

Financial Markets +
Institutions

fifth edition



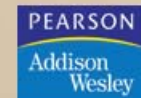
Frederic S. Mishkin

Stanley G. Eakins

Class 3

Derivatives

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Securities

- Characteristics
 - Contingent contractual claim
 - The contract specifies cash flow and ownership rights
 - Marketability
 - Can be sold at the market
- Necessary conditions:
 - Record-keeping technology
 - Legal infrastructure: contracting and enforcement



Derivatives

- Second level securities
 - Payoff depends on the value of other (underlying) securities
- Many instruments are like derivatives!
 - Bonuses tied to performance
 - Prices of stocks and bonds depend on the company's value
 - Value of the investment project depends on future cash flows
- Some derivatives are combinations of others
 - Forward as a portfolio of options
 - Swap as a portfolio of forwards



Forward/futures

- *Obligation* to buy / sell the underlying asset at T at the settlement price K
 - Long / short position
 - May be offset by the counter deal
- There is no exchange of payments when the contract is signed
 - The settlement price is chosen to make the contract worth exactly zero
- Payoff at T : $S_T - F$
 - Symmetric payoff

Forward/futures payoff

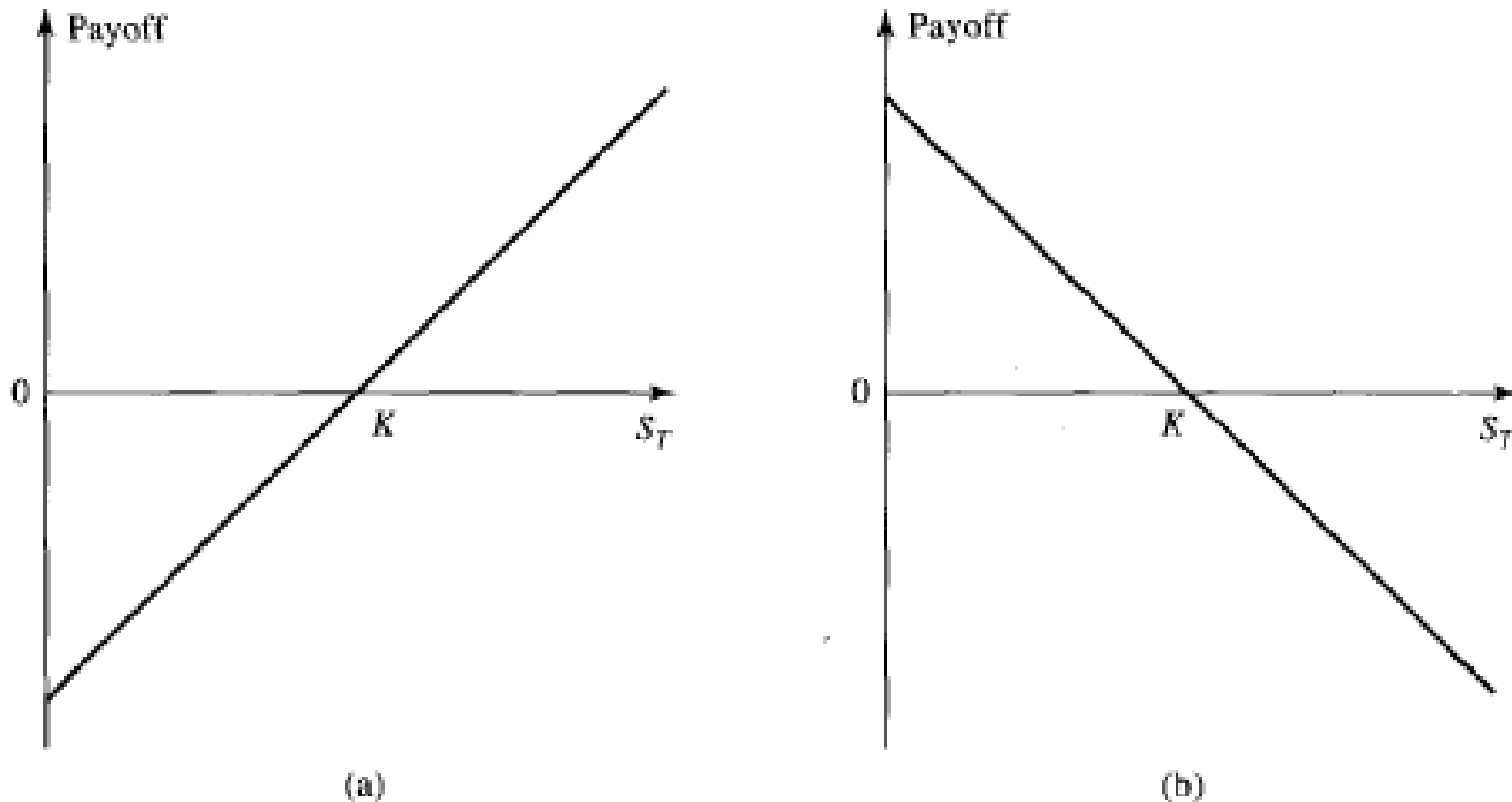


Figure 1.1 Payoffs from forward contracts: (a) long position, (b) short position.
Delivery price = K ; price of asset at maturity = S_T

Why do we need forward/futures?

- Hedging: reduce undesirable risks
 - E.g., we'll have grain to sell in September
 - *Short hedge*: sell September forward in spring
 - We now fix the future selling price

Why do we need forward/futures?

- Speculating: bet for a bullish or bearish market
 - E.g., expect the market to go up
 - Buy futures on the stock market index
 - Receive a high profit (or loss) on small investment
 - High leverage increases expected return and risk

Why do we need forward/futures?

- Arbitrage: find riskless profit opportunity (“free lunch”)
 - Buy undervalued asset and sell overvalued asset with the same risk characteristics
 - E.g., buy oil and sell oil futures
 - Pure arbitrage is very rare: there always some risks
 - Metallgesellschaft: sold 5-10y oil forwards and bought oil futures
 - 1993: the decline in oil price led to losses over \$1bln

Example: Hedging with Oil Forward

- An oil company extracts 1 mln. barrels each month
- The current oil price is \$50
- Two strategies:
 - 1: wait till the end of the month and sell at the market price
 - 2: sell now at one-month forward price \$49

Example: Hedging with Oil Forward

- Suppose the manager chose strategy 1 and the market price fell to \$45
 - Strategy 1 does not protect from the oil price risk
- Suppose the manager chose strategy 2 and the market price rose to \$55
 - Strategy 2 does protect from the downside risk, but also eliminates an upside potential
- In both cases, the manager was fired

Example: Hedging with Oil Forward

- What is the optimal solution?
 - Partial hedging: e.g., 50% *hedge ratio* = hedged volume / total volume
 - The strategy must be understood and approved by the top management!



Forward

- Specific terms
 - Very flexible for the initiating side
- Low liquidity
 - Hard to find the counterparty
 - Spot settlement
- Credit risk
 - The possibility of the default by the counterparty

The header features a collage of three images: on the left, a close-up of the 'NEW YORK' sign on a building facade; in the center, a large, bold, brown 'Futures' title; on the right, a group of people in a trading floor setting.

