International Capital Markets and Investment Practice

Part 2

Risk and return on capital markets

Prof. Dr. Peter Oertmann
TUM School of Management
Technical University of Munich
peter.oertmann@tum.de

Part 2: Risk and return on capital markets

a. Brush-up: Calculating risk and return

b. Capital market returns: A long-term perspective

c. Some facts on stock market volatilities and correlations

d. Case: Analyzing 25 years of stock market returns

Part 2: Positioning in the lecture

Major fields in asset management

- Diversification
- Asset allocation
- Security selection
- Investment strategy implementation
- Risk management
- Trading and execution

Knowledge base

- **Stylized facts on global markets** – Empirical research
- **Sources of risk and return** – Models and empirical research
- **Asset pricing** – Theories, models and empirical tests
- **Portfolio construction** – Models and empirical tests
- **Financial economics** – Models and empirical research
- **Time series analysis** – Models and empirical procedures

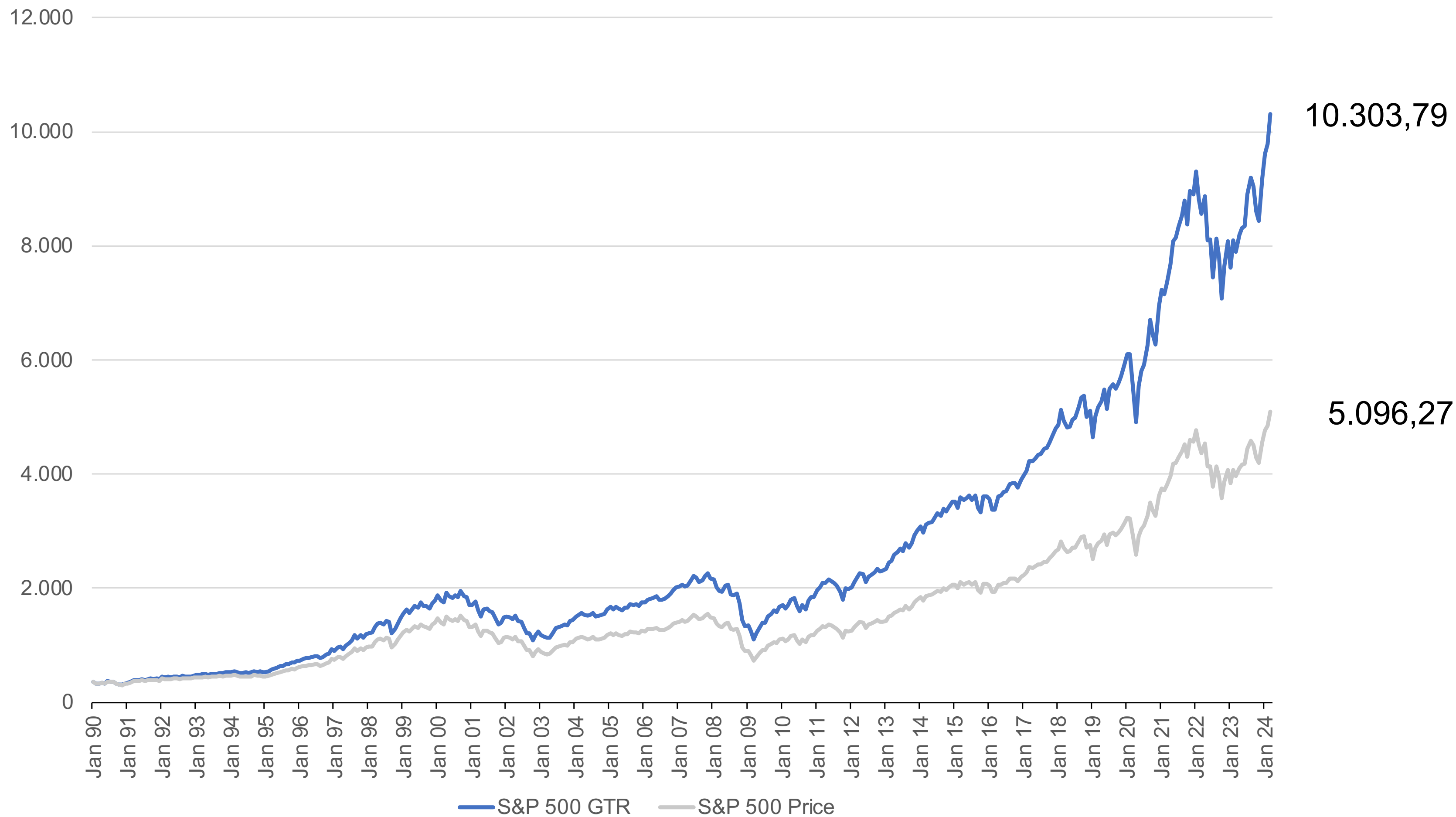
Part 2: Risk and return on capital markets

Our data: S&P 500 price and S&P 500 GTR index

	GTR	Price		GTR	Price		GTR	Price		GTR	Price		GTR	Price		GTR	Price		GTR	Price
31.12.89	379,41	353,40																		
31.01.90	353,94	329,08	31.01.95	590,64	470,42	31.01.00	1.919,84	1.394,46	31.01.05	1.755,68	1.181,27	31.01.10	1.771,40	1.073,87	31.01.15	3.656,28	1.994,99	31.01.20	6.551,00	3.225,52
28.02.90	358,50	331,89	28.02.95	613,65	487,39	29.02.00	1.883,50	1.366,42	28.02.05	1.792,63	1.203,60	28.02.10	1.826,27	1.104,49	28.02.15	3.866,42	2.104,50	29.02.20	6.011,73	2.954,22
31.03.90	368,00	339,94	31.03.95	631,76	500,71	31.03.00	2.067,76	1.498,58	31.03.05	1.760,89	1.180,59	31.03.10	1.936,48	1.169,43	31.03.15	3.805,27	2.067,89	31.03.20	5.269,20	2.584,59
30.04.90	358,82	330,80	30.04.95	650,36	514,71	30.04.00	2.005,55	1.452,43	30.04.05	1.727,49	1.156,85	30.04.10	1.967,05	1.186,69	30.04.15	3.841,78	2.085,51	30.04.20	5.944,68	2.912,43
31.05.90	393,80	361,23	31.05.95	676,36	533,40	31.05.00	1.964,40	1.420,60	31.05.05	1.782,46	1.191,50	31.05.10	1.809,98	1.089,41	31.05.15	3.891,18	2.107,39	31.05.20	6.227,81	3.044,31
30.06.90	391,14	358,02	30.06.95	692,07	544,75	30.06.00	2.012,83	1.454,60	30.06.05	1.784,99	1.191,33	30.06.10	1.715,23	1.030,71	30.06.15	3.815,85	2.063,11	30.06.20	6.351,67	3.100,29
31.07.90	389,89	356,15	31.07.95	715,02	562,06	31.07.00	1.981,36	1.430,83	31.07.05	1.851,37	1.234,18	31.07.10	1.835,40	1.101,60	31.07.15	3.895,80	2.103,84	31.07.20	6.709,81	3.271,12
31.08.90	354,65	322,56	31.08.95	716,82	561,88	31.08.00	2.104,43	1.517,68	31.08.05	1.834,48	1.220,33	31.08.10	1.752,55	1.049,33	31.08.15	3.660,75	1.972,18	31.08.20	7.192,11	3.500,31
30.09.90	337,39	306,05	30.09.95	747,07	584,41	30.09.00	1.993,33	1.436,51	30.09.05	1.849,33	1.228,81	30.09.10	1.908,95	1.141,20	30.09.15	3.570,17	1.920,03	30.09.20	6.918,84	3.363,00
31.10.90	335,95	304,00	31.10.95	744,40	581,50	31.10.00	1.984,91	1.429,40	31.10.05	1.818,50	1.207,01	31.10.10	1.981,59	1.183,26	31.10.15	3.871,33	2.079,36	31.10.20	6.734,84	3.269,96
30.11.90	357,67	322,22	30.11.95	777,07	605,37	30.11.00	1.828,42	1.314,95	30.11.05	1.887,28	1.249,48	30.11.10	1.981,84	1.180,55	30.11.15	3.882,84	2.080,41	30.11.20	7.472,06	3.621,63
31.12.90	367,63	330,22	31.12.95	792,04	615,93	31.12.00	1.837,37	1.320,28	31.12.05	1.887,94	1.248,29	31.12.10	2.114,29	1.257,64	31.12.15	3.821,60	2.043,94	31.12.20	7.759,35	3.756,07
31.01.91	383,64	343,93	31.01.96	819,00	636,02	31.01.01	1.902,55	1.366,01	31.01.06	1.937,93	1.280,09	31.01.11	2.164,40	1.286,12	31.01.16	3.631,96	1.940,24	31.01.21	7.681,01	3.714,24
28.02.91	411,08	367,07	29.02.96	826,59	640,43	28.02.01	1.729,08	1.239,94	28.02.06	1.943,19	1.280,66	28.02.11	2.238,55	1.327,22	29.02.16	3.627,06	1.932,23	28.02.21	7.892,81	3.811,15
31.03.91	421,03	375,22	31.03.96	834,55	645,50	31.03.01	1.619,54	1.160,33	31.03.06	1.967,38	1.294,83	31.03.11	2.239,44	1.325,83	31.03.16	3.873,11	2.059,74	31.03.21	8.238,48	3.972,89
30.04.91	422,03	375,35	30.04.96	846,85	654,17	30.04.01	1.745,39	1.249,46	30.04.06	1.993,79	1.310,61	30.04.11	2.305,76	1.363,61	30.04.16	3.888,13	2.065,30	30.04.21	8.678,16	4.181,17
31.05.91	440,24	389,83	31.05.96	868,69	669,12	31.05.01	1.757,09	1.255,82	31.05.06	1.936,41	1.270,09	31.05.11	2.279,66	1.345,20	31.05.16	3.957,95	2.096,96	31.05.21	8.738,77	4.204,11
30.06.91	420,07	371,16	30.06.96	872,01	670,63	30.06.01	1.714,32	1.224,42	30.06.06	1.939,03	1.270,20	30.06.11	2.241,66	1.320,64	30.06.16	3.968,21	2.098,86	30.06.21	8.942,78	4.297,50
31.07.91	439,65	387,81	31.07.96	833,48	639,95	31.07.01	1.697,45	1.211,23	31.07.06	1.951,00	1.276,66	31.07.11	2.196,08	1.292,28	31.07.16	4.114,51	2.173,60	31.07.21	9.155,21	4.395,26
31.08.91	450,06	395,43	31.08.96	851,06	651,99	31.08.01	1.591,18	1.133,58	31.08.06	1.997,42	1.303,82	31.08.11	2.076,78	1.218,89	31.08.16	4.120,29	2.170,95	31.08.21	9.433,58	4.522,68
30.09.91	442,53	387,86	30.09.96	898,97	687,31	30.09.01	1.462,69	1.040,94	30.09.06	2.048,89	1.335,85	30.09.11	1.930,79	1.131,42	30.09.16	4.121,06	2.168,27	30.09.21	8.994,83	4.307,54
31.10.91	448,48	392,46	31.10.96	923,76	705,27	31.10.01	1.490,58	1.059,78	31.10.06	2.115,65	1.377,94	31.10.11	2.141,81	1.253,30	31.10.16	4.045,89	2.126,15	31.10.21	9.625,02	4.605,38
30.11.91	430,41	375,22	30.11.96	993,58	757,02	30.11.01	1.604,92	1.139,45	30.11.06	2.155,89	1.400,63	30.11.11	2.137,08	1.246,96	30.11.16	4.195,73	2.198,81	30.11.21	9.558,33	4.567,00
31.12.91	479,63	417,09	31.12.96	973,90	740,74	31.12.01	1.618,98	1.148,08	31.12.06	2.186,13	1.418,30	31.12.11	2.158,94	1.257,61	31.12.16	4.278,66	2.238,83	31.12.21	9.986,70	4.766,18
31.01.92	470,70	408,79	31.01.97	1.034,74	786,16	31.01.02	1.595,35	1.130,21	31.01.07	2.219,19	1.438,24	31.01.12	2.255,69	1.312,41	31.01.17	4.359,82	2.278,87	31.01.22	9.469,92	4.515,55
29.02.92	476,79	412,70	28.02.97	1.042,85	790,82	28.02.02	1.564,59	1.106,73	28.02.07	2.175,78	1.406,82	29.02.12	2.353,23	1.365,68	28.02.17	4.532,93	2.363,64	28.02.22	9.186,37	4.373,94
31.03.92	467,52	403,69	31.03.97	1.000,00	757,12	31.03.02	1.623,43	1.147,39	31.03.07	2.200,12	1.420,86	31.03.12	2.430,68	1.408,47	31.03.17	4.538,21	2.362,72	31.03.22	9.527,46	4.530,41
30.04.92	481,25	414,95	30.04.97	1.059,70	801,34	30.04.02	1.525,00	1.076,92	30.04.07	2.297,58	1.482,37	30.04.12	2.415,42	1.397,91	30.04.17	4.584,82	2.384,20	30.04.22	8.696,65	4.131,93
31.05.92	483,60	415,35	31.05.97	1.124,22	848,28	31.05.02	1.513,77	1.067,14	31.05.07	2.377,75	1.530,62	31.05.12	2.270,25	1.310,33	31.05.17	4.649,34	2.411,80	31.05.22	8.712,60	4.132,15
30.06.92	476,41	408,14	30.06.97	1.174,59	885,14	30.06.02	1.405,94	989,81	30.06.07	2.338,25	1.503,35	30.06.12	2.363,79	1.362,16	30.06.17	4.678,36	2.423,41	30.06.22	7.993,43	3.785,38
31.07.92	495,87	424,21	31.07.97	1.268,05	954,29	31.07.02	1.296,34	911,62	31.07.07	2.265,75	1.455,28	31.07.12	2.396,62	1.379,32	31.07.17	4.774,56	2.470,30	31.07.22	8.730,46	4.130,29
31.08.92	485,72	414,03	31.08.97	1.197,01	899,47	31.08.02	1.304,86	916,07	31.08.07	2.299,71	1.473,99	31.08.12	2.450,60	1.406,58	31.08.17	4.789,18	2.471,65	31.08.22	8.374,42	3.955,00
30.09.92	491,43	417,80	30.09.97	1.262,56	947,28	30.09.02	1.163,04	815,28	30.09.07	2.385,72	1.526,75	30.09.12	2.513,93	1.440,67	30.09.17	4.887,97	2.519,36	30.09.22	7.603,14	3.585,62
31.10.92	493,13	418,68	31.10.97	1.220,40	914,62	31.10.02	1.265,41	885,76	31.10.07	2.423,67	1.549,38	31.10.12	2.467,51	1.412,16	31.10.17	5.002,03	2.575,26	31.10.22	8.218,71	3.871,98
30.11.92	509,92	431,35	30.11.97	1.276,89	955,40	30.11.02	1.339,89	936,31	30.11.07	2.322,34	1.481,14	30.11.12	2.481,82	1.416,18	30.11.17	5.155,44	2.647,58	30.11.22	8.678,00	4.080,11
31.12.92	516,18	435,71	31.12.97	1.298,82	970,43	31.12.02	1.261,18	879,82	31.12.07	2.306,23	1.468,36	31.12.12	2.504,44	1.426,19	31.12.17	5.212,76	2.673,61	31.12.22	8.178,02	3.839,50
31.01.93	520,49	438,78	31.01.98	1.313,19	980,28	31.01.03	1.228,14	855,70	31.01.08	2.167,90	1.378,55	31.01.13	2.634,16	1.498,11	31.01.18	5.511,21	2.823,81	31.01.23	8.691,88	4.076,60
28.02.93	527,59	443,38	28.02.98	1.407,90	1.049,34	28.02.03	1.209,71	841,15	29.02.08	2.097,48	1.330,63	28.02.13	2.669,92	1.514,68	28.02.18	5.308,09	2.713,83	28.02.23	8.479,81	3.970,15
31.03.93	538,72	451,67	31.03.98	1.480,00	1.101,75	31.03.03	1.221,46	848,18	31.03.08	2.088,42	1.322,70	31.03.13	2.770,05	1.569,19	31.03.18	5.173,19	2.640,87	31.03.23	8.791,13	4.109,31
30.04.93	525,70	440,19	30.04.98	1.494,89	1.111,75	30.04.03	1.322,07	916,92	30.04.08	2.190,13	1.385,59	30.04.13	2.823,42	1.597,57	30.04.18	5.193,04	2.648,05	28.04.23	8928,35	4169,48
31.05.93	539,76	450,19	31.05.98	1.469,19	1.090,82	31.05.03	1.391,72	963,59	31.05.08	2.218,50	1.400,38	31.05.13	2.889,46	1.630,74	31.05.18	5.318,10	2.705,27	31.05.23	8967,16	4179,83
30.06.93	541,34	450,53	30.06.98	1.528,87	1.133,84	30.06.03	1.409,48	974,50	30.06.08	2.031,47	1.280,00	30.06.13	2.850,66	1.606,28	30.06.18	5.350,83	2.718,37	30.06.23	9559,67	4450,38
31.07.93	539,16	448,13	31.07.98	1.512,59	1.120,67	31.07.03	1.434,33	990,31	31.07.08	2.014,39	1.267,38	31.07.13	2.995,72	1.685,73	31.07.18	5.549,96	2.816,29	31.07.23	9866,77	4588,96
31.08.93	559,62	463,56	31.08.98	1.293,90	957,28	31.08.03	1.462,30	1.008,01	31.08.08	2.043,53	1.282,83	31.08.13	2.908,96	1.632,97	31.08.18	5.730,80	2.901,52	31.08.23	9709,68	4507,66
30.09.93	555,33	458,93	30.09.98	1.376,79	1.017,01	30.09.03	1.446,77	995,97	30.09.08	1.861,44	1.166,36	30.09.13	3.000,18	1.681,55	30.09.18	5.763,42	2.913,98	29.09.23	9246,74	4288,05
31.10.93	566,82	467,83	31.10.98	1.488,78	1.098,67	31.10.03	1.528,62	1.050,71	31.10.08	1.548,81	968,75	31.10.13	3.138,09	1.756,54	31.10.18	5.369,49	2.711,74	31.10.23	9052,31	4193,8
30.11.93	561,41	461,79	30.11.98	1.579,02	1.163,63	30.11.03	1.542,07	1.058,20	30.11.08	1.437,68	896,24	30.11.13	3.233,72	1.805,81	30.11.18	5.478,91	2.760,17	30.11.23	9879,02	4567,8
31.12.93	568,20	466,45	31.12.98	1.670,01	1.229,23	31.12.03	1.622,94	1.111,92	31.12.08	1.452,98	903,25	31.12.13	3.315,59	1.848,36	31.12.18	4.984,22	2.506,85	29.12.23	10327,83	4769,83
31.01.94	587,52	481,61	31.01.99	1.739,84	1.279,64	31.01.04	1.652,73	1.131,13	31.01.09	1.330,51	825,88	31.01.14	3.200,95	1.782,59	31.01.19	5.383,63	2.704,10	31.01.24	10501,38	4845,65
28.02.94	571,57	467,14	28.02.99	1.685,77	1.238,33	29.02.04	1.675,70	1.144,94	28.02.09	1.188,84	735,09	28.02.14	3.347,38	1.859,45	28.02.19	5.556,49	2.784,49	29.02.24	11062,11	5096,27
31.03.94	546,65	445,77	31.03.99	1.753,21	1.286,37	31.03.04	1.650,42	1.126,21	31.03.09	1.292,98	797,87	31.03.14	3.375,51	1.872,34	31.03.19	5.664,46	2.834,40			
30.04.94	553,66	450,91	30.04.99	1.821,11	1.335,18	30.04.04	1.624,51	1.107,31	30.04.09	1.416,73	872,81	30.04.14	3.400,47	1.883,95	30.04.19	5.893,82	2.945,83			
31.05.94	562,75	456,50	31.05.99	1.778,10	1.301,84	31.05.04	1.646,80	1.120,68	31.05.09	1.495,97	919,14	31.05.14	3.480,29	1.923,57	31.05.19	5.519,27	2.752,06			
30.06.94	548,96	444,27	30.06.99	1.876,78	1.372,71	30.06.04	1.678,83	1.140,84	30.06.09	1.498,94	919,32	30.06.14	3.552,18	1.960,23	30.06.19	5.908,25	2.941,76			
31.07.94	566,98	458,26	31.07.99	1.818,18	1.328,72	31.07.04	1.623,26	1.101,72	31.07.09	1.612,31	987,48	31.07.14	3.503,19	1.930,67	31.07.19	5.993,17	2.980,38			
31.08.94	590,23	475,49	31.08.99	1.809,19	1.320,41	31.08.04	1.629,83	1.104,24	31.08.09	1.670,52	1.020,63	31.08.14	3.643,34	2.003,37	31.08.19	5.898,23	2.926,46			
30.09.94	575,80	462,69	30.09.99	1.759,59	1.282,71	30.09.04	1.647,48	1.114,58	30.09.09	1.732,86	1.057,08	30.09.14	3.592,25	1.972,29	30.09.19	6.008,59	2.976,74			
31.10.94	588,73	472,35	31.10.99	1.870,94	1.362,93	31.10.04	1.672,65	1.130,20	31.10.09	1.700,67	1.036,20	31.10.14	3.679,99	2.018,05	31.10.19	6.138,74	3.037,56			
30.11.94	567,29	453,69	30.11.99	1.908,97	1.388,91	30.11.04	1.740,33	1.173,82	30.11.09	1.802,68	1.095,63	30.11.14	3.778,96	2.067,56	30.11.19	6.361,56	3.140,98			
31.12.94	575,71	459,27	31.12.99	2.021,40	1.469,25	31.12.04	1.799,55	1.211,92	31.12.09	1.837,50	1.115,10	31.12.14	3.769,44	2.058,90	31.12.19	6.553,57	3.230,78			

