

# 포트폴리오 리스크 관리

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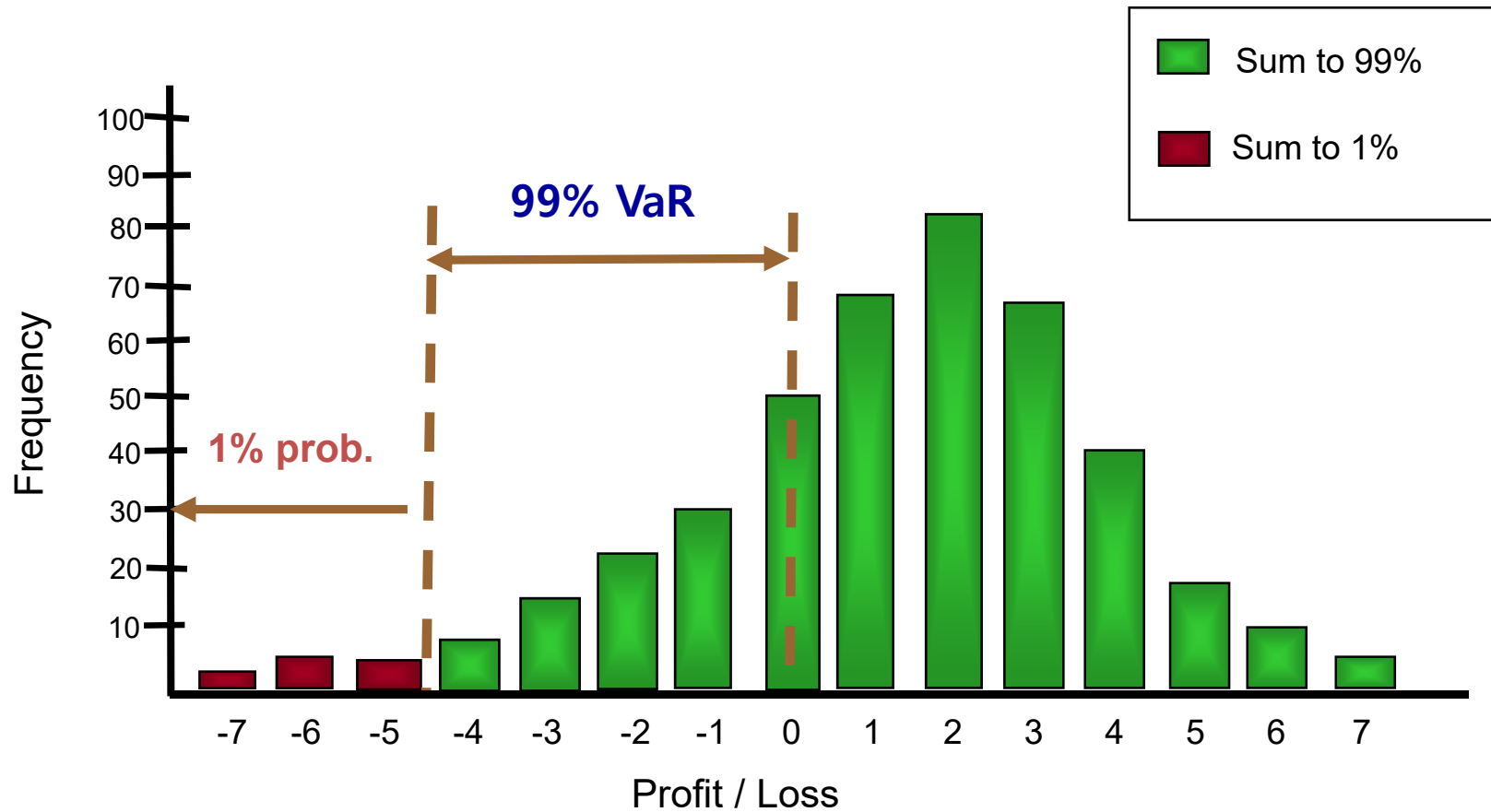
- History of VaR (Value-at-Risk)
- JP Morgan
- Chairman, Dennis Weatherstone (1980년 중반)
- What is the bank's total exposure over the next 24 hours measured across the bank's entire trading portfolio?
- What is the bank's maximum possible loss over the next 24 hours?