Futures

- Standardized exchange-traded contract
 - Amount, quality, delivery date, place, and conditions of the settlement
- High liquidity → popular among speculators
 - Can be offset by taking an opposite position
 - Usually, cash settlement

The header features a collage of three images: on the left, a close-up of the word 'NEW YORK' in raised letters on a building facade; in the center, a large, bold, brown serif font spelling 'Futures'; on the right, a group of people in a crowded, possibly financial or social setting.

Futures

- Credit risk taken by the exchange
 - The exchange clearing-house is a counterparty
 - Collateral: the initial / maintenance margin
 - The margin account guarantees the settlement for the exchange
 - Marking to market daily
 - E.g., long position: receive $A(F_t - F_{t-1})$ into account
 - where A is the position size, F_t is the settlement price at day t

Widely Traded Financial Futures Contracts

TABLE 1 *Widely Traded Financial Futures Contracts*

Type of Contract	Contract Size	Exchange*	Open Interest (January 12, 2005)
Interest-Rate Contracts			
Treasury bonds	\$100,000	CBT	634,817
Treasury notes	\$100,000	CBT	1,685,092
Five-year Treasury notes	\$100,000	CBT	1,156,187
Two-year Treasury notes	\$200,000	CBT	265,601
Thirty-day Fed funds	\$5 million	CBT	117,189
One-month LIBOR	\$3 million	CME	46,157
Municipal Bond Index	\$1000	CBT	2,822
Eurodollar	\$1 million	CME	5,293,924
Euroyen	100 million	CME	30,559
Sterling	£500,000	LIFFE	1,332,204
Long Gilt	£50,000	LIFFE	195,034
Three-month Euribor	1,000,000 euros	LIFFE	2,715,108
Euroswiss franc	SF 1 million	LIFFE	1,318
Euro-Buno	100,000 euros	EUREX	456,981
Canadian banker's acceptance	C\$1,000,000	ME	126,948

Widely Traded Financial Futures Contracts

Stock Index Contracts

Standard & Poor's 500 Index	\$250 × index	CME	685,553
Standard & Poor's MIDCAP 400	\$500 × index	CME	13,135
NASDAQ 100	\$100 × index	CME	3,500
Nikkei 225 Stock Average	\$5 × index	CME	31,146
Financial Times–Stock Exchange 100-Share Index	£10 per index point	LIFFE	464,473

Currency Contracts

Yen	¥12,500,000	CME	156,574
Euro	€125,000	CME	143,660
Canadian dollar	C\$100,000	CME	70,403
British pound	£62,500	CME	67,895
Swiss franc	SF 125,000	CME	53,945
Mexican peso	N\$ 500,000	CME	68,161

*Exchange abbreviations: CBT, Chicago Board of Trade; CME, Chicago Mercantile Exchange; LIFFE, London International Financial Futures Exchange; MATIF, Marché à Terme International de France; ME, Montreal Exchange.

Source: *Wall Street Journal*, January 12, 2005, p. C12. Republished by permission of Dow Jones, Inc. via Copyright Clearance Center, Inc.
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Options

- *European* call (put):
 - Right to buy (sell) the underlying asset at the expiration/maturity date T at the strike/exercise price K
- *American* call (put):
 - Can be exercised at any time before T
 - Always more expensive than European one
- *Right* for the buyer, only exercised if profitable
 - An obligation for the option *writer* to fulfil his promise, if necessary
 - Asymmetric payoff function

Call's payoff: $c_T = \max(S_T - K, 0)$

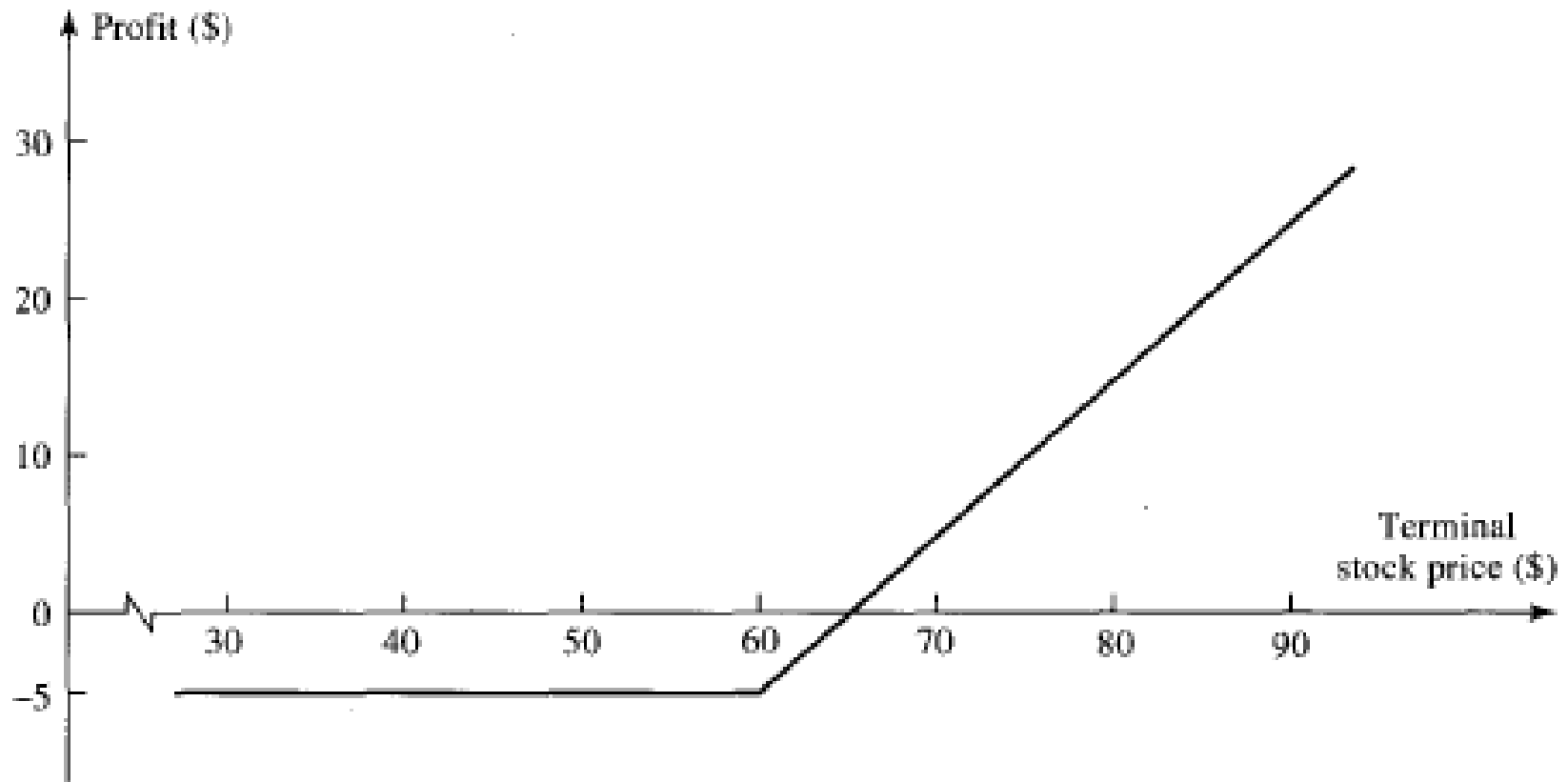


Figure 1.2 Profit from buying a European call option on one Microsoft share.
Option price = \$5; strike price = \$60