Note: The S&P 500 price index is the well-known index for the US stock market. GTR stands for Gross Total Return, it is the S&P 500 with distributed dividends reinvested. Source: Bloomberg, data file: S&P500.xlsx

Performance of US equities from 1 Jan 1990 to 28 Feb 2024



→ re-investing dividends in fund (thesauriered)

Source: Bloomberg, data file: S&P500.xlsx, own calculations

Calculating returns

Time period

Return (Simple return)

$$R_{it} = \frac{P_{it} - P_{i,t-1}}{P_{i,t-1}}$$

Continuously compounded return

reinvesting

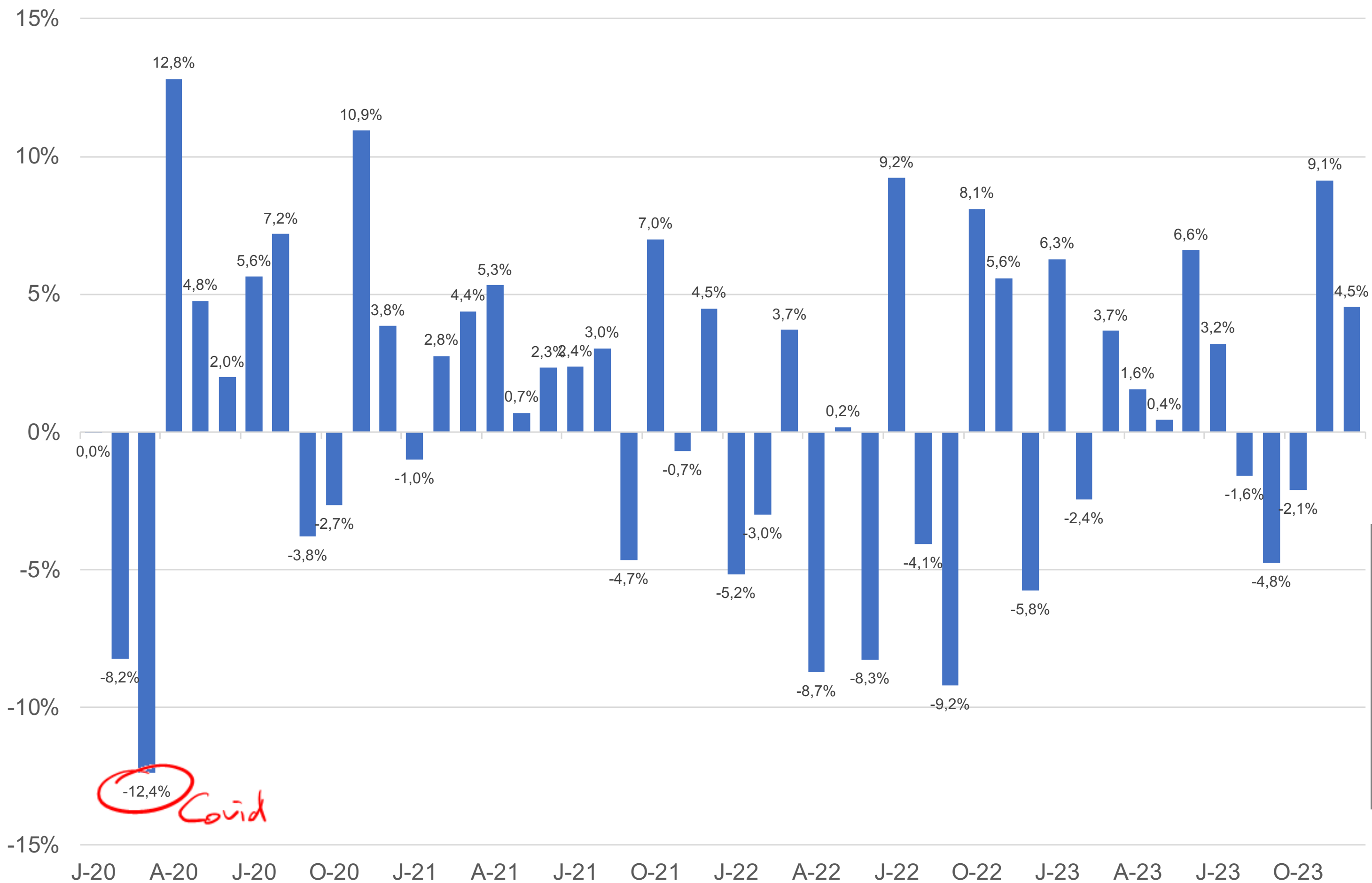
$$R_{it} = \ln\left(\frac{P_{it}}{P_{i,t-1}}\right)$$

Source: Bloomberg, data file: S&P500.xlsx, own calculations

Example: US equity market returns

	S&P 500 Price	Simple return	Log return
31.12.21	4.766,18		
31.01.22	4.515,55	-5,26%	-5,40%
28.02.22	4.373,94	-3,14%	-3,19%
31.03.22	4.530,41	3,58%	3,51%
30.04.22	4.131,93	-8,80%	-9,21%
31.05.22	4.132,15	0,01%	0,01%
30.06.22	3.785,38	-8,39%	-8,77%
31.07.22	4.130,29	9,11%	8,72%
31.08.22	3.955,00	-4,24%	-4,34%
30.09.22	3.585,62	-9,34%	-9,80%
31.10.22	3.871,98	7,99%	7,68%
30.11.22	4.080,11	5,38%	5,24%
31.12.22	3.839,50	-5,90%	-6,08%
31.01.23	4.076,60	6,18%	5,99%
28.02.23	3.970,15	-2,61%	-2,65%
31.03.23	4.109,31	3,51%	3,45%