4:15 report (1990)

- Value Risk, Risk Value, Value at Risk
- BIS (Bank for International Settlement) (1998)
- BIS regulation (VaR → Expected Shortfall) (2023)

# VaR (Value-at-Risk)



# VaR and Expected Shortfall (ES)

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- There is 1% probability that we will lose more than  $V$  dollars over the next 24 hours

$$V = 99\% \text{ 1-day VaR}$$

- Expected shortfall (ES)
  - Expected loss over the next 24 hours conditional on the loss being greater than  $V$  (99% 1-day VaR)

$$\text{Expected loss} = 99\% \text{ 1-day ES}$$

# 방법론 (Methodologies)

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- Delta normal method
- **Historical simulation method**
- Monte-Carlo simulation method

# Portfolio

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Index	Portfolio value
DJIA	4,000
FTSE 100	3,000
CAC 40	1,000
Nikkei 225	2,000
<b>Total</b>	<b>10,000</b>

위의 포트폴리오에 대하여 historical simulation 방법을 이용하여  
99% 1-day VaR(Value-at-Risk)와 99% 1-day ES(Expected Shortfall)을 구하시오.  
과거 500 영업일의 주가자료 및 환율 자료를 이용하기로 결정

# Data

			Portfolio	S&P500	FTSE 100	CAC40	Nikkei 225	단위
Today	2020-07-08		Investments	4000	3000	1000	2000	(USD)
위의 포트폴리오에 대하여 historical simulation 방법을 이용하여 99% 1-day VaR(Value-at-Risk)와 99% 1-day ES(Expected Shortfall)을 구하시오. 과거 500 영업일의 주가자료 및 환율 자료를 이용하기로 결정								
						Exchange Rate		
Day	Date	S&P500	FTSE 100	CAC40	Nikkei 225	USD/GBP	EUR/USD	JPY/USD
0	2018-05-09	5,292.90	6,515.12	14,248.81	35149.26	1.3553	0.8426	109.024
1	2018-05-10	5,343.70	6,590.48	14,277.96	35287.76	1.3545	0.8441	109.847
2	2018-05-11	5,354.69	6,642.39	14,319.78	35697.62	1.3523	0.8391	109.436
3	2018-05-14	5,359.66	6,639.69	14,325.19	35866.05	1.3554	0.8367	109.338
4	2018-05-15	5,323.23	6,638.76	14,357.45	35791.01	1.3562	0.8381	109.731
5	2018-05-16	5,346.33	6,664.90	14,394.63	35632.92	1.3500	0.8460	110.297
6	2018-05-17	5,343.29	6,667.40	14,535.89	35822.93	1.3548	0.8462	110.359
7	2018-05-18	5,329.66	6,701.47	14,516.73	35967.22	1.3515	0.8478	110.828
8	2018-05-21	5,369.19	6,722.95	14,578.76	36080.17	1.3477	0.8499	110.880
9	2018-05-22	5,352.45	6,789.04	14,608.69	36014.24	1.3432	0.8480	110.978
10	2018-05-23	5,369.99	6,711.88	14,416.36	35589.79	1.3441	0.8483	110.726
11	2018-05-24	5,359.32	6,672.36	14,371.29	35193.37	1.3371	0.8540	109.869
12	2018-05-25	5,347.31	6,660.70	14,356.01	35215.08	1.3383	0.8531	109.312
13	2018-05-29	5,285.70	6,580.63	14,111.34	35070.21	1.3316	0.8601	109.389
14	2018-05-30	5,353.76	6,587.09	14,143.06	34537.05	1.3254	0.8666	108.394
15	2018-05-31	5,318.10	6,620.84	14,069.56	34824.56	1.3284	0.8571	108.712