Put's payoff: $p_T = \max(K - S_T, 0)$

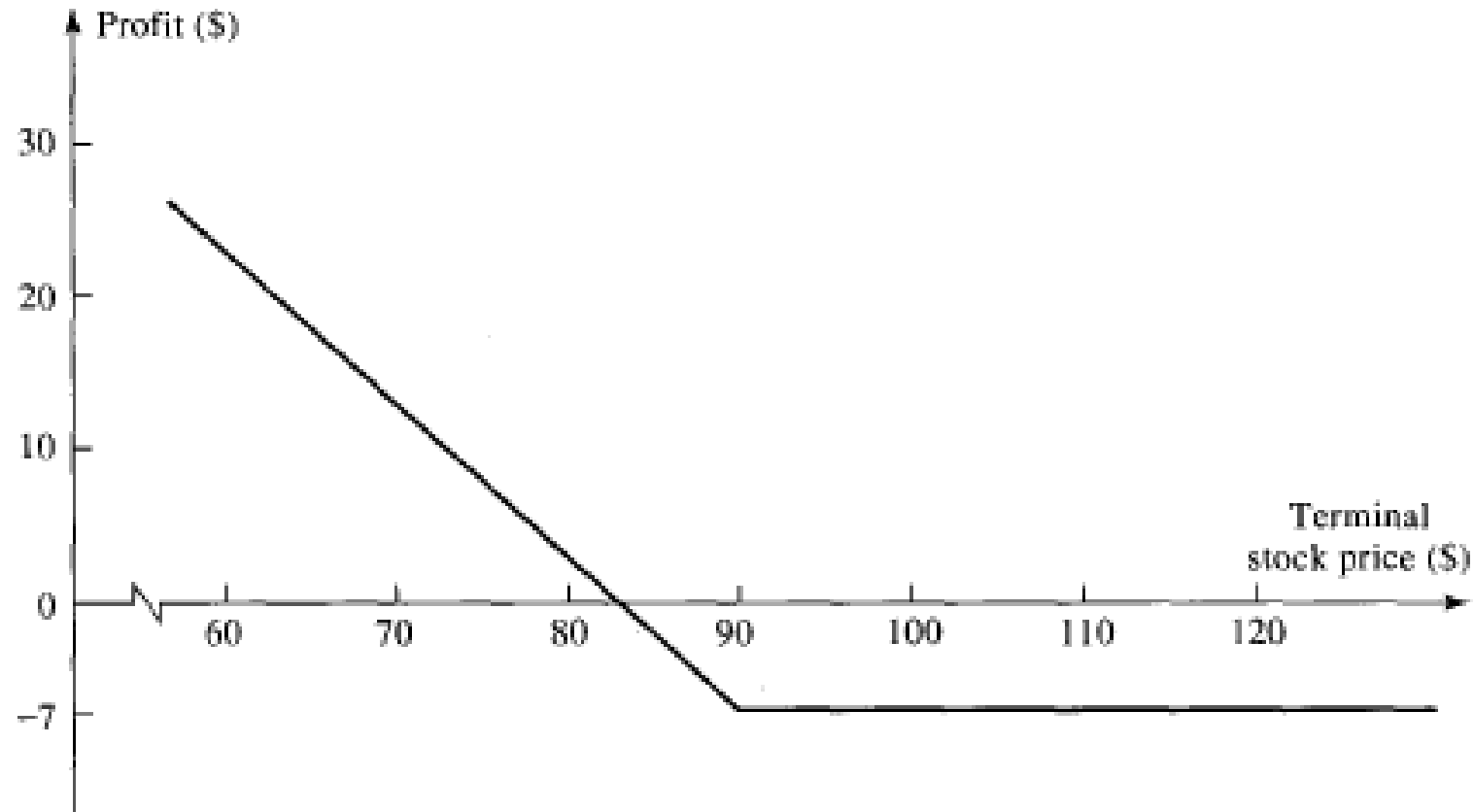
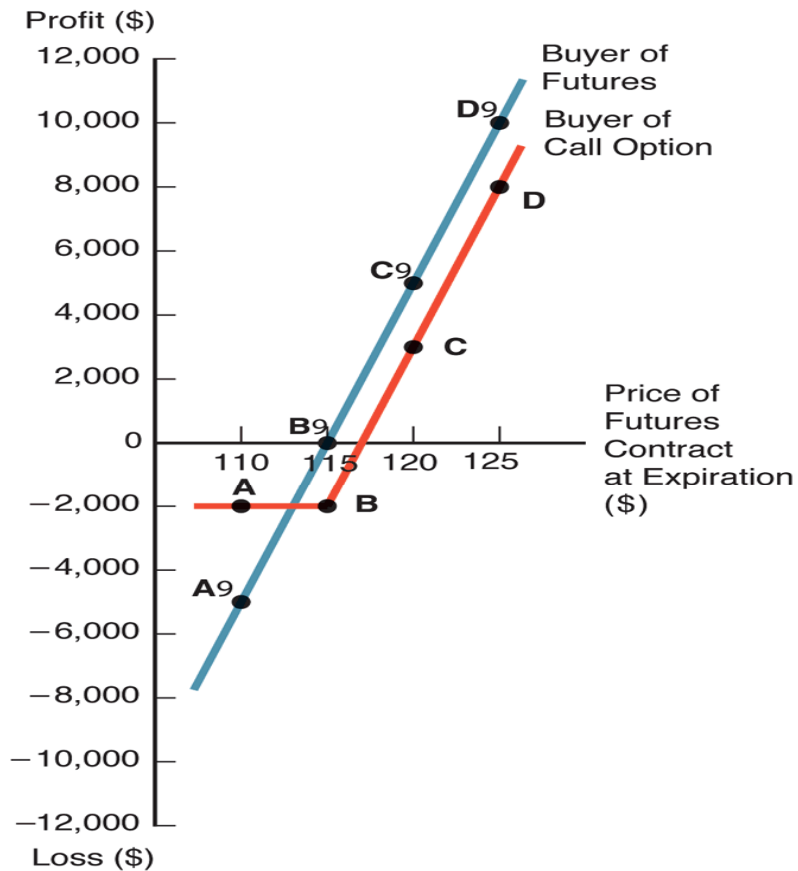


Figure 1.3 Profit from buying a European put option on one IBM share.
Option price = \$7; strike price = \$90