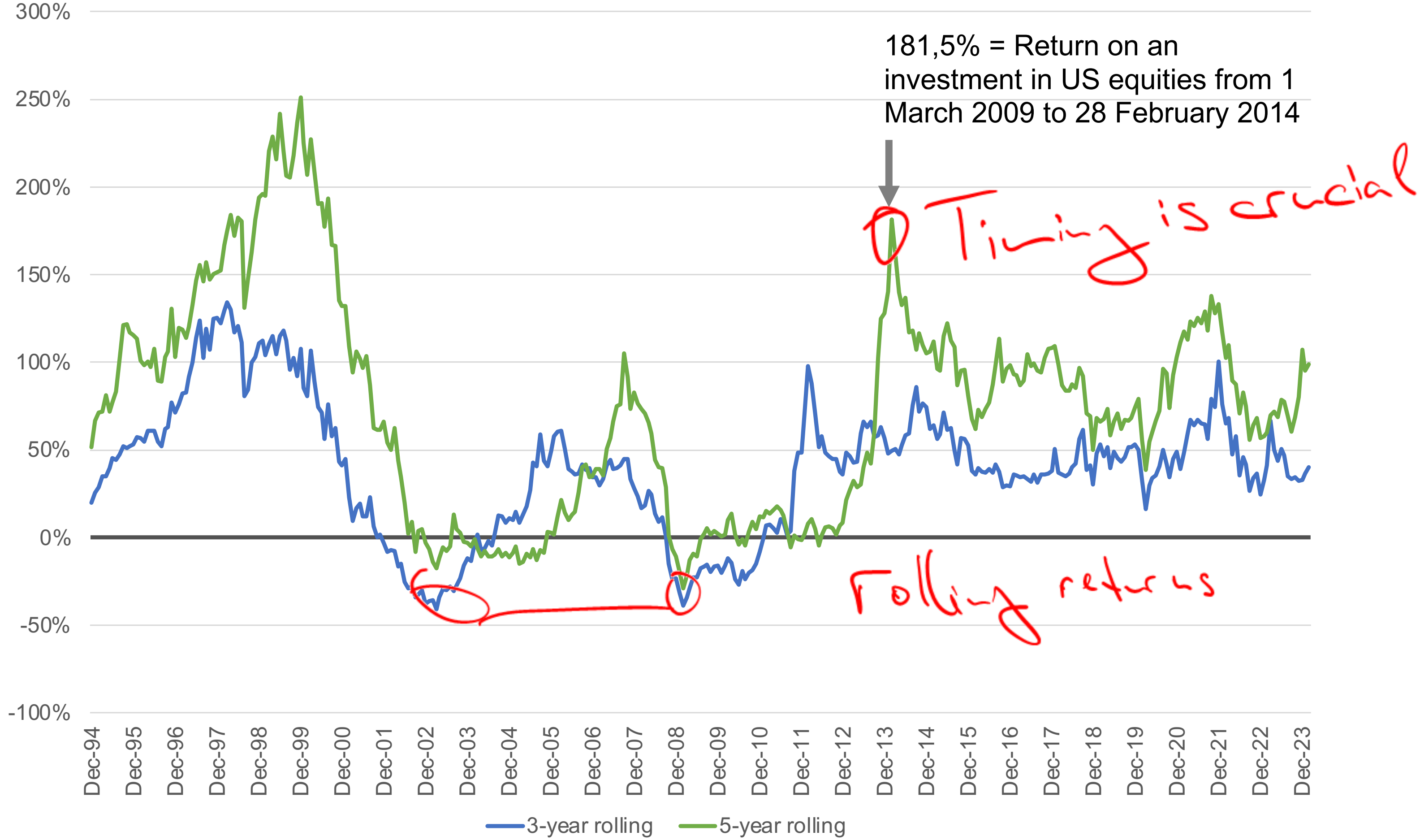
Monthly US equity market returns since 2020



	S&P 500 GTR
2020	18,40%
2021	28,71%
2022	-18,11%
2023	26,29%

Source: Bloomberg, data file: S&P500.xlsx, own calculations

Cumulative return of US equities over rolling 3- and 5-year periods



Source: Bloomberg, data file: S&P500.xlsx, own calculations

Exercise question

On 23 March 2020, shortly after the start of the Covid-19 pandemic, Apple's share price (NASDAQ: AAPL) was quoted at USD 56.09.

One year later on 23 March 2021, the price was USD 122.54.

Calculate the difference between the simple and the continuously compounded return.

simple return: $\frac{122.54 - 56.09}{56.09} = 118.47\%$

comp. return: $\ln\left(\frac{122.54}{56.09}\right) = 78.14\%$

$\Delta = 40.3\%$

Measuring investment risk

Variance of return

- Measure of dispersion
- Mean squared deviation of returns form the mean return

$$\sigma_i^2 = \text{Var}(R_i) = \frac{1}{T}\cdot\sum_{t=1}^{T}(R_{it}-\bar{R}_i)^2$$

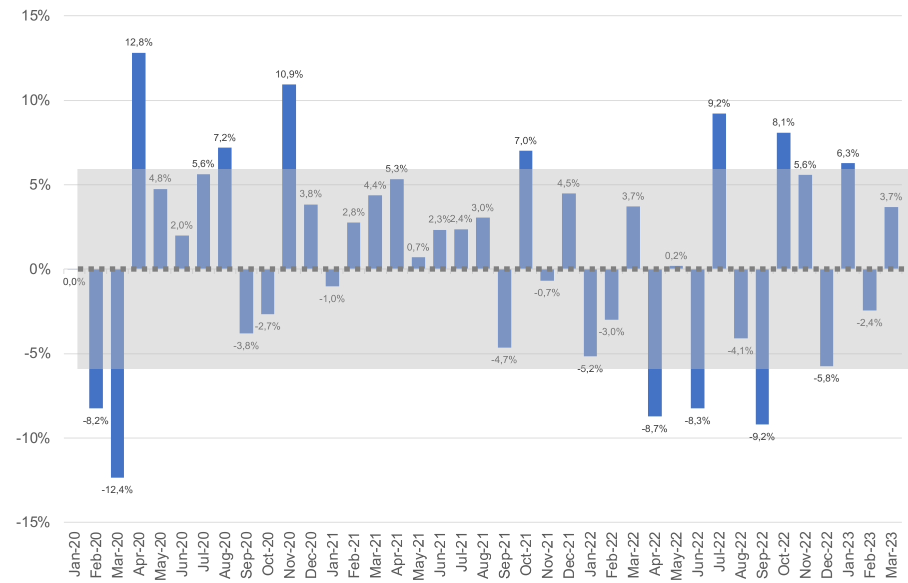
Volatility

Square root of variance

$$\sigma_i = \text{Std}(R_i) = \sqrt{\frac{1}{T}\cdot\sum_{t=1}^{T}(R_{it}-\bar{R}_i)^2}$$

Example: US equity market returns

S&P 500 GTR, Jan 2020 to Mar 2023



Volatility:
5.98 % (monthly) → 20.72 % (yearly)

↳ $5.98 \cdot \sqrt{12}$

Source: Bloomberg, data file: S&P500.xlsx, own calculations

Measuring investment risk (cont.)

Volatility from different perspectives

22 trading days in 1 month

Transformation rules

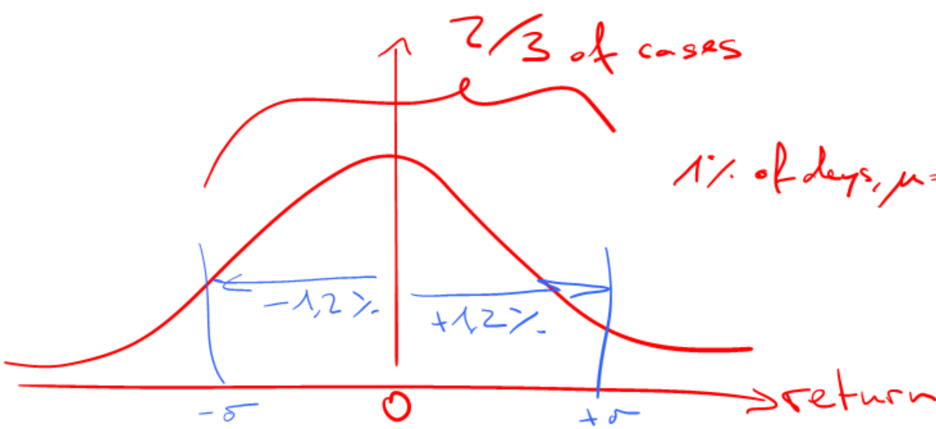
(daily volatility) × √(22 days)

= (monthly volatility)

(monthly volatility) × √(12 months)

= (yearly volatility)

Volatility = p(return of an asset ∓ mean ± σ)



1% of days, μ ∓ return →

Volatility calculations

Yearly	Monthly	Daily
100.0%	28.9%	6.2%
80.0%	23.1%	4.9%
60.0%	17.3%	3.7%
50.0%	14.4%	3.1%
40.0%	11.5%	2.5%
30.0%	8.7%	1.8%
20.0%	5.8%	1.2%
15.0%	4.3%	0.9%
10.0%	2.9%	0.6%

Emerg. Market

Dev. Market.

Exercise: Verify these calculations

	S&P 500 GTR	S&P 500 Price
Average annual return (log)	9,87%	7,81%
Average annual return	10,37%	8,12%
Return Jan 90 to Feb 24	2.815,62%	1.342,07%
Volatility	15,00%	15,01%
Mimimum monthly return	-16,79%	-16,94%
Maximum monthly return	12,82%	12,68%

Source: Bloomberg, data file: S&P500.xlsx, own calculations

Calculating portfolio returns → weighted returns of single assets

Approach

- Weighting the returns of portfolio components (single assets)
- Using simple (!) returns, not continuous returns

Two asset case

$$R_{pt} = w_1 \cdot R_{1t} + w_2 \cdot R_{2t}$$

↳ Portfolio return

Mean: $$\bar{R}_p = w_1 \cdot \bar{R}_1 + w_2 \cdot \bar{R}_2$$

↳ Mean portfolio return

N (many) asset case

$$R_{pt} = \sum_{i=1}^{N} w_i \cdot R_{it}$$

Mean: $$\bar{R}_p = \sum_{i=1}^{N} w_i \cdot \bar{R}_i$$

Measuring the risk of a portfolio

Please note

- Simple weighting of the variances / volatilities of the portfolio components is not adequate
- Return covariances have to be taken into account

Portfolio variance

2 asset case

$$\sigma_p^2 = w_1^2 \cdot \sigma_1^2 + w_2^2 \cdot \sigma_2^2 + \underbrace{2 \cdot w_1 \cdot w_2 \cdot \sigma_{12}}_{\text{Covariance}}$$

3 asset case

$$\sigma_p^2 = w_1^2 \cdot \sigma_1^2 + w_2^2 \cdot \sigma_2^2 + w_3^2 \cdot \sigma_3^2$$

$$+ \underbrace{2 \cdot w_1 \cdot w_2 \cdot \sigma_{12}}_{\text{Cov}_{1,2}} + \underbrace{2 \cdot w_1 \cdot w_3 \cdot \sigma_{13}}_{\text{Cov}_{1,3}} + \underbrace{2 \cdot w_2 \cdot w_3 \cdot \sigma_{23}}_{\text{Cov}_{2,3}}$$

Measuring the risk of a portfolio (cont.)

General formula of portfolio variance

Matrix notation

$$\sigma_p^2 = \underline{w}'\,\underline{V}\,\underline{w} = \begin{bmatrix} w_1 & w_2 & w_3 & \cdots \end{bmatrix} \begin{bmatrix} \sigma_{11} & \sigma_{12} & \sigma_{13} & \cdots \\ \sigma_{21} & \sigma_{22} & \sigma_{33} & \\ \sigma_{31} & \sigma_{32} & \sigma_{33} & \\ \vdots & & & \end{bmatrix} \begin{bmatrix} w_1 \\ w_2 \\ w_3 \\ \vdots \end{bmatrix}$$

where w portfolio weight of an asset

σ_{ii} asset variance

σ_{ij} covariance between two assets

‚Double-sum‘ notation

$$\sigma_p^2 = \sum_{i=1}^{N} \sum_{j=1}^{N} w_i \cdot w_j \cdot \sigma_{ij}$$

Measuring the risk of a portfolio (cont.)

Crucial insights

- Portfolio risk is based on the variances of its components as well as on the covariance between its components
- Covariances between the portfolio components contribute the largest part to portfolio risk

Covariances dominate

Number of ...

Assets	VAR's	COV's
2	2	2
3	3	6
4	4	12
5	5	20
10	10	90
100	100	9900
1000	1000	999000
2500	2500	6247500
x	x	z

#cov = #assets · # var − # assets

Exercise question

The volatility of the S&P500 (US stock market) is 14.29% and the volatility of the Nikkei (Japanese stock market) is 20.03%. The correlation between the two stock markets is 0.56.

Calculate the volatility of a portfolio with 40% invested in S&P500 and 60% invested in Nikkei.

$\sigma^{S\&P} = 14.29\%$ $\sigma^{N'} = 20.03\%$

$$\sigma_p^2 = 0{,}4^2 \cdot 0{,}1429^2 + 0{,}6^2 \cdot 0{,}2003^2 + 2 \cdot 0{,}4 \cdot 0{,}6 \cdot \underbrace{0{,}56 \cdot 0{,}1429 \cdot 0{,}2003}_{\text{cov}}$$

$$= 0{,}0254$$

$$\sigma = \sqrt{0{,}0254} = 0{,}1593 \leftarrow \text{Risk (aka } \sigma \text{ aka volatility)}$$

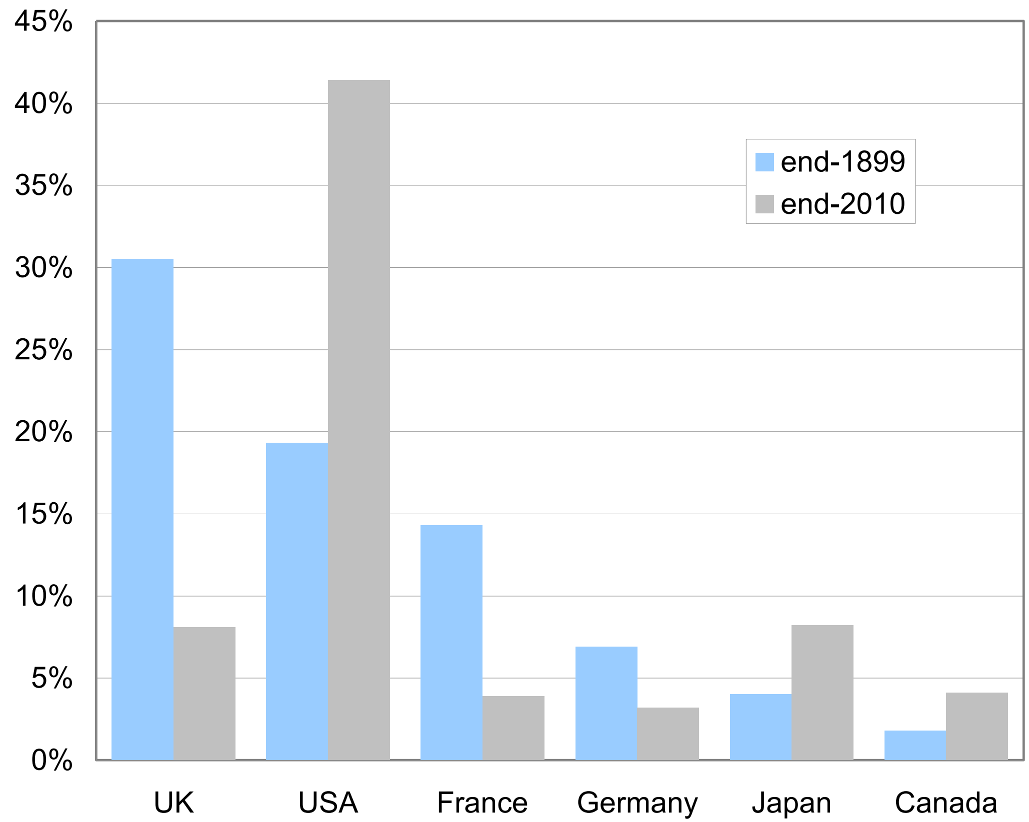
$$\text{cov}(A,B) = \text{Corr}(A,B) \cdot \text{Var}(A) \cdot \text{Var}(B)$$