# USD Adjusted

Day	Date	S&P500	FTSE 100	CAC40	Nikkei 225	Exchange Rate			USD Adjusted		
						USD/GBP	EUR/USD	JPY/USD	FTSE 100	CAC40	Nikkei 225
0	2018-05-09	5,292.90	6,515.12	14,248.81	35149.26	1.3553	0.8426	109.024	8,830.23	16,910.33	322.40
1	2018-05-10	5,343.70	6,590.48	14,277.96	35287.76	1.3545	0.8441	109.847	8,926.56	16,915.41	321.24
2	2018-05-11	5,354.69	6,642.39	14,319.78	35697.62	1.3523	0.8391	109.436	8,982.76	17,065.64	326.20
3	2018-05-14	5,359.66	6,639.69	14,325.19	35866.05	1.3554	0.8367	109.338	8,999.31	17,121.67	328.03
4	2018-05-15	5,323.23	6,638.76	14,357.45	35791.01	1.3562	0.8381	109.731	9,003.79	17,130.13	326.17
5	2018-05-16	5,346.33	6,664.90	14,394.63	35632.92	1.3500	0.8460	110.297	8,997.75	17,015.73	323.06
6	2018-05-17	5,343.29	6,667.40	14,535.89	35822.93	1.3548	0.8462	110.359	9,033.19	17,177.03	324.60
7	2018-05-18	5,329.66	6,701.47	14,516.73	35967.22	1.3515	0.8478	110.828	9,057.26	17,122.82	324.53
8	2018-05-21	5,369.19	6,722.95	14,578.76	36080.17	1.3477	0.8499	110.880	9,060.58	17,154.31	325.40
9	2018-05-22	5,352.45	6,789.04	14,608.69	36014.24	1.3432	0.8480	110.978	9,118.92	17,227.23	324.52

495	2020-06-30	6,351.67	5,781.82	13,611.91	36547.19	1.2311	0.8891	107.590	7,117.75	15,309.59	339.69
496	2020-07-01	6,383.76	5,723.02	13,591.32	36273.43	1.2389	0.8900	107.989	7,090.40	15,271.15	335.90
497	2020-07-02	6,414.16	5,796.88	13,930.79	36313.16	1.2465	0.8888	107.366	7,225.69	15,674.06	338.22
498	2020-07-06	6,516.05	5,796.26	14,031.46	37245.31	1.2476	0.8891	107.579	7,231.14	15,781.47	346.21
499	2020-07-07	6,445.59	5,817.60	13,953.12	37081.75	1.2495	0.8840	107.359	7,269.36	15,784.97	345.40
500	2020-07-08	6,496.14	5,784.23	13,782.82	36793.09	1.2543	0.8869	107.578	7,255.04	15,540.44	342.01

# 500 scenarios for tomorrow

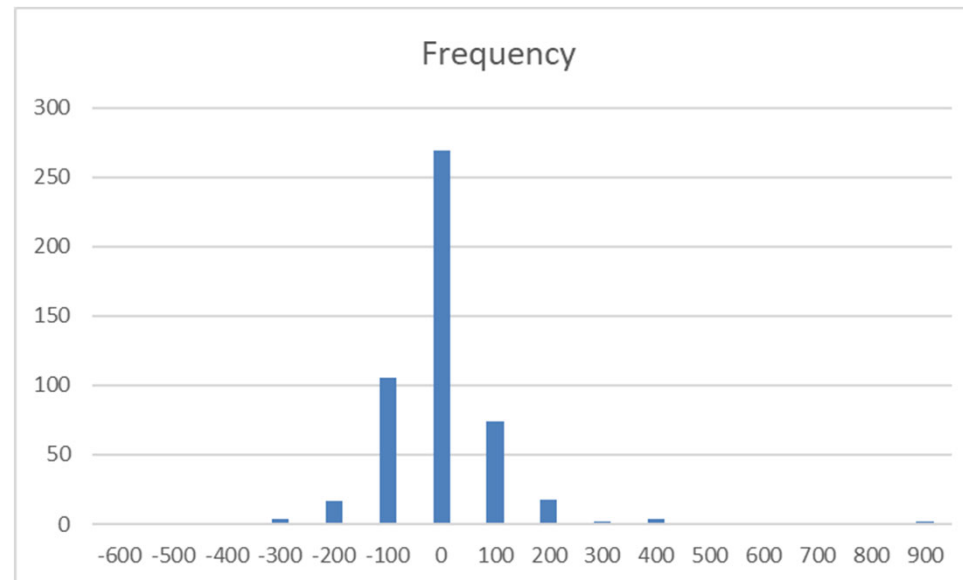
	(USD)							
Scenario	S&P500	FTSE 100	CAC40	Nikkei 225		Portfolio value		Loss
1	<b>6,558.49</b>	7,334.19	15,545.12	340.79		10,064.26		(64.26)
2	6,509.50	7,300.72	15,678.46	347.28		10,066.82		(66.82)
3	6,502.17	7,268.41	15,591.47	343.93		10,023.76		(23.76)
4	6,451.99	7,258.65	15,548.12	340.08		9,963.47		36.53
5	6,524.33	7,250.18	15,436.66	338.76		9,989.62		10.38
6	6,492.45	7,283.62	15,687.76	343.64		10,028.56		(28.56)
7	6,479.57	7,274.38	15,491.40	341.94		9,994.19		5.81
8	6,544.32	7,257.70	15,569.02	342.93		10,037.94		(37.94)
9	6,475.89	7,301.76	15,606.50	341.09		10,005.68		(5.68)
10	6,517.43	7,177.51	15,330.79	338.75		9,948.48		51.52
11	6,483.23	7,174.91	15,388.82	340.84		9,942.31		57.69
12	6,481.58	7,248.96	15,540.48	343.97		9,999.95		0.05
13	6,421.29	7,131.46	15,150.91	340.37		9,868.12		131.88
14	6,579.79	7,228.48	15,458.01	339.91		10,022.89		(22.89)
15	6,452.87	7,308.58	15,631.04	343.85		10,012.08		(12.08)