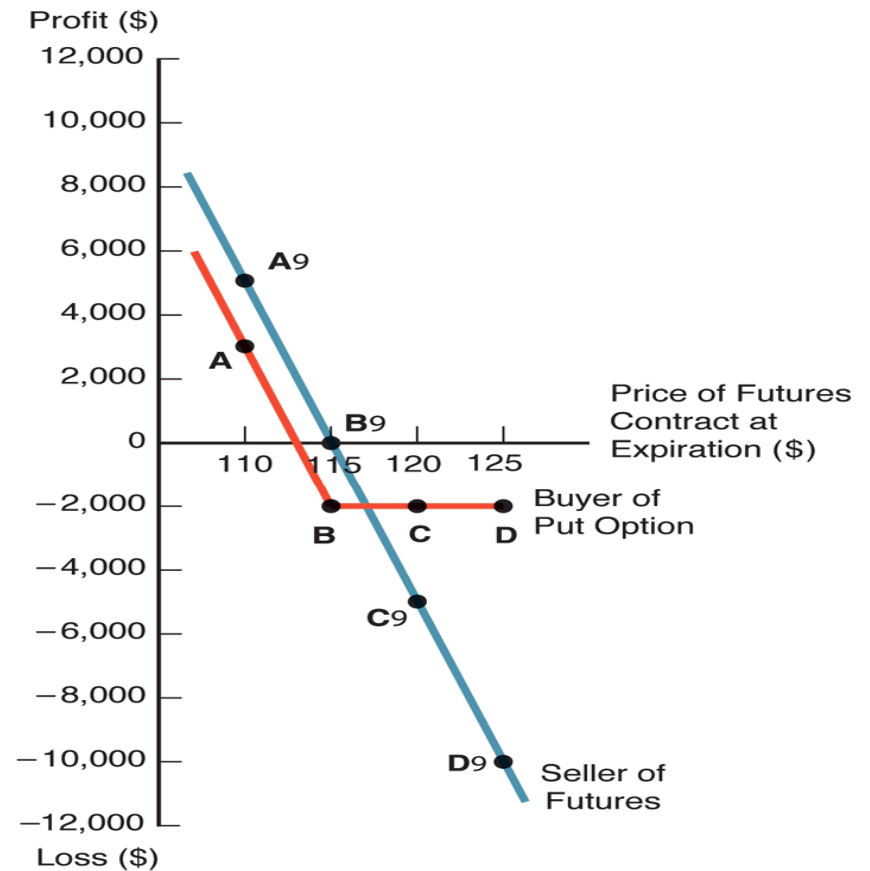
Example: Hedging with Oil Option

- Another strategy:
 - 3: buy one-month put option with strike \$49
- This protects from the downside risk and keeps an upside potential
- But at a fixed price
 - The option's price (premium)

Options vs. Futures



(a) Profit or loss for buyer of call option and buyer of futures



(b) Profit or loss for buyer of put option and seller of futures

Figure 25.1 Profits and Losses on Options versus Futures Contracts



Option terminology

- How much is the option worth?
 - Option *premium*, paid by the buyer to the writer of the option
- Moneyness
 - What would the option bring if it currently expired?
Profit / nothing / loss
 - IN / AT / OFF-the-money options

The background of the slide features a collage of images: a classical architectural frieze with the word 'EUREKA' visible, a close-up of a hand holding a pen over a document, and a group of people in a meeting or classroom setting.

Option terminology

- *Intrinsic value* = profit from the option if exercised now
- *Time value* = option's premium - intrinsic value
 - Positive, since the market expects positive developments before maturity
 - If the underlying price goes up, the option will give higher profit
 - If the underlying price falls, the option can't lose more than 0
 - The higher the volatility of the underlying asset, the better!



Option pricing

- No-arbitrage approach
 - If two portfolios yield the same payoff in the future, they must have the same price now
- Synthetic forward: long call, short put
- European call-put parity: $c_0 + Ke^{-rT} = p_0 + S_0$
 - Call with cash = covered put
- Black-Scholes model (1973)
 - Prices of European call and put options

Equity as a call option

- The company's capital structure includes
 - Equity, with value E
 - Pure-discount debt, with face value F and maturity T
- Default occurs at maturity if the company's value $V_T < F$
 - Stockholders receive at T : $\max(V_T - F, 0)$
 - Creditors receive at T : $\min(V_T, F)$



Equity as a call option

- Stockholders: call option on the company
 - Price of the underlying asset: V
 - Exercise price: F
 - Exercise date: T
- Creditors: basic asset (the company) & short call
 - Or bond and short put



Other uses of options

- Convertible bonds: embedded call option on a stock
 - Bondholders may receive a share in the company's profits
- Redeemable bonds: embedded short call option on the bond
 - The company can buy out the bond for the face value if the interest rates fall



Other uses of options

- Executive stock options
 - Call on the company's stock given to the managers for proper incentives
- Real options
 - Evaluate projects with dynamic strategy in response to the changes in the environment
 - E.g., the oil company may change extraction in response to the oil price



Exotic options

- Bermudan option
 - Can be exercised at several exercise dates
- Exchange option: $\max(S_A - S_B, 0)$
 - Gives right to exchange one asset for another
- Binary option: $I\{S_T - X > 0\}$
 - Fixed payoff



Exotic options

- Asian option: $\max(S_{\text{avg}} - X, 0)$
 - Payoff depends on *average* rather than final price
- Barrier option:
 - Knock-in (-out)
 - The call or put becomes worthy (worthless) only after the stock price hits the barrier



Swaps

- Interest rate swap
 - Exchange of fixed-rate and floating-rate interest payments for a fixed par value
 - Like a portfolio of forwards on interest rates...
 - or long fixed-rate bond vs. short floating-rate bond
- Purpose
 - Hedge interest rate risk



Swaps

- Currency swap
 - Exchange of interest payments in different currencies
 - Like a portfolio of currency forwards
- Purpose
 - Issue bonds in the cheapest way in one currency
 - Hedge currency risk via swaps

Mini-case 3: Weather derivatives

- Instruments with payoff depending on the nature
 - Temperature, rainfall, hurricanes, etc.
- Futures on temperature in a large city on a certain date
 - The underlying: # days with t below 18° during November to March period
 - Traded at CME since 1999
- Catastrophe (*cat*) bonds that lose principal in case of an extreme natural disaster
 - Trigger types: actual losses / windspeed / ground acceleration
 - The current issuance volume: \$5 bln per year

Who is interested in futures on temperature?