Part 2: Risk and return on capital markets

Relative sizes of world stock markets

	end-1899	end-2010
UK	30,5%	8,1%
USA	19,3%	41,4%
France	14,3%	3,9%
Germany	6,9%	3,2%
Japan	4,0%	8,2%
Canada	1,8%	4,1%
Russia	3,9%	
Belgium	3,8%	
Austria-Hungary	3,5%	5,2%
Netherlands	1,6%	
Italy	1,6%	
Australia		3,4%
Switzerland		3,0%
Spain	5,1%	1,4%
Sweden		1,3%
Others	3,7%	16,8%

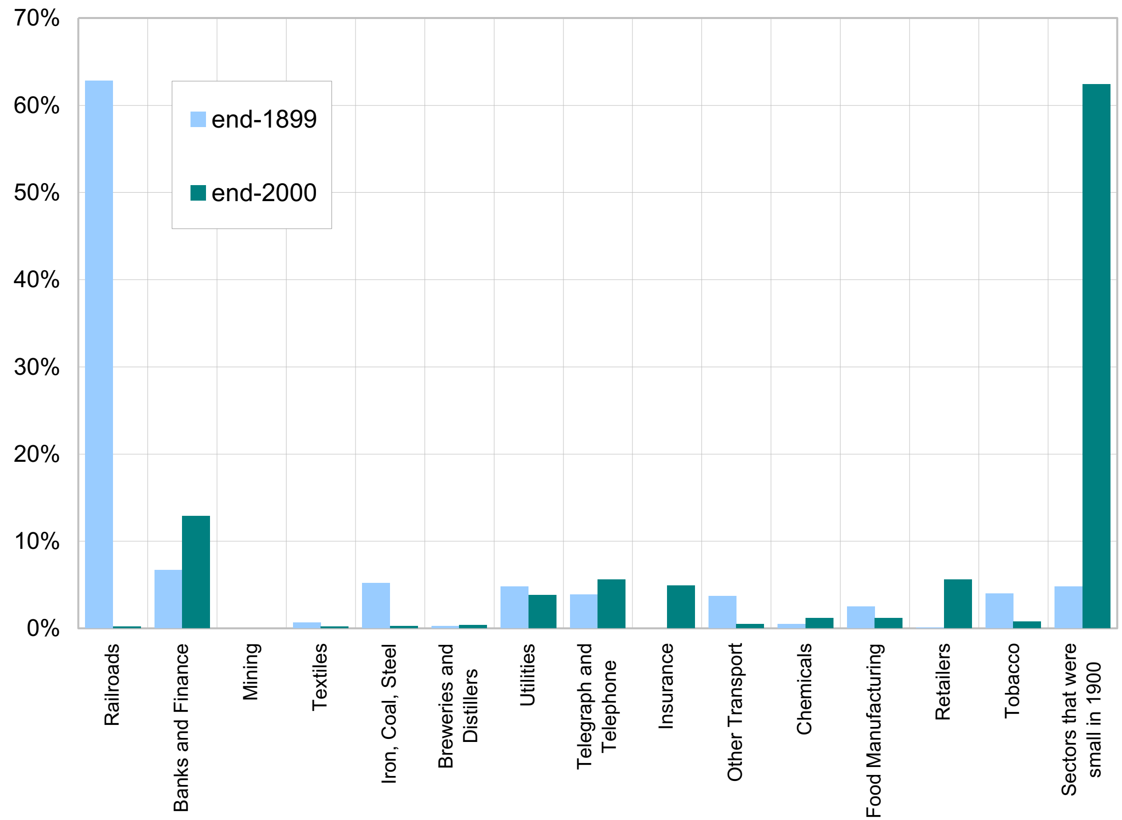
emerging markets



Data source: Elroy Dimson, Paul Marsh and Mike Staunton, Triumph of the Optimists, 2002; Credit Suisse AG, 2011; own calculations

Sector weightings within US stock market

US Sectors	**Weight**	
	end-1899	**end-2000**
Railroads	62,8%	0,2%
Banks and Finance	6,7%	12,9%
Mining	0,0%	0,0%
Textiles	0,7%	0,2%
Iron, Coal, Steel	5,2%	0,3%
Breweries and Distillers	0,3%	0,4%
Utilities	4,8%	3,8%
Telegraph and Telephone	3,9%	5,6%
Insurance	0,0%	4,9%
Other Transport	3,7%	0,5%
Chemicals	0,5%	1,2%
Food Manufacturing	2,5%	1,2%
Retailers	0,1%	5,6%
Tobacco	4,0%	0,8%
Sectors that were small in 1900	4,8%	62,4%



Data source: Elroy Dimson, Paul Marsh and Mike Staunton, Triumph of the Optimists, 2002

Returns and risk of international markets from 1900 to 2010

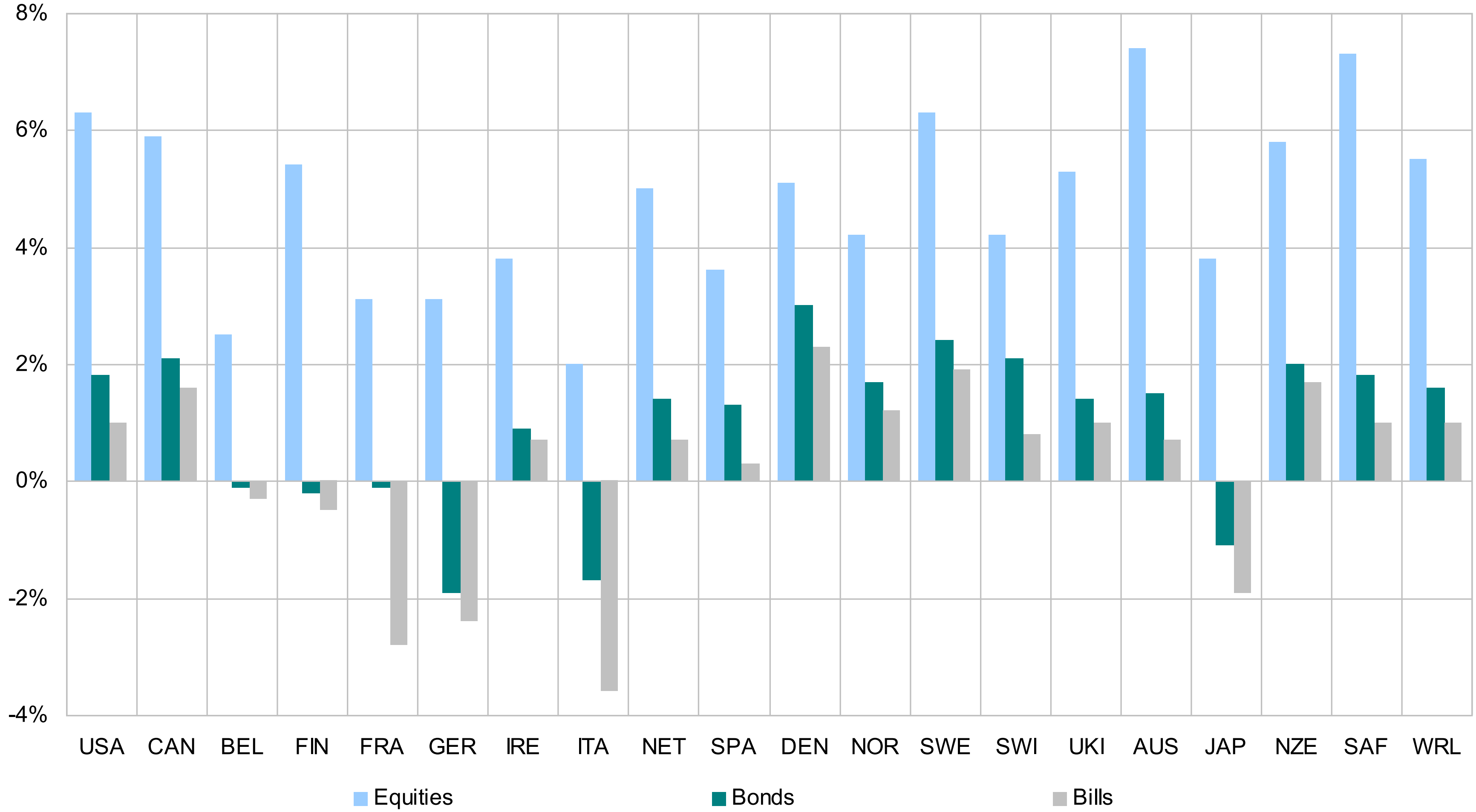
nominal returns adjusted for inflation

		Real return			Nominal return			Standard deviation		
		Equities	Bonds	Bills	Equities	Bonds	Bills	Equities	Bonds	Bills
North America										
USA	New York Stock Exchange, est. 1792	6,3%	1,8%	1,0%	9,4%	4,8%	3,9%	20,3%	10,2%	4,7%
Canada	Toronto Stock Exchange, est. 1861	5,9%	2,1%	1,6%	9,1%	5,2%	4,7%	17,2%	10,4%	4,9%
Europe (Eurozone)										
Belgium	Brussels stock exchange, est. 1801	2,5%	-0,1%	-0,3%	8,0%	5,2%	5,0%	23,6%	12,0%	8,0%
Finland	Helsinki Stock Exchange, est. 1912	5,4%	-0,2%	-0,5%	13,1%	7,1%	6,8%	30,3%	13,7%	11,9%
France	Paris stock exchange dates back to 1724	3,1%	-0,1%	-2,8%	10,5%	7,1%	4,2%	23,5%	13.0%	9,6%
Germany	German stock exchange dates back to 1685	3,1%	-1,9%	-2,4%	8,3%	2,8%	2,3%	32,2%	15,5%	13,2%
Ireland	Stock exchanges in Dublin and Cork date back to 1793	3,8%	0,9%	0,7%	8,2%	5,2%	5,0%	23,2%	14,9%	6,7%
Italy	Stock exchange in Milan dates back to 1808	2,0%	-1,7%	-3,6%	10,6%	6,7%	4,5%	29,0%	14,1%	11,5%
Netherlands	Amsterdam stock exchange dates back to 1611	5,0%	1,4%	0,7%	8,0%	4,4%	3,6%	21,8%	9,4%	5,0%
Spain	Madrid Stock Exchange, est. 1831	3,6%	1,3%	0,3%	9,6%	7,2%	6,2%	22,3%	11,8%	5,9%
Europa (Others)										
Denmark	Copenhagen Stock Exchange, est. 1808	5,1%	3,0%	2,3%	9,2%	7,1%	6,2%	20,9%	11,7%	6,0%
Norway	Oslo Stock Exchange, est. 1819	4,2%	1,7%	1,2%	8,1%	5,5%	4,9%	27,4%	12,2%	7,2%
Sweden	Stockholm Stock Exchange, est. 1863	6,3%	2,4%	1,9%	10,1%	6,1%	5,5%	22,9%	12,4%	6,8%
Switzerland	Swiss stock markets date back to 1850	4,2%	2,1%	0,8%	6,6%	4,5%	3,1%	19,8%	9,3%	5,0%
UK	Stock trading dates back to 1698	5,3%	1,4%	1,0%	9,5%	5,4%	5,0%	20,0%	13,7%	6,4%
Asia-Pacific										
Australia	Australian Securities Exchange (ASX), est. 1861	7,4%	1,5%	0,7%	11,6%	5,4%	4,6%	18,2%	13,2%	5,4%
Japan	Tokyo stock exchange, est. 1878	3,8%	-1,1%	-1,9%	11,1%	5,8%	5,0%	29,8%	20,1%	13,9%
New Zealand	New Zealand Exchange dates back to 1870	5,8%	2,0%	1,7%	9,8%	5,8%	5,5%	19,7%	9,0%	4,7%
Africa										
South Africa	Johannesburg stock exchange (JSE), est. 1887	7,3%	1,8%	1,0%	12,6%	6,8%	6,0%	22,6%	10,4%	6,2%
World	GDP-weighted indices, denominated in USD	5,5%	1,6%	1,0%	8,6%	4,7%	3,9%	17,7%	10,4%	4,7%

volatility of world

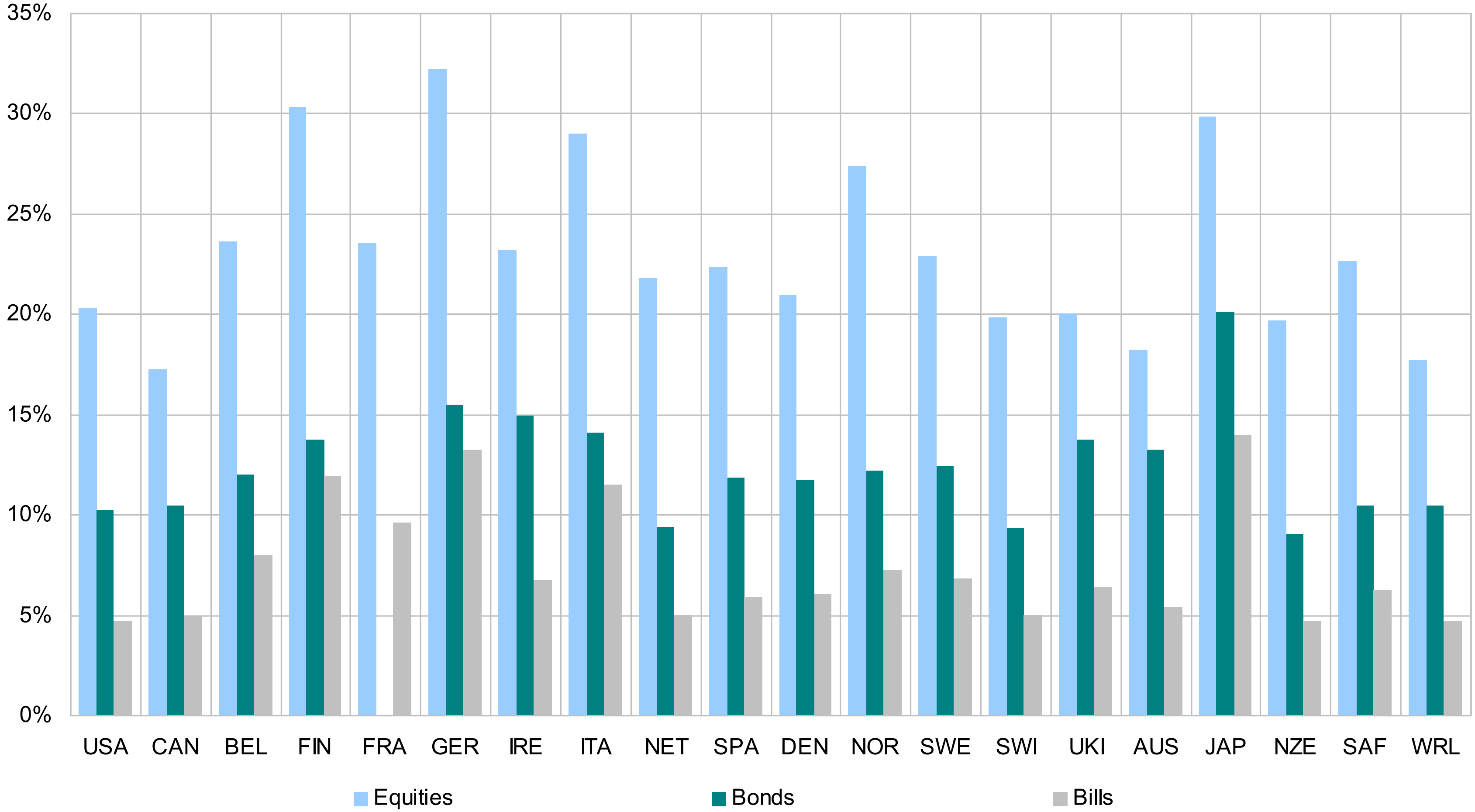
Data source: Elroy Dimson, Paul Marsh and Mike Staunton, Triumph of the Optimists, 2002; Credit Suisse AG, 2011; Wikipedia; own calculations