$$6558.49 = 6496.14 \times \frac{5343.70}{5292.90}$$



# Histogram of Profit/Loss

Loss	max	922.48
	min	(639.36)
-550	-600	1
-450	-500	1
-350	-400	1
-250	-300	4
-150	-200	17
-50	-100	105
50	0	269
150	100	74
250	200	18
350	300	2
450	400	4
550	500	1
650	600	0
750	700	1
850	800	0
950	900	2



# Profit/Loss sorted

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Scenario	Loss					
427	922.48					
429	858.42		99% 1-day VaR	422.29	4.22%	
424	653.54		99% 1-day ES	669.39	6.69%	
415	490.22					
482	422.29					
440	362.73					
426	360.53					
431	353.79					
417	323.51					
433	305.22					
452	245.15					
418	241.56					
140	231.27					

# Profit/Loss sorted (python)

	S&P500	FTSE100(\$)	CAC40(\$)	Nikkei225(\$)	portfolio value	P/L	P/L(%)
Scenario							
427	3620.34	2663.72	872.97	1920.49	9077.52	-922.48	-9.22
429	3520.81	2767.97	940.02	1912.78	9141.58	-858.42	-8.58
424	3696.53	2779.70	929.33	1940.90	9346.46	-653.54	-6.54
415	3749.44	2860.74	947.29	1952.31	9509.78	-490.22	-4.90
482	3764.68	2898.86	955.73	1958.43	9577.71	-422.29	-4.22
...	...	...	...	...	...	...	...
485	4075.92	3088.10	1036.23	2094.66	10294.91	294.91	2.95
430	4239.95	3016.26	1029.14	2010.79	10296.14	296.14	2.96
443	4281.38	2968.02	1042.21	2071.59	10363.19	363.19	3.63
435	4046.15	3299.22	1048.38	2155.06	10548.81	548.81	5.49
434	4375.74	3036.15	1091.87	2135.60	10639.36	639.36	6.39

500 rows × 7 columns

99% 1-day VaR (Value-at-Risk) = 422.29 \$

99% 1-day ES (Expected Shortfall) = 669.39 \$

# Histogram of Profit/Loss

```
1 import matplotlib.pyplot as plt
2 plt.hist(df['P/L'], bins=range(-950, 651, 50))
```

```
(array([ 1.,  1.,  0.,  0.,  0.,  1.,  0.,  0.,  0.,  1.,  1.,
        3.,  2.,  0.,  8., 10., 27., 47., 120., 149., 80., 25.,
        8.,  9.,  4.,  0.,  1.,  0.,  0.,  1.,  0.,  1.]),
 array([-950, -900, -850, -800, -750, -700, -650, -600, -550, -500, -450,
        -400, -350, -300, -250, -200, -150, -100, -50,  0,  50, 100,
        150, 200, 250, 300, 350, 400, 450, 500, 550, 600, 650])),
<BarContainer object of 32 artists>)
```