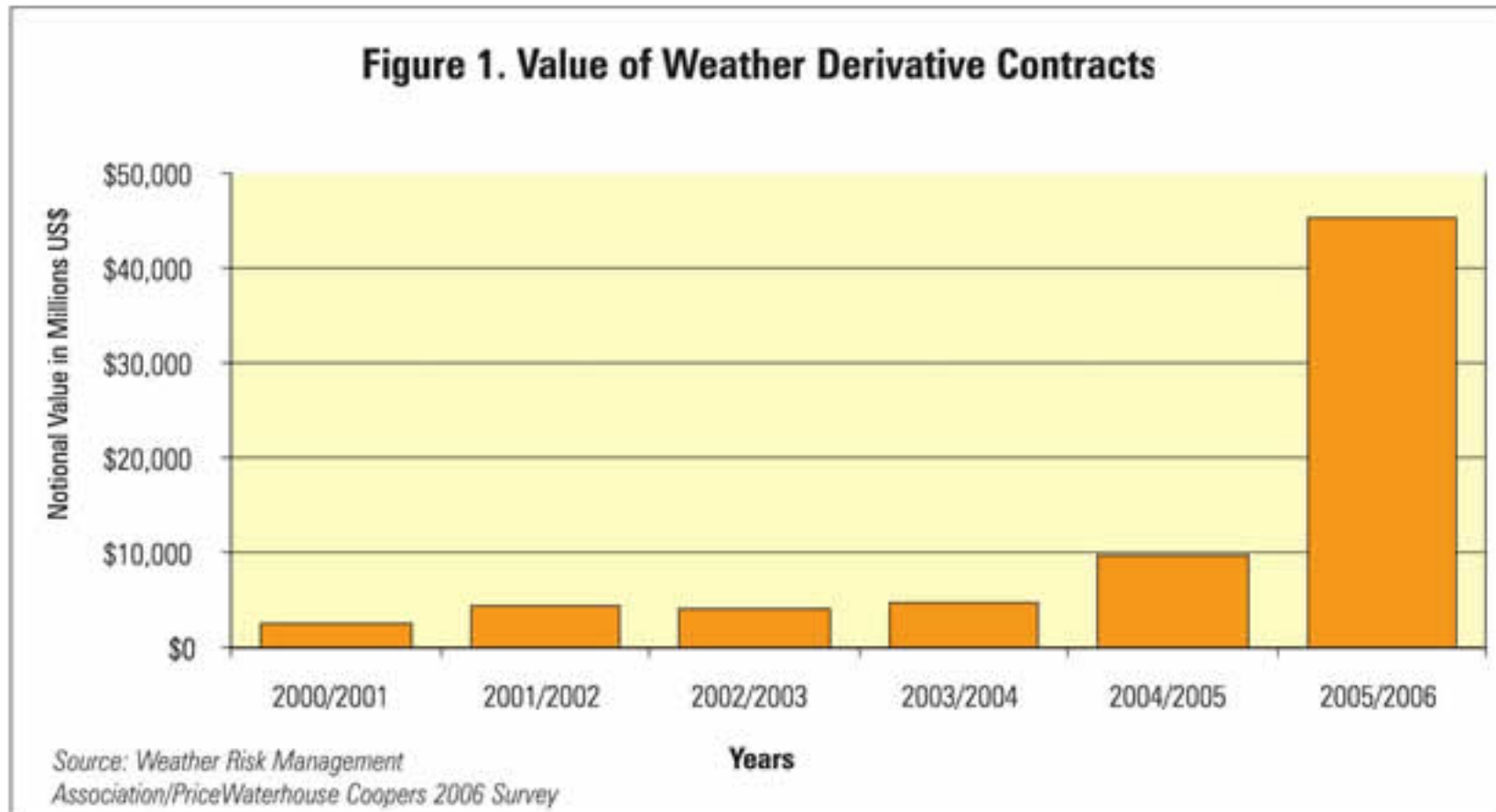
- Hedging weather risks
 - Gas and power companies, recreational centers, farmers, etc.
- Speculating / investing
 - Instl investors: the payoff is uncorrelated with stocks / bonds
 - Hedge funds: the market “cannot be predicted, but can be forecast”
 - The underlying cannot be manipulated
- Getting more precise information
 - Energy companies



Who is interested in cat bonds?

- Hedging risks
 - Insurance companies: issuing bonds is cheaper than reinsurance
 - The rate is LIBOR + 3-5%, paid only if there is no catastrophe
 - The maturity is 3-5 years
- Sharing risks
 - Investors: willing to put a small fraction of the portfolio to the instrument, which on average gives a high return
- Getting more precise information
 - The government

The weather derivatives market



Are derivatives “financial weapons of mass destruction”?

- Major concerns
 - Derivatives allow financial institutions to increase their leverage
 - This could lead to excessive risks and ultimately to the bankruptcy
 - Derivatives are too complicated
 - Risks are not properly understood

Are derivatives “financial weapons of mass destruction”?

- Many cases of big losses for banks and corporations
 - Orange County, 1994: \$1.7 bln on interest rate derivatives
 - Barings bank, 1995: \$1.4 bln on stock index futures
 - Sumitomo corporation, 1996: \$2.6 bln on copper options
 - Amaranth hedge fund, 2006: \$6.2 bln on energy futures and options

Are derivatives “financial weapons of mass destruction”?

- Who is guilty?
 - Advisors: investment banks did not describe risks properly
 - Decision-makers: had an incentive to show good results, at a cost of higher risks
 - Company management: all cases resulted from a failure in risk management
 - The strategy was not clearly specified
 - The risks were not properly understood
 - Traders could hide losses for a long time



Role of derivatives: efficient risk sharing

- To hedge risks
 - Make risk-offsetting bets
- To speculate
 - Take a view on the future direction of the market
- To lock in arbitrage profit
 - Long-short (self-financed) portfolio
- To change the nature of liability/investment
 - Without a need to remove it
- ...at low cost !

OTC derivatives statistics (\$bln)

Risk Category / Instrument	Notional amounts outstanding					Gross market values				
	Jun 2004	Dec 2004	Jun 2005	Dec 2005	Jun 2006	Jun 2004	Dec 2004	Jun 2005	Dec 2005	Jun 2006
Total contracts	220,058	257,894	281,493	297,670	369,906	6,395	9,377	10,605	9,749	10,074
Foreign exchange contracts	26,997	29,289	31,081	31,364	38,111	867	1,546	1,141	997	1,134
Forwards and forex swaps	13,926	14,951	15,801	15,873	19,415	308	643	464	406	436
Currency swaps	7,033	8,223	8,236	8,504	9,669	442	745	549	453	533
Options	6,038	6,115	7,045	6,987	9,027	116	158	129	138	166
Interest rate contracts	164,626	190,502	204,795	211,970	262,296	3,951	5,417	6,699	5,397	5,549
Forward rate agreements	13,144	12,789	13,973	14,269	18,117	29	22	31	22	25
Interest rate swaps	127,570	150,631	163,749	169,106	207,323	3,562	4,903	6,077	4,778	4,944
Options	23,912	27,082	27,072	28,596	36,856	360	492	592	597	579
Equity-linked contracts	4,521	4,385	4,551	5,793	6,783	294	498	382	582	671
Forwards and swaps	691	756	1,086	1,177	1,423	63	76	88	112	147
Options	3,829	3,629	3,464	4,617	5,361	231	422	294	470	523
Commodity contracts	1,270	1,443	2,940	5,434	6,394	166	169	376	871	718
Gold	318	369	288	334	456	45	32	24	51	77
Other commodities	952	1,074	2,652	5,100	5,938	121	137	351	820	641
Forwards and swaps	503	558	1,748	1,909	2,186					
Options	449	516	904	3,191	3,752					
Credit default swaps	...	6,396	10,211	13,908	20,352	...	133	188	243	294
Single-name instruments	...	5,117	7,310	10,432	13,873	...	112	136	171	186
Multi-name instruments	...	1,279	2,901	3,476	6,479	...	22	52	71	109
Unallocated	22,644	25,879	27,915	29,199	35,969	1,116	1,613	1,818	1,659	1,707
Memorandum Item:										
Gross Credit Exposure						1,478	2,075	1,897	1,900	2,032