Real returns of international markets from 1900 to 2010



Data source: Elroy Dimson, Paul Marsh and Mike Staunton, Triumph of the Optimists, 2002; Credit Suisse AG, 2011; own calculations

Standard deviations of international markets from 1900 to 2010

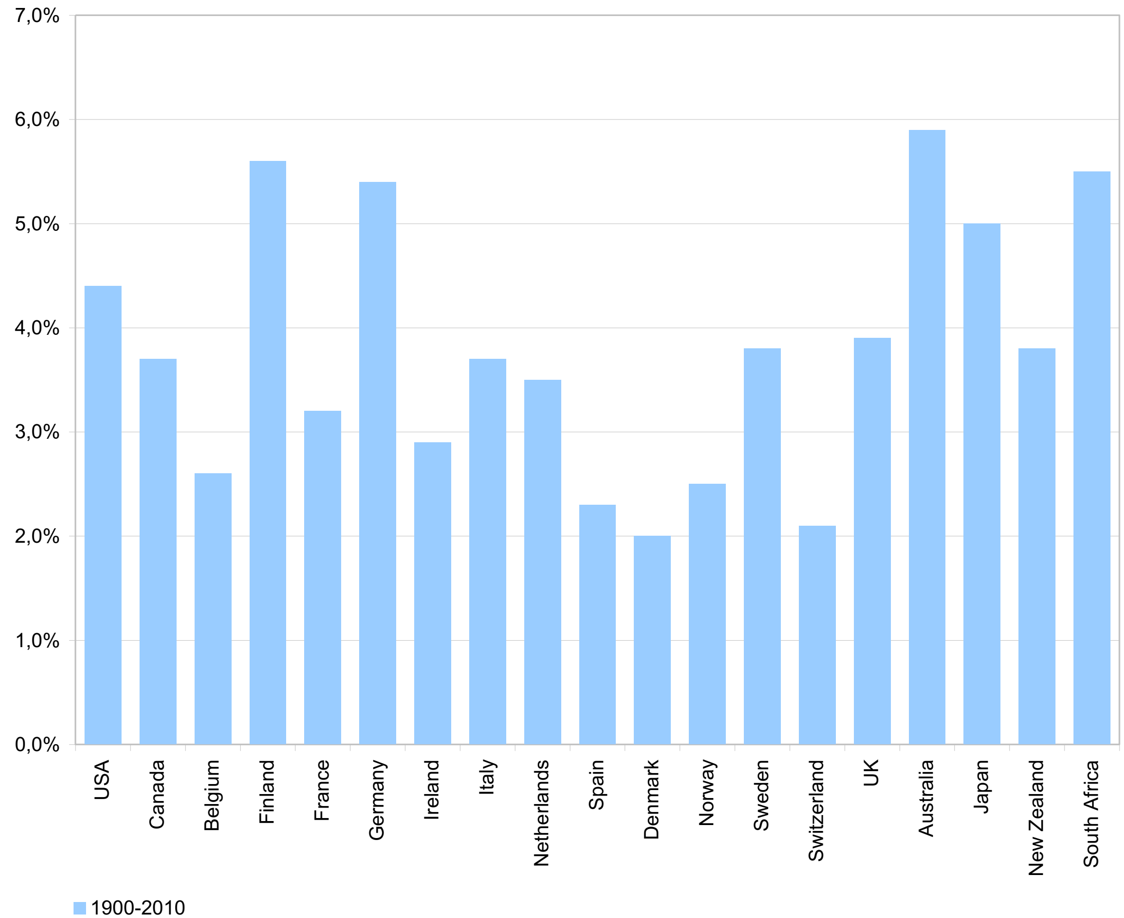


Data source: Elroy Dimson, Paul Marsh and Mike Staunton, Triumph of the Optimists, 2002; Credit Suisse AG, 2011; own calculations

= Δ equity market vs bonds market

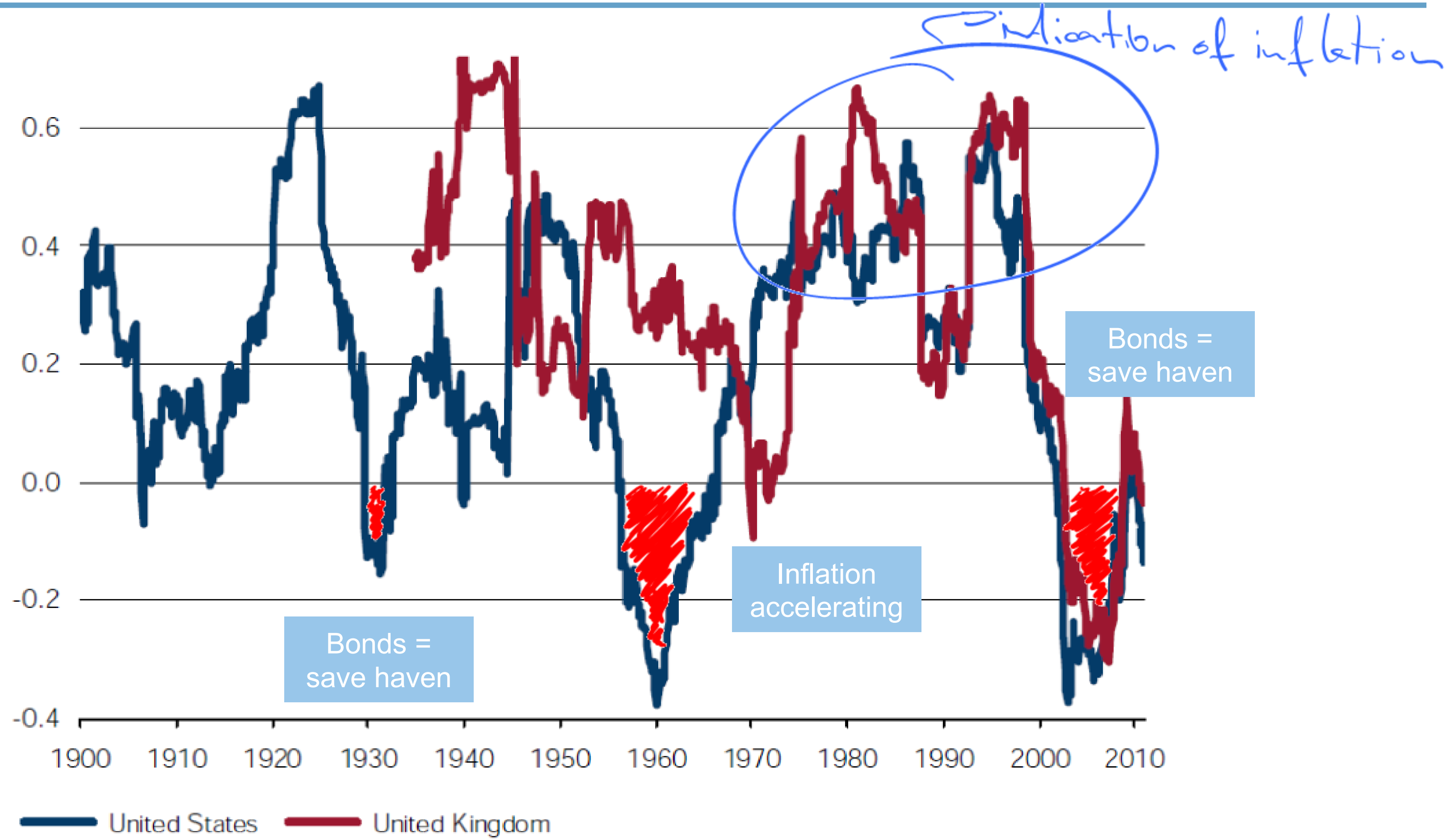
Equity risk premiums of international stock markets

	Equity risk premium vs. bonds		
	1900-2010	1961-2010	2001-2010
North America			
USA	4,4%	2,6%	-3,9%
Canada	3,7%	1,7%	-0,9%
Europe (Eurozone)			
Belgium	2,6%	1,0%	-4,7%
Finland	5,6%	4,6%	-7,3%
France	3,2%	-0,9%	-6,0%
Germany	5,4%	-0,1%	-4,3%
Ireland	2,9%	3,5%	-6,2%
Italy	3,7%	-1,9%	-7,3%
Netherlands	3,5%	3,3%	-7,1%
Spain	2,3%	3,4%	1,3%
Europa (Others)			
Denmark	2,0%	1,2%	0,9%
Norway	2,5%	2,8%	3,1%
Sweden	3,8%	4,8%	0,3%
Switzerland	2,1%	2,1%	-4,2%
UK	3,9%	3,4%	-1,3%
Asia-Pacific			
Australia	5,9%	3,5%	2,7%
Japan	5,0%	-1,4%	-5,2%
New Zealand	3,8%	2,2%	1,1%
Africa			
South Africa	5,5%	6,9%	5,8%
World	3,8%	1,2%	-4,0%



Data source: Elroy Dimson, Paul Marsh and Mike Staunton, Triumph of the Optimists, 2002; Credit Suisse AG, 2011; own calculations

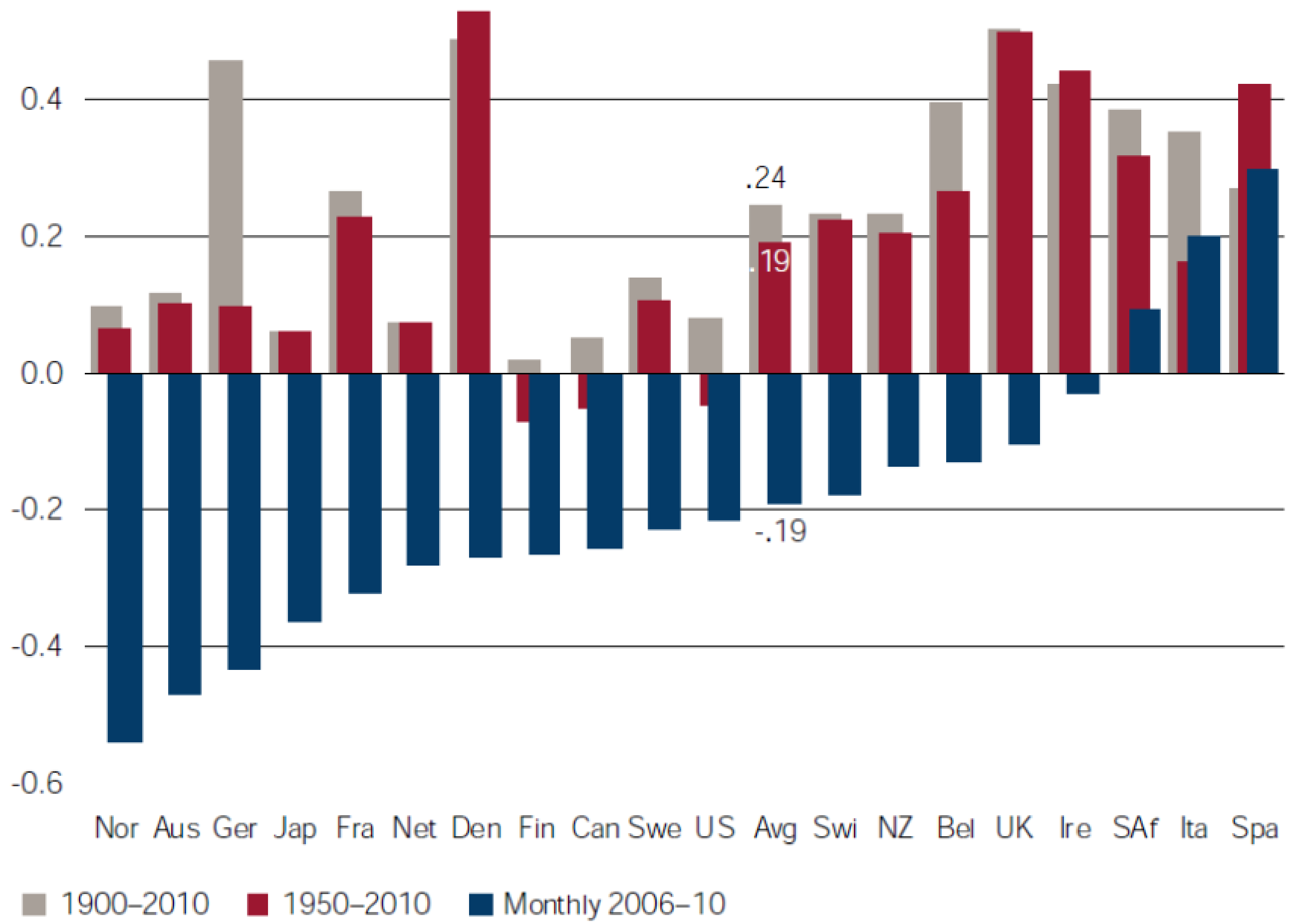
Stock-bond correlations (60-months rolling window, real returns)



→ Correlations vary over time

Data source: Credit Suisse Global Investment Returns Yearbook 2011, Credit Suisse AG

Stock-bond correlations over various time horizons for real returns



Data source: Credit Suisse Global Investment Returns Yearbook 2011, Credit Suisse AG

US stock-bond correlation until February 2024

Data source: Bloomberg, S&P 500 price index, US 10-year yield

Summary of facts

- Stock markets considerably changed since 1900
- International stock markets returned 2.5 to 7.4% on a yearly basis in real terms over the period 1900 to 2010, the return of the “world market” was 5.5%
- The long-term equity risk premium is positive, the “world market” equity risk premium is 3.8% over the period 1900 to 2010
- Over the first decade of the 21st century (2000-2010) the equity risk premium was significantly negative for many stock markets
- The average long-term correlation between stock and bond markets is positive with a coefficient of 0.24
- Bonds diversify stock portfolios, especially in times of an increased risk aversion; but inflation shocks lead to a higher co-movement between stocks and bonds
- Over the last 20 years the stock-bond correlation was predominantly negative

Part 2: Risk and return on capital markets

a. Brush-up: Calculating risk and return

b. Capital market returns: A long-term perspective

c. Some facts on stock market volatilities and correlations

d. Hands-on: Analyzing 25 years of stock market returns

→ negative correlation in times of crisis (as bond = safe)

→ positive correlation in times of inflation

A study for 13 stock markets

Research questions

- Does stock market risk depend on market conditions?
- How do volatility and correlation interact?
- Is stock market risk related to economic conditions?

