不完美，扫描过程中的收益可能受到交易所设定的收益允许因素的限制。

CME SPAN® - Scanning Based Spread Example

- Long 90 Bond futures & Short 90 10yr futures

Scenario	Underlying Price Move	Volatility Move	Portfolio Gain/Loss
1	UNCHANGED	UP	$0
2	UNCHANGED	DOWN	$0
3	UP 33%	UP	-$15,255
4	UP 33%	DOWN	-$15,255
5	DOWN 33%	UP	$54,095
6	DOWN 33%	DOWN	$54,095
7	UP 67%	UP	-$30,420
8	UP 67%	DOWN	-$30,420
9	DOWN 67%	UP	$108,131
10	DOWN 67%	DOWN	$108,131
11	UP 100%	UP	-$45,675
12	UP 100%	DOWN	-$45,675
13	DOWN 100%	UP	$162,225
14	DOWN 100%	DOWN	$162,225
15	UP 300%	UP	-$45,202
16	Down 300%	UP	$160,619
Scanning Based PB Requirement			**$162,225**

说明波动率的变化不影响期货，只影响期权

价格下降100%，那么多头就亏损，空头就盈利。此处多头的亏损大于空头的盈利，差额是162225。

CME SPAN® - Short Option Minimum

- Deep out-of-the-money short options may show zero or minimal Scan Risk given the price & volatility moves in the 16 market scenarios.
- However, in extreme events these options may move closer to-the money or in-the-money, thereby generating potentially large losses.
- To account for this potential exposure, a Short Option Minimum can be set for each product.

问题：short option minimum是根据什么设置的呢？

- If the Scan Risk is lower than the Short Option Minimum, then the Short Option Minimum is charged.
- The next slide shows an example of the Short Option Minimum using a deep out-of-the-money short put.
  - Short 1 SP 500 Mar 2019 1750 Put (underlying price is 2790)

1.期权空头 2.到期日：2019年3月 3.行权价1750 4.现货价格2790
如果多头方现在马上平仓，只能卖1750，是亏损的，所以是虚值期权

  - Short Option Minimum on 1 SP 500 is $240

问题：240是怎么算出来的？

CME SPAN® - Short Option Minimum Example

- Scan Risk is $228, however SOM is $240, so the requirement is $240.

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Scenario	Underlying Price Move	Volatility Move	Portfolio Gain/Loss
1	UNCHANGED	UP	$52
2	UNCHANGED	DOWN	-$1
3	UP 33%	UP	$38
4	UP 33%	DOWN	-$1
5	DOWN 33%	UP	$70
6	DOWN 33%	DOWN	-$1
7	UP 67%	UP	$28
8	UP 67%	DOWN	-$1
9	DOWN 67%	UP	$95
10	DOWN 67%	DOWN	-$1
11	UP 100%	UP	$20
12	UP 100%	DOWN	-$1
13	DOWN 100%	UP	$127
14	DOWN 100%	DOWN	-$1
15	UP 300%	UP	$1
16	Down 300%	UP	$228
	Scanning Based PB Requirement		**$228**

CME SPAN® - Summary of SPAN Analysis

- **Scan Risk**: Evaluate the directional market risk.
- **Intra-Commodity Spread Charge**: Evaluate the basis risk between contract periods with different expirations within the same product.
- **Inter-Commodity Spread Credit**: Evaluate credit available for offsetting positions in related instruments.
- **Delivery Add-On Charge**: Evaluate contract periods for increasing volatility during delivery.
- **Short Option Minimum**: Evaluate short option positions for potential increased risk, using the greater of the Scan Risk or Short Option Minimum.
- SPAN Requirement for a Combined Commodity is the greater of:
  - ➢(Scan Risk + Intra Commodity Spread Charge + Delivery Charge – Inter Commodity Spread Credit)
  - ➢Short Option Minimum 这个公式是最核心的
- The Total SPAN Requirement for a portfolio is the sum of the SPAN Requirement for all Combined Commodities.