Derivatives traded on the organised exchanges

Instrument / location	Amounts outstanding				Turnover					
	Dec 2003	Dec 2004	Dec 2005	Sep 2006	2004	2005	Q4 2005	Q1 2006	Q2 2006	Q3 2006
Futures										
All markets	13,752.9	18,903.7	21,619.2	25,824.5	840,188.4	1,005,818.7	245,335.8	292,260.9	332,374.0	327,830.1
Interest rate	13,123.7	18,164.9	20,708.7	24,699.0	783,140.2	939,590.2	225,314.8	270,598.2	308,254.1	305,141.7
Currency	79.9	103.5	107.6	139.9	6,614.7	11,126.2	3,044.3	3,276.1	3,998.9	3,646.5
Equity index	549.3	635.2	802.9	985.6	50,433.5	55,102.3	16,976.8	18,386.6	20,121.0	19,042.0
North America	7,700.0	10,465.9	12,326.8	14,677.6	440,774.7	564,237.1	131,553.6	167,022.2	185,523.3	186,171.6
Interest rate	7,384.6	10,043.6	11,855.2	14,072.8	414,309.7	529,120.9	122,048.2	156,874.2	173,062.7	174,936.1
Currency	64.9	91.5	90.7	102.9	6,080.9	10,258.4	2,795.3	2,942.6	3,603.7	3,237.2
Equity index	250.4	330.7	380.8	501.9	20,384.0	24,857.9	6,710.1	7,205.4	8,857.0	7,998.3
Europe	4,363.2	5,972.4	6,284.8	7,551.5	336,632.1	380,613.0	95,882.9	104,297.6	122,131.2	117,832.1
Interest rate	4,200.2	5,756.1	6,050.5	7,226.5	322,977.6	362,066.3	90,410.3	98,224.1	115,247.5	110,841.4
Currency	0.3	0.3	2.4	3.0	12.5	37.0	8.6	8.3	14.2	11.2
Equity index	162.7	215.9	231.9	322.1	13,642.1	18,509.7	5,464.0	6,065.1	6,869.5	6,979.6
Asia and Pacific	1,531.2	2,293.8	2,695.0	3,230.1	56,878.9	53,091.5	15,715.3	18,470.0	22,216.5	21,120.6
Interest rate	1,395.4	2,208.0	2,509.8	3,065.1	40,694.2	41,666.7	11,013.2	13,500.8	18,063.4	17,276.7
Currency	3.4	3.7	4.3	20.2	107.2	133.7	35.3	35.1	58.7	79.9
Equity index	132.5	82.0	180.9	144.7	16,077.5	11,291.2	4,666.9	4,934.1	4,094.4	3,764.0
Other Markets	158.5	171.6	312.7	365.3	5,902.7	7,877.0	2,184.1	2,471.2	2,502.9	2,705.8
Interest rate	143.4	157.2	293.2	334.6	5,158.6	6,736.3	1,843.2	1,999.0	1,880.5	2,087.6
Currency	11.3	7.9	10.2	13.9	414.1	697.1	205.1	290.1	322.3	318.2
Equity index	3.7	6.6	9.3	16.8	329.9	443.6	135.8	182.1	300.1	300.0

Derivatives traded on the organised exchanges

Instrument / location	Amounts outstanding				Turnover						
	Dec 2003	Dec 2004	Dec 2005	Sep 2006	2004	2005	Q4 2005	Q1 2006	Q2 2006	Q3 2006	
Options											
All markets	23,034.0	27,688.8	36,196.9	49,753.9	312,070.5	402,594.7	99,122.9	136,441.6	152,135.0	137,304.2	
Interest rate	20,793.8	24,604.1	31,588.2	43,369.3	260,056.4	328,778.9	76,831.1	111,273.6	125,938.4	113,057.5	
Currency	37.9	60.7	66.1	68.0	588.7	943.7	234.2	258.6	279.0	264.6	
Equity index	2,202.4	3,024.0	4,542.6	6,316.5	51,425.4	72,872.1	22,057.6	24,909.4	25,917.6	23,982.1	
North America	11,804.0	17,142.6	24,067.4	31,221.1	181,496.2	254,511.2	57,615.5	88,440.7	104,386.1	90,045.6	
Interest rate	10,381.8	15,286.7	21,255.4	27,488.1	163,161.2	229,976.4	50,509.8	80,981.8	94,583.5	81,465.4	
Currency	18.5	40.6	28.3	34.1	346.1	449.0	91.4	106.2	137.5	88.7	
Equity index	1,403.7	1,815.2	2,783.8	3,698.9	17,988.9	24,085.8	7,014.3	7,352.7	9,665.1	8,491.4	
Europe	11,043.3	10,335.5	11,697.6	17,079.8	101,950.5	105,908.1	28,456.7	32,217.6	32,692.9	32,849.0	
Interest rate	10,357.2	9,282.0	10,235.7	14,703.5	95,261.7	96,704.2	25,759.2	29,147.0	29,591.4	29,624.0	
Currency	0.3	0.5	0.6	1.3	3.0	7.6	1.7	1.1	1.5	3.5	
Equity index	685.8	1,053.0	1,461.4	2,375.0	6,685.8	9,196.2	2,695.8	3,069.5	3,100.0	3,221.5	
Asia and Pacific	128.7	133.1	319.0	1,304.7	27,573.9	40,312.1	12,494.7	15,066.0	14,386.5	13,636.0	
Interest rate	44.2	13.7	67.4	1,102.8	1,469.5	1,947.8	502.4	1,013.4	1,641.7	1,812.5	
Currency	-	-	-	-	-	-	-	-	-	-	
Equity index	84.5	119.4	251.6	201.9	26,104.4	38,364.4	11,992.3	14,052.6	12,744.8	11,823.6	
Other Markets	58.0	77.6	112.9	148.3	1,049.8	1,863.2	556.0	717.3	669.5	773.6	
Interest rate	10.6	21.7	29.8	74.9	164.1	150.4	59.6	131.4	121.8	155.6	
Currency	19.0	19.5	37.2	32.7	239.5	487.1	141.2	151.3	140.0	172.4	
Equity index	28.4	36.4	45.8	40.7	646.2	1,225.7	355.2	434.5	407.7	445.5	

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Stanley G. Eakins

Discussion topic

What are the most promising derivatives to develop in Russia?

Most popular derivatives in Russia

- Currency derivatives
 - OTC forwards, swaps on USD/RUB
 - MICEX/RTS: futures on USD/RUB, EUR/RUB
- Interest rate derivatives
 - MICEX/RTS: futures on bonds, MosIBOR, and MosPrime
 - OTC options on bonds
- Stocks derivatives
 - RTS: futures and options on RTS index, Gazprom, Lukoil,...