	Mean (%)	SD (%)	Skewness	Kurtosis
Australia	4.3	28.9	−0.680	6.402
Austria	7.4	19.6	−1.770	14.848
Canada	5.8	22.3	0.165	7.284
France	8.9	22.8	−0.504	5.397
Germany	8.8	19.3	−0.324	4.744
Hong Kong	12.6	40.9	−0.616	5.296
Italy	8.4	22.4	−0.889	8.046
Netherlands	12.3	18.3	−0.294	3.871
Singapore	7.0	31.8	−0.527	6.079
Spain	7.2	24.0	−0.688	9.647
Switzerland	10.5	16.9	−0.659	5.564
United Kingdom	9.3	24.7	−0.638	5.820
United States	8.4	20.3	0.027	8.169
Average	8.5	24.0	−0.569	7.013

Note: The table shows descriptive statistics for monthly MSCI stock market returns over the period from 1970.01 to 1998.08. All returns are continuously compounded and denominated in Swiss francs. Means and standard deviations (SD) are reported on an annual basis.

Source: Zimmermann/Drobetz/Oertmann (2002), Chapter 3

Correlations over the sample period → corr between two markets

	Australia	Austria	Canada	France	Germany	Hong Kong	Italy	Netherlands	Singapore	Spain	Switzerland	United Kingdom	United States
Australia	1.000												
Austria	0.328	1.000											
Canada	0.411	0.500	1.000										
France	0.584	0.426	0.595	1.000									
Germany	0.282	0.469	0.351	0.382	1.000								
Hong Kong	0.175	0.359	0.369	0.328	0.334	1.000							
Italy	0.407	0.670	0.618	0.687	0.505	0.417	1.000						
Netherlands	0.282	0.558	0.375	0.373	0.620	0.371	0.535	1.000					
Singapore	0.358	0.466	0.450	0.440	0.341	0.422	0.495	0.334	1.000				
Spain	0.421	0.542	0.575	0.669	0.424	0.355	0.701	0.487	0.410	1.000			
Switzerland	0.290	0.687	0.452	0.394	0.472	0.363	0.527	0.554	0.467	0.490	1.000		
United Kingdom	0.303	0.620	0.572	0.476	0.463	0.385	0.687	0.570	0.454	0.581	0.563	1.000	
United States	0.323	0.815	0.520	0.491	0.467	0.377	0.712	0.603	0.502	0.597	0.626	0.623	1.000
Average	0.347	0.537	0.482	0.487	0.426	0.355	0.580	0.472	0.428	0.521	0.491	0.525	0.555
Ø (Average)	0.477												

Note: The table shows the correlation coefficients of monthly MSCI stock market returns over the period from 1970.01 to 1998.08. All returns are continuously compounded and denominated in Swiss francs.

Correlation and volatility

	Full Sample Volatility (%)	Up-volatility (%)	Down-volatility (%)	Number of Upstates	Number of Downstates
Australia	28.9	24.8	33.2	182	161
Austria	19.6	21.3	18.2	157	186
Canada	22.3	21.4	23.2	172	171
France	22.8	21.6	24.0	176	167
Germany	19.3	17.7	21.0	180	163
Hong Kong	40.9	36.9	45.1	179	164
Italy	22.4	20.2	24.9	192	151
Netherlands	18.3	17.4	19.2	172	171
Singapore	31.8	29.9	33.8	177	166
Spain	24.0	22.6	25.5	172	171
Switzerland	16.9	15.6	18.2	175	168
United Kingdom	24.7	23.6	26.6	185	158
United States	20.3	18.8	21.9	177	166
Average	24.0	22.4	25.8		

Down > Up ⇒ Risk increases when market goes down

Note: The table shows three volatility numbers for each stock market: Either the volatility is computed over the full sample from 1970.01 to 1998.08, for upmarkets, or for downmarkets. Up- and downmarkets are classified on the basis of whether returns are above or below their average value in a specific month. All returns are continuously compounded and denominated in Swiss francs.

Correlation and volatility

Approach of Solnik, Boucrelle, and Le Fur (1996)

- Regression of 36-month moving correlation between two countries on both countries' 36-month moving volatilities
- Using monthly innovations to correct for autocorrelation

$$\Delta\rho_{ij,t} = a + b_1 \cdot \Delta\sigma_{j,t} + b_2 \cdot \Delta\sigma_{i,t} + u_{ij,t}$$

- Setup of the moving regression

36 months → ρ, σ, σ

36 months → ρ, σ, σ

36 months → ρ, σ, σ … … … … [1970.01 to 1998.08]

Time

Correlation and volatility – regression results for the U.S. market

	Exogenous Variables b_1				
	Volatility (U.S.)	*t*-value	Volatility (Non-U.S.) b_2	*t*-value	Adjusted R^2
Australia	4.758	4.481	3.713	7.767	0.513
Austria	6.803	7.598	0.322	0.360	0.165
Canada	2.937	4.375	1.365	2.305	0.287
France	6.576	7.228	2.295	2.727	0.239
Germany	5.918	6.480	5.635	5.139	0.312
Hong Kong	2.752	1.651	0.366	0.605	0.019
Italy	4.742	4.682	4.602	4.037	0.134
Netherlands	1.366	1.893	6.220	8.440	0.377
Singapore	3.667	3.260	2.779	5.239	0.274
Spain	5.550	6.223	3.368	4.464	0.238
Switzerland	3.636	3.859	7.627	7.175	0.354
United Kingdom	4.135	5.555	3.990	8.026	0.401

Note: The changes of the correlation coefficients between the United States stock market and other MSCI markets are regressed on a constant and the innovations in the associated national volatility. Monthly MSCI stock market returns over the period from 1970.01 to 1998.08 are used. All are denominated is Swiss francs.

→ increas of volatility here increases correlation to US markets

} if the risk in a market increases ⇒ the correlation between other markets also increases

Correlation and volatility – regression results for the Swiss market

	Exogenous Variables				
	Volatility (Swiss)	*t*-value	Volatility (Non-Swiss)	*t*-value	Adjusted R^2
Australia	8.451	7.408	4.423	9.713	0.575
Austria	6.635	7.509	1.911	2.439	0.200
Canada	6.916	6.367	5.162	6.101	0.381
France	9.0126	8.542	2.460	2.844	0.349
Germany	5.864	5.482	3.425	3.008	0.276
Hong Kong	12.474	8.301	0.584	1.205	0.284
Italy	6.444	5.775	6.279	5.640	0.209
Netherlands	6.561	6.643	3.567	3.990	0.447
Singapore	11.410	7.909	2.819	4.676	0.454
Spain	8.131	7.398	2.618	3.176	0.242
United Kingdom	5.310	4.722	5.569	8.366	0.454
United States	7.627	7.175	3.636	3.859	0.354

Note: The changes of the correlation coefficients between the Swiss stock market and other MSCI markets are regressed on a constant and the innovations in the associated national volatility. Monthly MSCI stock market returns over the period from 1970.01 to 1998.08 are used. All are denominated is Swiss francs.

down-down

Semi-correlations – “up-up” vs. “down-down”

	Australia	Austria	Canada	France	Germany	Hong Kong	Italy	Netherlands	Singapore	Spain	Switzerland	United Kingdom	United States	Average	Ø (Average)
Australia		0.290	0.714	0.595	0.531	0.560	0.307	0.678	0.573	0.477	0.214	0.536	0.671	0.548	0.512
Austria	0.063		0.278	0.439	0.626	0.240	0.384	0.329	0.463	0.443	0.230	0.242	0.337	0.494	
Canada	0.372	0.030		0.470	0.473	0.532	0.375	0.646	0.523	0.420	0.180	0.578	0.742	0.509	
France	0.179	0.047	0.129		0.613	0.477	0.221	0.649	0.563	0.457	0.396	0.481	0.541	0.505	
Germany	−0.015	0.265	0.057	0.349		0.495	0.341	0.657	0.598	0.535	0.448	0.495	0.555	0.507	
Hong Kong	0.243	−0.089	0.391	0.004	0.101		0.453	0.573	0.646	0.368	0.211	0.425	0.530	0.498	
Italy	0.177	0.127	0.092	0.299	0.054	0.044		0.381	0.333	0.334	0.203	0.252	0.380	0.485	
Netherlands	0.160	0.175	0.364	0.385	0.333	0.425	0.063		0.498	0.361	0.388	0.595	0.652	0.510	
Singapore	0.215	−0.020	0.319	0.299	0.053	0.505	0.175	0.236		0.477	0.376	0.496	0.656	0.498	
Spain	0.145	0.336	0.243	0.156	0.232	0.018	0.243	0.216	−0.020		0.121	0.317	0.442	0.481	
Switzerland	0.582	0.437	0.608	0.562	0.683	0.508	0.379	0.707	0.609	0.401		0.582	0.611	0.556	
United Kingdom	0.357	−0.016	0.382	0.382	0.116	0.367	0.106	0.380	0.484	0.034	0.361		0.601	0.509	
United States	0.251	0.116	0.617	0.175	0.060	0.150	−0.013	0.261	0.267	0.256	0.223	0.224		0.560	
Average	0.187	0.105	0.265	0.233	0.171	0.198	0.131	0.282	0.241	0.165	0.279	0.265	0.216		
Ø (Average)	0.211														

Note: The table reports the semi-correlations of monthly MSCI stock market returns over the period from 1970.01 to 1998.08. All returns are continuously compounded and denominated in Swiss francs. Up-up (both markets experience returns above their averages) correlations are shown on the left-hand side of the diagonal, down-down (both markets experience returns below their averages) correlations on the right-hand side.

up-up

recession

Correlations during expansions and recessions

	Australia	Austria	Canada	France	Germany	Hong Kong	Italy	Netherlands	Singapore	Spain	Switzerland	United Kingdom	United States	Average	Ø (Average)
Australia		0.323	0.705	0.591	0.460	0.492	0.326	0.601	0.525	0.544	0.437	0.584	0.690	0.576	0.577
Austria	0.262		0.388	0.558	0.743	0.404	0.596	0.423	0.538	0.651	0.349	0.343	0.456	0.556	
Canada	0.668	0.297		0.589	0.441	0.515	0.363	0.680	0.567	0.521	0.503	0.653	0.781	0.565	
France	0.391	0.357	0.462		0.661	0.545	0.500	0.664	0.621	0.614	0.521	0.596	0.570	0.570	
Germany	0.359	0.508	0.417	0.570		0.422	0.583	0.669	0.538	0.624	0.636	0.564	0.521	0.565	
Hong Kong	0.434	0.241	0.427	0.240	0.319		0.473	0.587	0.745	0.449	0.339	0.644	0.549	0.562	
Italy	0.374	0.066	0.371	0.320	0.255	0.279		0.476	0.507	0.705	0.311	0.429	0.415	0.567	
Netherlands	0.494	0.404	0.643	0.598	0.681	0.426	0.397		0.623	0.516	0.648	0.778	0.673	0.588	
Singapore	0.518	0.204	0.524	0.263	0.300	0.559	0.353	0.448		0.413	0.385	0.715	0.661	0.584	
Spain	0.436	0.280	0.450	0.408	0.386	0.300	0.341	0.478	0.299		0.354	0.436	0.522	0.576	
Switzerland	0.553	0.559	0.605	0.721	0.719	0.489	0.505	0.801	0.630	0.538		0.650	0.634	0.617	
United Kingdom	0.541	0.293	0.589	0.557	0.440	0.356	0.373	0.636	0.479	0.456	0.537		0.602	0.586	
United States	0.587	0.269	0.823	0.486	0.474	0.412	0.363	0.699	0.540	0.484	0.566	0.617		0.590	
Average	0.463	0.410	0.442	0.436	0.432	0.420	0.425	0.461	0.444	0.459	0.465	0.503	0.527		
Ø (Average)	0.453														

Note: The table reports the correlations of monthly MSCI stock market returns over the period from 1970.01 to 1998.08 through business cycles. All returns are continuously compounded and denominated in Swiss francs. The dating of the business cycle is taken from the National Bureau of Economic Research (NBER). Expansion correlations are shown to the left of the diagonal and recession correlations on the right-hand side.

expansion

Summing up

Most important findings

- Stock market volatility is higher when markets go down
- In periods of high volatility, stock markets become more correlated – and in periods of low volatility, they are less correlated
- Higher correlations are detected when equity markets go down simultaneously, as well as when real economic activity is shrinking

Implications for investors

- Optimal portfolios are unstable because market parameters are time-varying
- Bad news lead to higher volatility than good news
- International diversification benefits seem to vanish in exactly those market environments when they are most strongly needed (down-down > up-up)
- Widely used portfolio risk measures such as VaR, or shortfall, are affected by asymmetric parameters