CME SPAN® - Net Option Value

net option value还是没有完全理解，需要再查其他资料

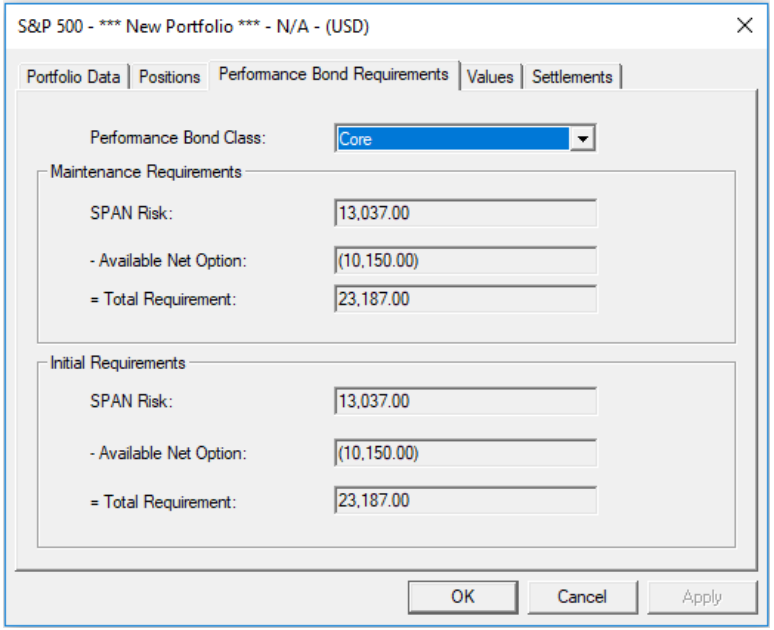
期权的按市值计价反映在SPAN的净期权价值成分中。

- Mark-to-market of options is reflected in the Net Option Value component of SPAN.
- The Total Performance Bond Requirement for a portfolio reflects the Total SPAN Requirement and the Net Option Value of the portfolio.
- **The Net Option Value (NOV)** of a portfolio is equal to the Long Option Value minus the Short Option Value.
- **Long Option Value (LOV):** The total value of all the long options in the portfolio.
- **Short Option Value (SOV):** The total value of all the short options in the portfolio.
- LOV reduces the overall Total Performance Bond Requirement.
- SOV increases the overall Total Performance Bond Requirement.

个人理解：期权多头可以选择行权或者不行权，如果到期时是OTM，就不行权，也不会亏损，只会付出期权费。但期权空头就不一样了，到期时如果是深度ITM，也必须配合行权，所以就更有风险，所以SOV会增加保证金要求。

CME SPAN® - Net Short Option Value

- The portfolio below includes:
  - ➢Long 1 Mar 2019 SP Futures (price is 2,790)
  - ➢Short 1 Mar 2019 SP 2750 Call Option (price is $51.36, option value is $11,975) 个人猜测51.36指的是每单位的期权费
  - ➢Long 1 Mar 2019 SP 2650 Put Option (price is $5.94, option value is $1,825)

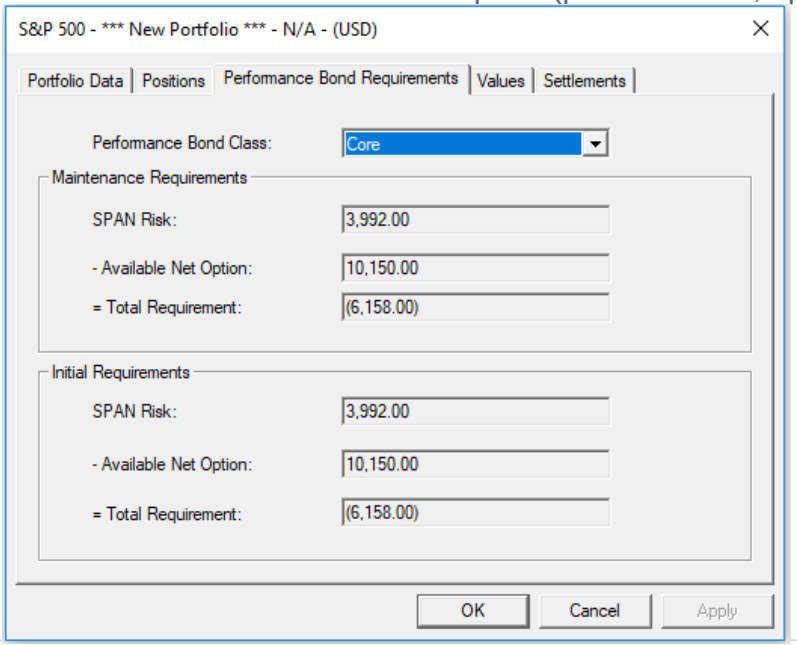


SPAN Risk = $13,037
LOV = $1,825
SOV = $11,975
ANOV = ($10,150)
SPAN Risk - ANOV = Total Requirement
$13,037 - ($10,150) = $23,187

此处应该是+才对

CME SPAN® - Net Long Option Value

- The portfolio below includes:
  - ➢Short 1 Mar 2019 SP Futures (price is 2790)
  - ➢Long 1 Mar 2019 SP 2750 Call Option (price is $51.36, option value is $11,975)
  - ➢Short 1 Mar 2019 SP 2650 Put Option (price is $5.94, option value is $1,825)



SPAN Risk = $3,992
LOV = $11,975
SOV = $1,825
ANOV = $10,150
SPAN Risk - ANOV = Total Requirement
$3,992 - $10,150 = ($6,158)

Disclaimer

Neither futures trading nor swaps trading are suitable for all investors, and each involves the risk of loss. Swaps trading should only be undertaken by investors who are Eligible Contract Participants (ECPs) within the meaning of Section 1a(18) of the Commodity Exchange Act. Futures and swaps each are leveraged investments and, because only a percentage of a contract's value is required to trade, it is possible to lose more than the amount of money deposited for either a futures or swaps position. Therefore, traders should only use funds that they can afford to lose without affecting their lifestyles and only a portion of those funds should be devoted to any one trade because traders cannot expect to profit on every trade.

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