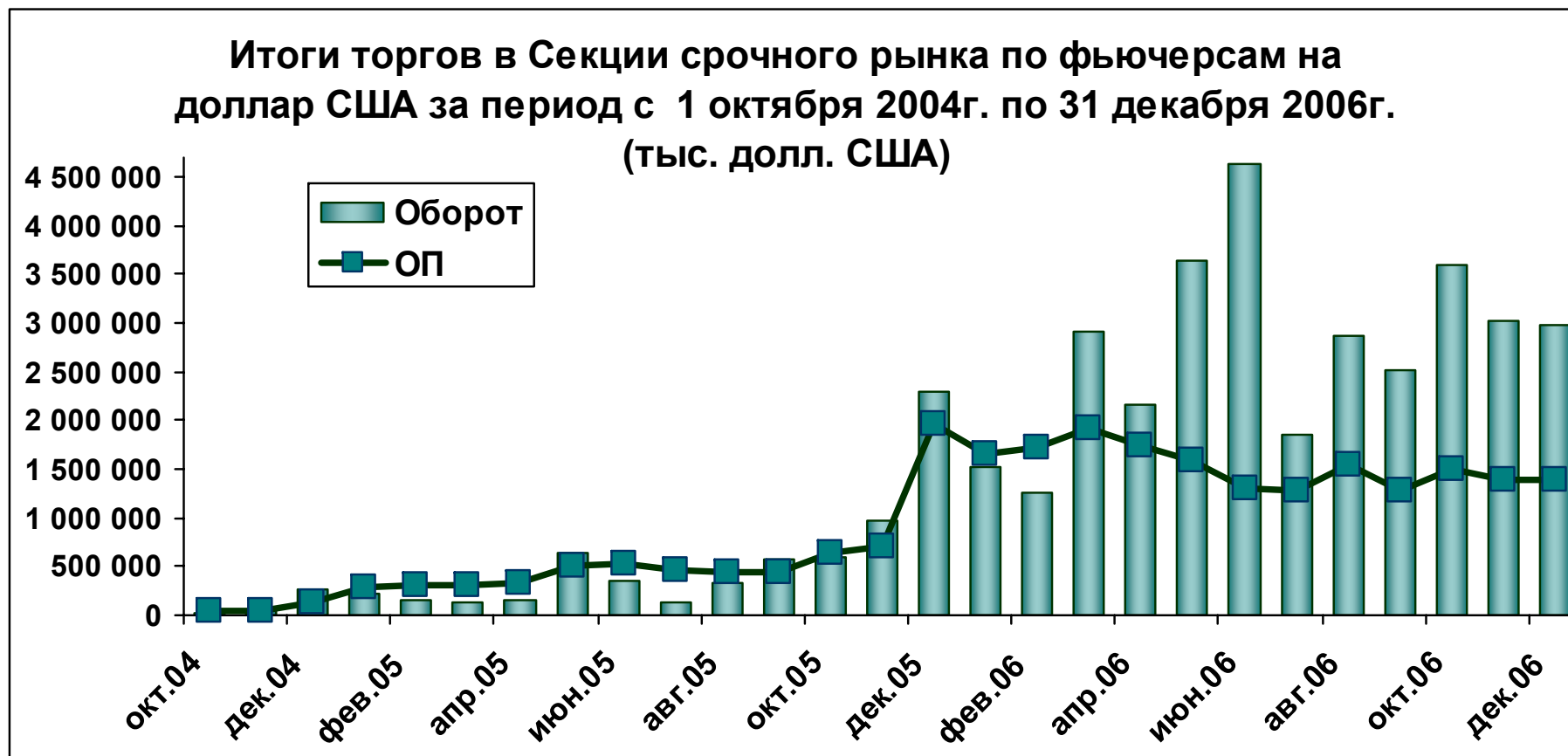


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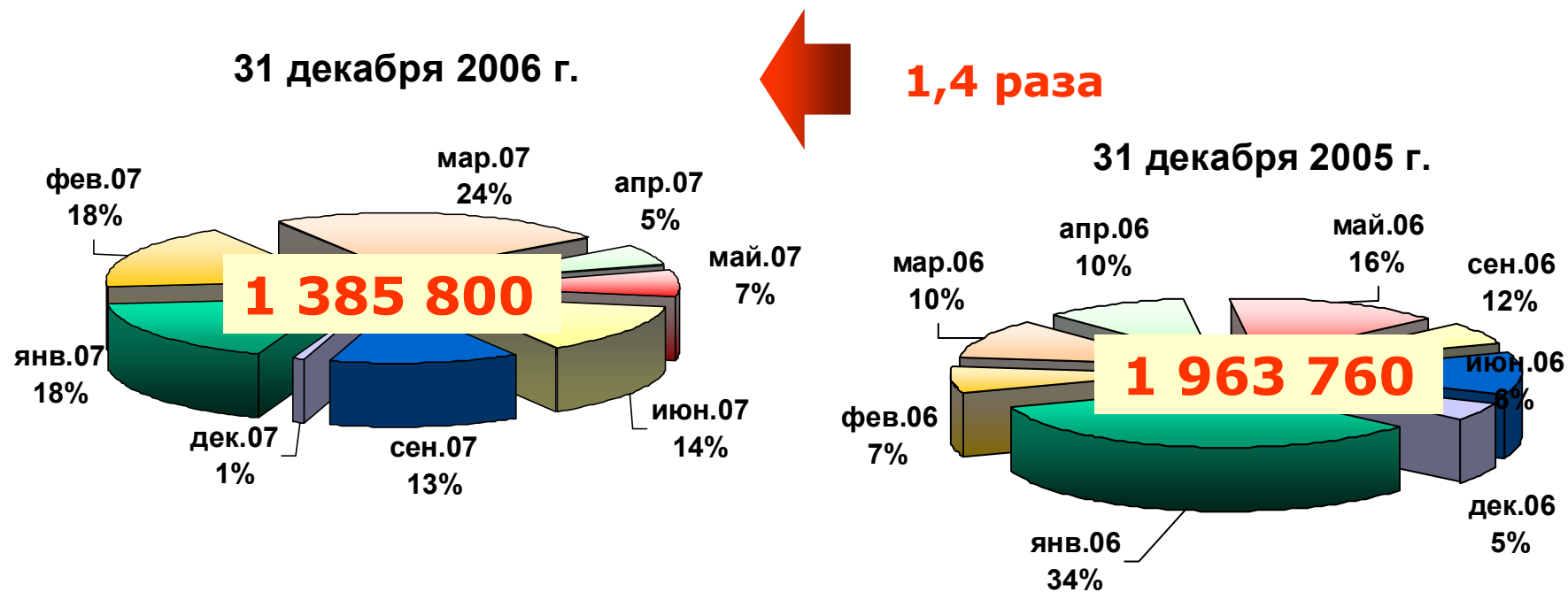
- Lack of the netting principle in the legislation on bankruptcy and taxation
- Low liquidity
- Fragmentation
 - Large banks vs. others
- Lack of the generally acknowledged interest rates