Part 2: Risk and return on capital markets

a. Brush-up: Calculating risk and return
b. Capital market returns: A long-term perspective
c. Some facts on stock market volatilities and correlations
d. Case: Analyzing 25 years of stock market returns

Introduction into the case

- As a researcher in an asset management company, you have the task to analyze the long-term evolution of international equity markets, i.e.
  - Average returns
  - Volatilities
  - Long-term correlations between markets
  - Correlation regimes

- Your data set (Case1.xlsx) includes 16 stock market indices in local currencies covering developed markets in North America, Europe and Asia-Pacific
  - Monthly stock market data starting on December 31, 1992, and ending on February 28, 2018
  - Indexed to ”100” at the beginning of the period

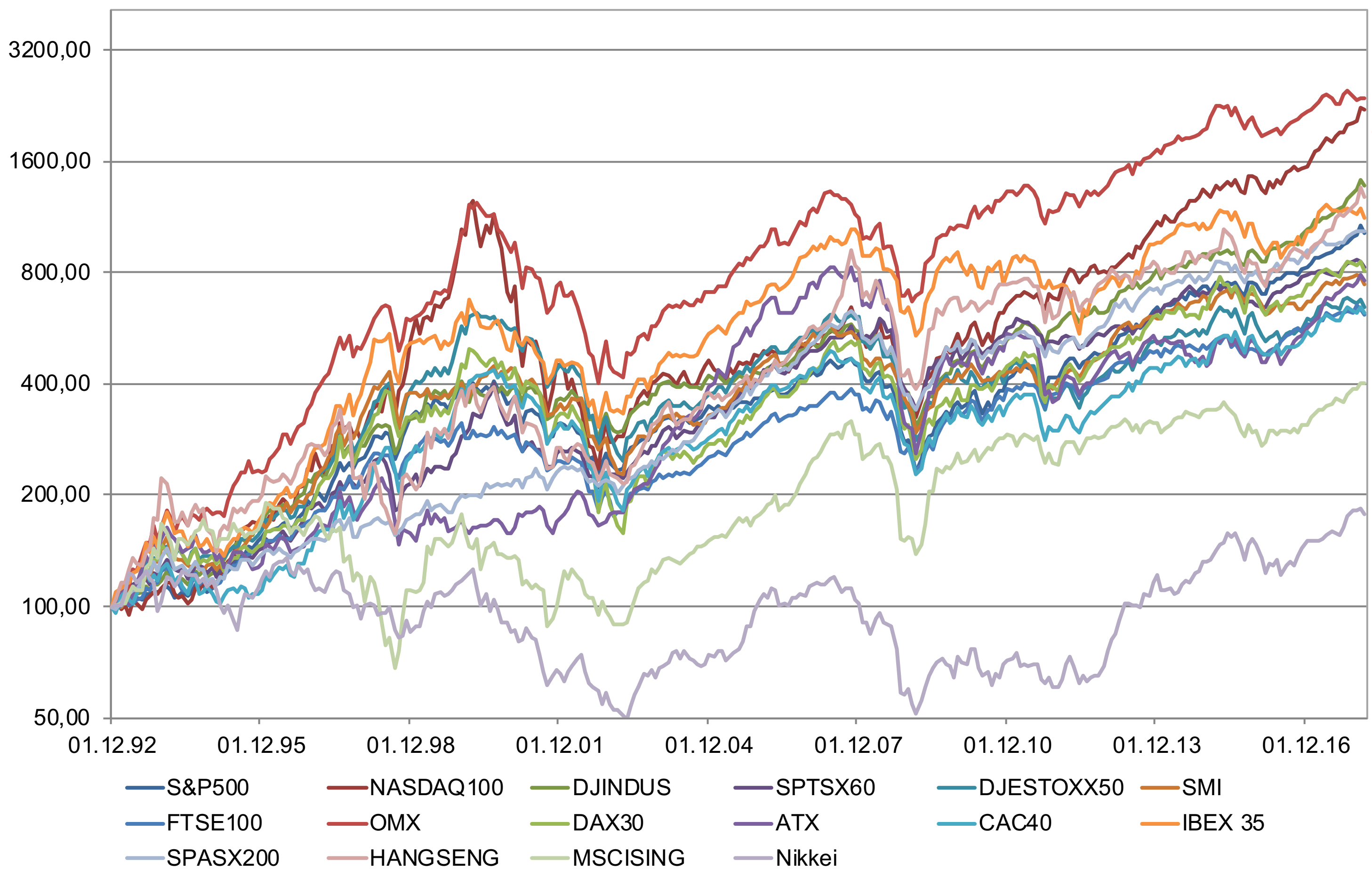
Stock market indices (Case1.xls)

	12/31/92	01/31/93	...	02/28/18
S&P500	100,00	100,84	...	1028,34
NASDAQ100	100,00	102,94	...	2201,10
DJINDUS	100,00	100,34	...	1366,59
SPTSX60	100,00	98,34	...	825,99
DJESTOXX50	100,00	101,03	...	645,70
SMI	100,00	99,25	...	745,06
FTSE100	100,00	98,78	...	617,50
OMX	100,00	96,93	...	2356,90
DAX30	100,00	101,73	...	804,88
ATX	100,00	103,17	...	760,85
CAC40	100,00	95,43	...	624,97
IBEX 35	100,00	108,99	...	1127,30
SPASX200	100,00	98,20	...	1038,61
HANGSENG	100,00	104,36	...	1282,95
MSCISING	100,00	101,01	...	399,27
Nikkei	100,00	100,59	...	176,77

Tasks

1. Display the long-term performance of the equity markets
2. Calculate mean returns and volatilities over the total period
3. Calculate yearly returns for the stock markets
4. Calculate the correlations between the markets over the period 1993-2017
5. Calculate the correlations for five sub-periods
   - 1993-1997
   - 1998-2002
   - 2003-2007
   - 2008-2012
   - 2013-2017
6. Analyze the correlation regimes

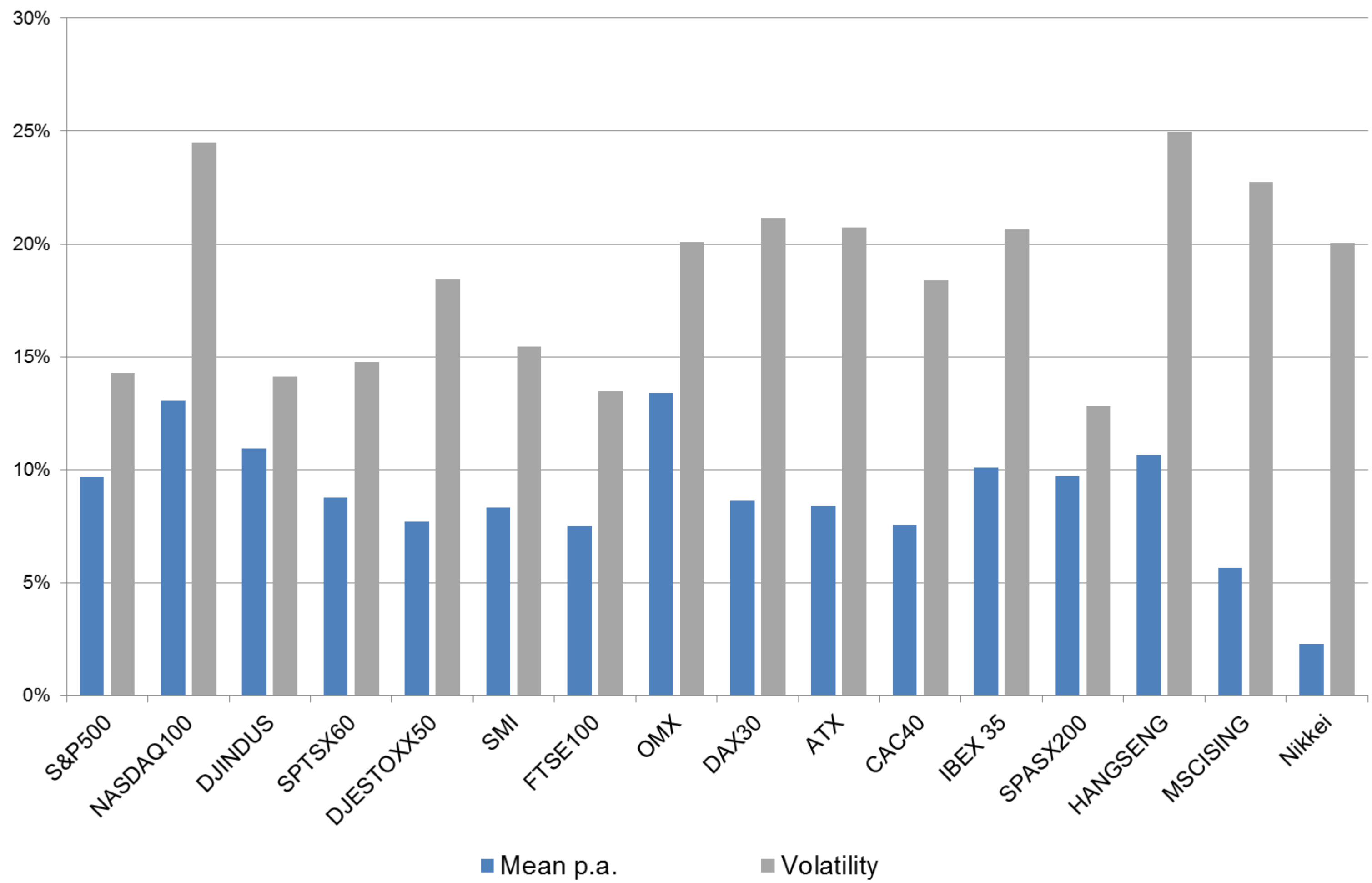
International stock markets: Long-term performance



Asset pricing model
(why are the returns so different?)

Source: Case1.xlsx data, own calculations

International stock markets: Mean returns and volatilities



Source: Case1.xlsx data, own calculations

International stock markets: Yearly returns

	North America				Europe								Asia & Pacific			
	USA			Canada	Europe	Switzerland	UK	Sweden	Germany	Austria	France	Spain	Australia	Hong Kong	Singapore	Japan
	S&P500	NASDAQ100	DJINDUS	SPTSX60	DJESTOXX50	SMI	FTSE100	OMX	DAX30	ATX	CAC40	IBEX 35	SPASX200	HANGSENG	MSCI	Nikkei
Full	9,7%	13,1%	10,9%	8,8%	7,7%	8,3%	7,5%	13,4%	8,6%	8,4%	7,6%	10,1%	9,7%	10,7%	5,7%	2,3%
1993	10,1%	11,8%	16,9%	26,5%	43,6%	43,3%	25,2%	62,6%	46,7%	52,4%	26,1%	61,2%	35,1%	123,1%	68,1%	3,0%
1994	1,3%	1,8%	5,0%	0,2%	-5,0%	-9,3%	-6,5%	8,9%	-7,1%	-6,3%	-14,4%	-11,7%	-12,1%	-29,9%	-5,1%	13,6%
1995	37,6%	43,1%	36,9%	12,9%	18,0%	27,9%	26,0%	30,0%	7,3%	-8,8%	2,8%	22,6%	16,0%	27,3%	7,7%	1,5%
1996	23,0%	42,8%	28,7%	28,4%	26,5%	21,6%	16,9%	53,9%	27,8%	19,6%	27,6%	47,2%	9,9%	37,6%	-1,8%	-1,9%
1997	33,4%	20,8%	24,9%	17,6%	40,1%	60,9%	28,7%	39,9%	47,1%	15,4%	33,0%	44,7%	8,4%	-17,5%	-29,2%	-20,5%
1998	28,6%	85,5%	18,1%	-0,3%	34,9%	15,7%	17,5%	19,1%	17,7%	-12,5%	34,1%	38,5%	5,9%	-2,7%	-7,3%	-8,5%
1999	21,0%	102,1%	27,2%	34,1%	48,6%	7,1%	20,6%	73,7%	39,1%	9,4%	54,1%	20,4%	14,7%	74,1%	60,5%	37,9%
2000	-9,1%	-36,8%	-4,8%	7,9%	-1,7%	9,3%	-8,2%	-10,9%	-7,5%	-8,1%	1,0%	-20,6%	6,1%	-9,1%	-23,8%	-26,7%
2001	-11,9%	-32,6%	-5,4%	-14,9%	-19,1%	-20,2%	-14,1%	-18,1%	-19,8%	9,4%	-20,3%	-6,1%	11,4%	-22,4%	-17,8%	-22,9%
2002	-22,1%	-37,5%	-15,0%	-14,0%	-36,1%	-27,1%	-22,2%	-40,5%	-43,9%	3,2%	-31,9%	-26,5%	-7,8%	-15,6%	-15,9%	-17,9%
2003	28,7%	49,4%	28,3%	25,5%	18,4%	20,9%	17,9%	33,1%	37,1%	37,1%	19,9%	32,6%	16,0%	41,2%	35,7%	25,7%
2004	10,9%	10,7%	5,3%	13,8%	9,4%	5,4%	11,2%	19,7%	7,3%	60,4%	11,4%	21,3%	29,5%	17,1%	18,5%	8,6%
2005	4,9%	1,9%	1,7%	26,3%	24,3%	35,9%	20,8%	33,2%	27,1%	53,4%	26,6%	22,1%	24,1%	8,4%	17,4%	41,8%
2006	15,8%	7,2%	19,0%	19,1%	18,0%	18,2%	14,4%	22,8%	22,0%	24,0%	20,9%	36,3%	25,5%	39,0%	36,2%	8,1%
2007	5,5%	19,2%	8,9%	11,1%	9,6%	-1,4%	7,4%	-3,1%	22,3%	3,1%	4,2%	10,8%	17,4%	43,4%	20,8%	-10,0%
2008	-37,0%	-41,6%	-31,9%	-31,2%	-42,4%	-33,0%	-28,3%	-36,3%	-40,4%	-60,2%	-40,3%	-36,2%	-37,5%	-46,4%	-47,3%	-41,1%
2009	26,5%	54,6%	22,7%	31,9%	25,6%	22,1%	27,3%	49,2%	23,8%	48,7%	27,6%	41,3%	39,1%	56,7%	69,6%	21,1%
2010	15,1%	20,1%	14,1%	13,8%	-2,8%	1,2%	12,6%	24,8%	16,1%	19,8%	0,6%	-12,7%	2,9%	8,6%	11,5%	-1,3%
2011	2,1%	3,6%	8,4%	-9,1%	-14,1%	-4,6%	-2,2%	-11,7%	-14,7%	-33,1%	-13,4%	-7,3%	-9,2%	-17,4%	-16,9%	-15,6%
2012	16,0%	18,3%	10,2%	8,1%	18,1%	19,1%	10,0%	16,3%	29,1%	30,5%	20,4%	2,2%	22,2%	27,4%	23,4%	25,6%
2013	32,4%	36,9%	29,7%	13,3%	21,5%	23,9%	18,7%	25,3%	25,5%	8,7%	22,2%	27,6%	22,0%	6,6%	5,1%	59,4%
2014	13,7%	19,4%	10,0%	12,3%	4,0%	12,9%	0,7%	13,8%	2,7%	-13,1%	2,7%	8,5%	7,1%	5,3%	8,2%	9,0%
2015	1,4%	9,8%	0,2%	-7,8%	6,4%	1,1%	-1,3%	2,1%	9,6%	12,9%	11,9%	-3,7%	4,2%	-3,9%	-11,9%	11,0%
2016	12,0%	7,3%	16,5%	21,4%	3,7%	-3,4%	19,1%	9,3%	6,9%	11,1%	8,9%	2,5%	13,4%	4,3%	3,3%	2,4%
2017	21,8%	33,0%	28,1%	9,8%	9,2%	17,9%	11,9%	7,7%	12,5%	32,8%	12,7%	11,3%	13,4%	41,3%	25,5%	21,3%