The USD/RUB futures at MICEX

The total trading volume in 2006: \$34 bln

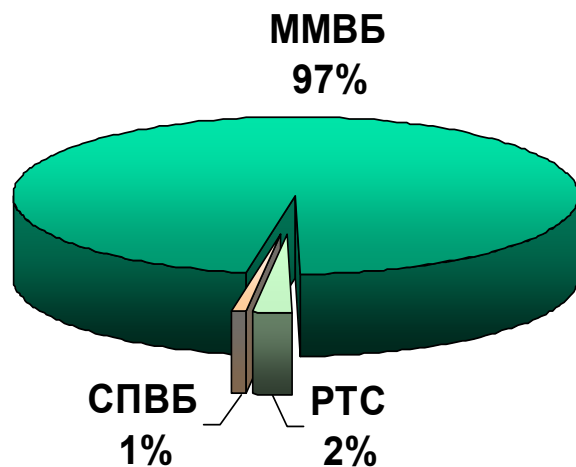


The open interest

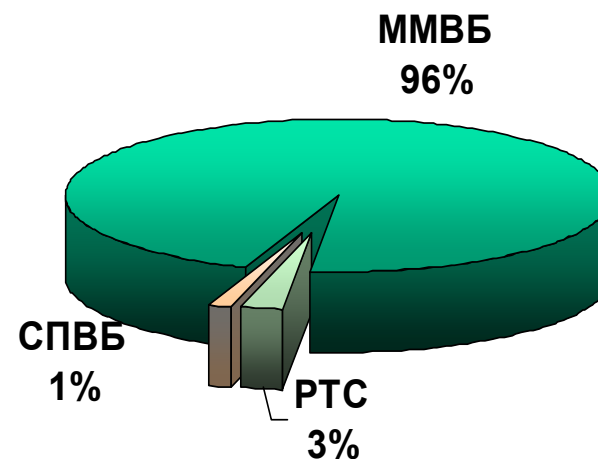


The USD/RUB futures markets

Доли бирж в обороте с начала года по декабрь 2006 года



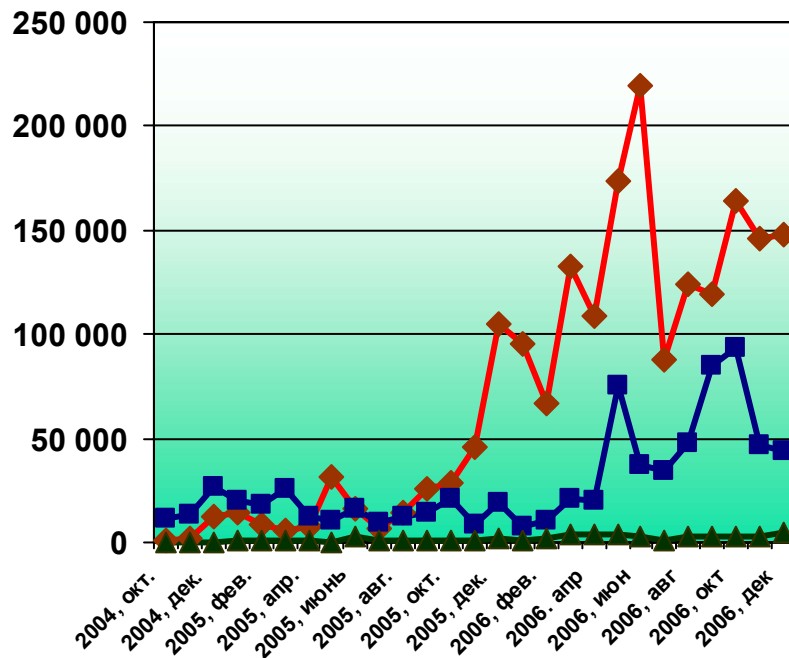
Доли бирж в объеме открытых позиций по состоянию на 30 ноября 2006 г.



** Данные берутся с официальных сайтов бирж. При расчете открытых позиций учитывается только одна сторона по сделке*

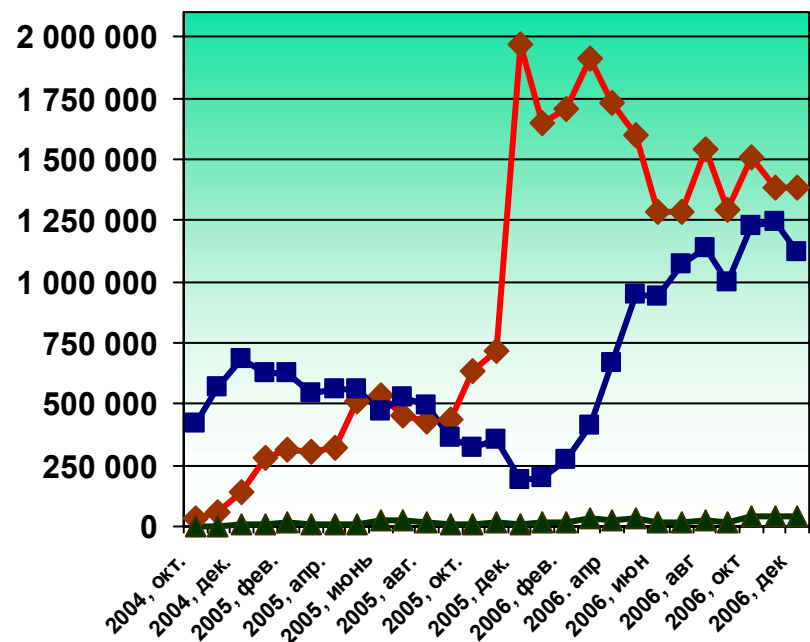
The USD/RUB futures markets: MICEX vs. CME vs. FORTS

Среднедневной оборот (тыс. долл. США)



◆ MMBB ■ CME ▲ FORTS

Открытые позиции (тыс. долл. США)

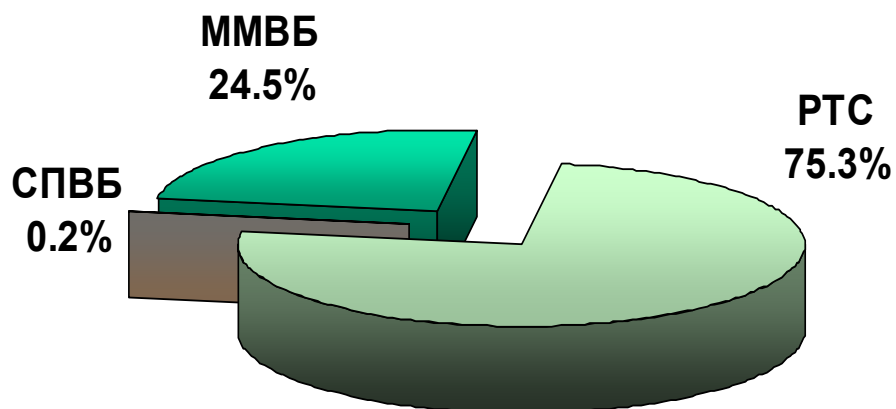


◆ MMBB ■ CME ▲ FORTS

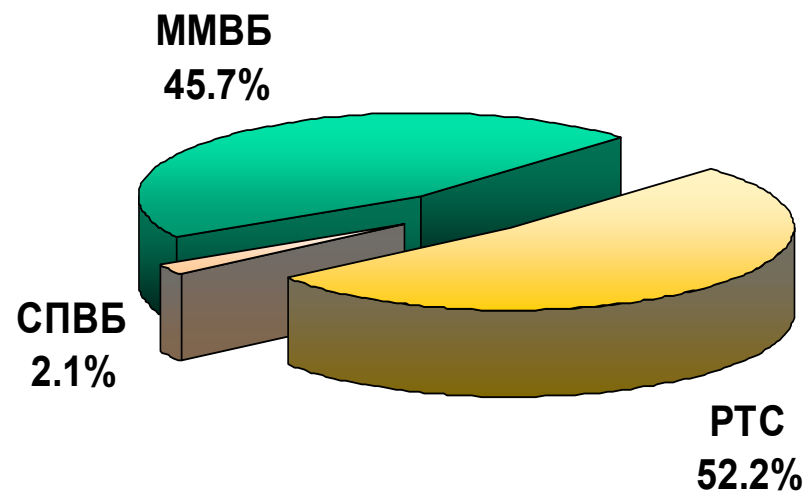
* Данные берутся с официальных сайтов бирж. При расчете открытых позиций учитывается только одна сторона по сделке

The derivatives market in Russia

Доли российских бирж в суммарном обороте
с начала года по декабрь 2006 года



Доли российских бирж в объеме открытых
позиций по состоянию на 31 декабря 2006 г.



** Данные берутся с официальных сайтов бирж. При расчете открытых позиций учитывается только одна сторона по сделке*