Source: Case1.xlsx data, own calculations

International stock markets: Correlations 1993-2017

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1 S&P500		0,82	0,95	0,77	0,79	0,69	0,79	0,70	0,76	0,62	0,75	0,68	0,69	0,64	0,63	0,56
2 NASDAQ100	0,82		0,70	0,68	0,66	0,48	0,63	0,66	0,65	0,40	0,63	0,60	0,55	0,56	0,52	0,47
3 DJINDUS	0,95	0,70		0,71	0,75	0,69	0,77	0,67	0,73	0,61	0,71	0,65	0,66	0,64	0,66	0,52
4 SPTSX60	0,77	0,68	0,71		0,66	0,57	0,68	0,61	0,62	0,63	0,65	0,59	0,64	0,64	0,59	0,50
5 DJESTOXX50	0,79	0,66	0,75	0,66		0,77	0,82	0,82	0,94	0,68	0,96	0,84	0,67	0,57	0,56	0,54
6 SMI	0,69	0,48	0,69	0,57	0,77		0,71	0,66	0,72	0,60	0,74	0,67	0,58	0,47	0,48	0,47
7 FTSE100	0,79	0,63	0,77	0,68	0,82	0,71		0,70	0,76	0,68	0,80	0,71	0,70	0,62	0,59	0,48
8 OMX	0,70	0,66	0,67	0,61	0,82	0,66	0,70		0,79	0,57	0,78	0,73	0,62	0,58	0,54	0,53
9 DAX30	0,76	0,65	0,73	0,62	0,94	0,72	0,76	0,79		0,65	0,88	0,74	0,63	0,56	0,56	0,51
10 ATX	0,62	0,40	0,61	0,63	0,68	0,60	0,68	0,57	0,65		0,66	0,62	0,66	0,57	0,56	0,50
11 CAC40	0,75	0,63	0,71	0,65	0,96	0,74	0,80	0,78	0,88	0,66		0,79	0,64	0,53	0,52	0,52
12 IBEX 35	0,68	0,60	0,65	0,59	0,84	0,67	0,71	0,73	0,74	0,62	0,79		0,62	0,56	0,52	0,51
13 SPASX200	0,69	0,55	0,66	0,64	0,67	0,58	0,70	0,62	0,63	0,66	0,64	0,62		0,63	0,62	0,58
14 HANGSENG	0,64	0,56	0,64	0,64	0,57	0,47	0,62	0,58	0,56	0,57	0,53	0,56	0,63		0,77	0,44
15 MSCISING	0,63	0,52	0,66	0,59	0,56	0,48	0,59	0,54	0,56	0,56	0,52	0,52	0,62	0,77		0,46
16 Nikkei	0,56	0,47	0,52	0,50	0,54	0,47	0,48	0,53	0,51	0,50	0,52	0,51	0,58	0,44	0,46	
Average	0,72	0,60	0,70	0,64	0,73	0,62	0,69	0,66	0,70	0,60	0,71	0,66	0,63	0,59	0,57	0,51
Overall average	**0,65**															

Source: Case1.xlsx data, own calculations

International stock markets: Correlations 1993-1997

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1 S&P500		0,75	0,94	0,69	0,68	0,57	0,61	0,58	0,55	0,47	0,56	0,55	0,60	0,58	0,52	0,33
2 NASDAQ100	0,75		0,66	0,48	0,40	0,31	0,46	0,43	0,30	0,31	0,28	0,40	0,36	0,45	0,38	0,18
3 DJINDUS	0,94	0,66		0,75	0,69	0,58	0,61	0,61	0,57	0,50	0,57	0,60	0,68	0,66	0,58	0,38
4 SPTSX60	0,69	0,48	0,75		0,56	0,44	0,59	0,49	0,45	0,60	0,47	0,46	0,65	0,67	0,50	0,32
5 DJESTOXX50	0,68	0,40	0,69	0,56		0,64	0,73	0,69	0,91	0,75	0,90	0,72	0,72	0,63	0,63	0,35
6 SMI	0,57	0,31	0,58	0,44	0,64		0,53	0,53	0,60	0,51	0,57	0,61	0,54	0,45	0,44	0,24
7 FTSE100	0,61	0,46	0,61	0,59	0,73	0,53		0,52	0,64	0,59	0,68	0,62	0,73	0,64	0,55	0,18
8 OMX	0,58	0,43	0,61	0,49	0,69	0,53	0,52		0,55	0,57	0,58	0,71	0,69	0,60	0,54	0,39
9 DAX30	0,55	0,30	0,57	0,45	0,91	0,60	0,64	0,55		0,74	0,74	0,57	0,63	0,58	0,59	0,23
10 ATX	0,47	0,31	0,50	0,60	0,75	0,51	0,59	0,57	0,74		0,59	0,54	0,63	0,57	0,50	0,21
11 CAC40	0,56	0,28	0,57	0,47	0,90	0,57	0,68	0,58	0,74	0,59		0,64	0,60	0,47	0,48	0,29
12 IBEX 35	0,55	0,40	0,60	0,46	0,72	0,61	0,62	0,71	0,57	0,54	0,64		0,74	0,57	0,53	0,42
13 SPASX200	0,60	0,36	0,68	0,65	0,72	0,54	0,73	0,69	0,63	0,63	0,60	0,74		0,73	0,62	0,47
14 HANGSENG	0,58	0,45	0,66	0,67	0,63	0,45	0,64	0,60	0,58	0,57	0,47	0,57	0,73		0,80	0,27
15 MSCISING	0,52	0,38	0,58	0,50	0,63	0,44	0,55	0,54	0,59	0,50	0,48	0,53	0,62	0,80		0,33
16 Nikkei	0,33	0,18	0,38	0,32	0,35	0,24	0,18	0,39	0,23	0,21	0,29	0,42	0,47	0,27	0,33	
Average	0,60	0,41	0,63	0,54	0,67	0,50	0,58	0,57	0,58	0,54	0,56	0,58	0,63	0,58	0,53	0,31
Overall average	**0,55**															

Source: Case1.xlsx data, own calculations

International stock markets: Correlations 1998-2002

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1 S&P500		0,83	0,92	0,83	0,80	0,70	0,85	0,73	0,79	0,44	0,78	0,72	0,67	0,63	0,59	0,50
2 NASDAQ100	0,83		0,65	0,72	0,71	0,45	0,67	0,74	0,71	0,16	0,70	0,67	0,65	0,57	0,47	0,54
3 DJINDUS	0,92	0,65		0,73	0,75	0,72	0,86	0,69	0,77	0,57	0,73	0,67	0,63	0,64	0,67	0,45
4 SPTSX60	0,83	0,72	0,73		0,67	0,65	0,67	0,67	0,66	0,48	0,69	0,64	0,61	0,62	0,53	0,53
5 DJESTOXX50	0,80	0,71	0,75	0,67		0,81	0,87	0,90	0,95	0,50	0,98	0,85	0,60	0,50	0,44	0,49
6 SMI	0,70	0,45	0,72	0,65	0,81		0,83	0,68	0,74	0,63	0,81	0,72	0,54	0,47	0,43	0,49
7 FTSE100	0,85	0,67	0,86	0,67	0,87	0,83		0,76	0,82	0,61	0,85	0,79	0,63	0,61	0,55	0,48
8 OMX	0,73	0,74	0,69	0,67	0,90	0,68	0,76		0,88	0,41	0,88	0,80	0,56	0,54	0,41	0,49
9 DAX30	0,79	0,71	0,77	0,66	0,95	0,74	0,82	0,88		0,51	0,93	0,82	0,61	0,52	0,46	0,46
10 ATX	0,44	0,16	0,57	0,48	0,50	0,63	0,61	0,41	0,51		0,49	0,54	0,42	0,40	0,40	0,31
11 CAC40	0,78	0,70	0,73	0,69	0,98	0,81	0,85	0,88	0,93	0,49		0,84	0,56	0,50	0,42	0,48
12 IBEX 35	0,72	0,67	0,67	0,64	0,85	0,72	0,79	0,80	0,82	0,54	0,84		0,57	0,54	0,43	0,49
13 SPASX200	0,67	0,65	0,63	0,61	0,60	0,54	0,63	0,56	0,61	0,42	0,56	0,57		0,56	0,66	0,58
14 HANGSENG	0,63	0,57	0,64	0,62	0,50	0,47	0,61	0,54	0,52	0,40	0,50	0,54	0,56		0,72	0,41
15 MSCISING	0,59	0,47	0,67	0,53	0,44	0,43	0,55	0,41	0,46	0,40	0,42	0,43	0,66	0,72		0,32
16 Nikkei	0,50	0,54	0,45	0,53	0,49	0,49	0,48	0,49	0,46	0,31	0,48	0,49	0,58	0,41	0,32	
Average	0,72	0,62	0,70	0,65	0,72	0,64	0,72	0,68	0,71	0,46	0,71	0,67	0,59	0,55	0,50	0,47
Overall average	**0,63**															

Source: Case1.xlsx data, own calculations

International stock markets: Correlations 2003-2007

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1 S&P500		0,82	0,94	0,70	0,78	0,68	0,69	0,67	0,77	0,54	0,76	0,62	0,65	0,55	0,62	0,44
2 NASDAQ100	0,82		0,74	0,63	0,58	0,43	0,51	0,51	0,59	0,41	0,57	0,50	0,51	0,54	0,51	0,39
3 DJINDUS	0,94	0,74		0,59	0,71	0,64	0,62	0,63	0,71	0,43	0,68	0,56	0,58	0,51	0,62	0,44
4 SPTSX60	0,70	0,63	0,59		0,65	0,44	0,61	0,53	0,58	0,61	0,66	0,57	0,60	0,63	0,64	0,57
5 DJESTOXX50	0,78	0,58	0,71	0,65		0,83	0,76	0,82	0,95	0,59	0,96	0,78	0,60	0,35	0,54	0,46
6 SMI	0,68	0,43	0,64	0,44	0,83		0,63	0,78	0,81	0,54	0,81	0,63	0,50	0,26	0,52	0,44
7 FTSE100	0,69	0,51	0,62	0,61	0,76	0,63		0,66	0,70	0,56	0,73	0,62	0,60	0,39	0,56	0,47
8 OMX	0,67	0,51	0,63	0,53	0,82	0,78	0,66		0,79	0,61	0,79	0,62	0,58	0,29	0,59	0,48
9 DAX30	0,77	0,59	0,71	0,58	0,95	0,81	0,70	0,79		0,53	0,92	0,70	0,56	0,29	0,54	0,42
10 ATX	0,54	0,41	0,43	0,61	0,59	0,54	0,56	0,61	0,53		0,59	0,59	0,56	0,33	0,51	0,55
11 CAC40	0,76	0,57	0,68	0,66	0,96	0,81	0,73	0,79	0,92	0,59		0,71	0,61	0,34	0,54	0,50
12 IBEX 35	0,62	0,50	0,56	0,57	0,78	0,63	0,62	0,62	0,70	0,59	0,71		0,49	0,37	0,47	0,35
13 SPASX200	0,65	0,51	0,58	0,60	0,60	0,50	0,60	0,58	0,56	0,56	0,61	0,49		0,41	0,59	0,54
14 HANGSENG	0,55	0,54	0,51	0,63	0,35	0,26	0,39	0,29	0,29	0,33	0,34	0,37	0,41		0,59	0,24
15 MSCISING	0,62	0,51	0,62	0,64	0,54	0,52	0,56	0,59	0,54	0,51	0,54	0,47	0,59	0,59		0,54
16 Nikkei	0,44	0,39	0,44	0,57	0,46	0,44	0,47	0,48	0,42	0,55	0,50	0,35	0,54	0,24	0,54	
Average	0,68	0,55	0,63	0,60	0,69	0,60	0,61	0,62	0,66	0,53	0,68	0,57	0,56	0,41	0,56	0,46
Overall average	**0,59**															

Source: Case1.xlsx data, own calculations

International stock markets: Correlations 2008-2012

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1 S&P500		0,92	0,98	0,82	0,88	0,79	0,89	0,76	0,85	0,85	0,88	0,75	0,87	0,77	0,79	0,75
2 NASDAQ100	0,92		0,87	0,79	0,83	0,74	0,84	0,76	0,83	0,81	0,83	0,69	0,86	0,75	0,78	0,74
3 DJINDUS	0,98	0,87		0,76	0,86	0,79	0,87	0,74	0,82	0,79	0,85	0,75	0,83	0,74	0,75	0,69
4 SPTSX60	0,82	0,79	0,76		0,71	0,64	0,79	0,60	0,68	0,85	0,73	0,60	0,82	0,75	0,78	0,68
5 DJESTOXX50	0,88	0,83	0,86	0,71		0,83	0,89	0,79	0,94	0,82	0,98	0,89	0,83	0,77	0,77	0,74
6 SMI	0,79	0,74	0,79	0,64	0,83		0,80	0,68	0,78	0,74	0,84	0,68	0,79	0,66	0,65	0,65
7 FTSE100	0,89	0,84	0,87	0,79	0,89	0,80		0,77	0,84	0,84	0,90	0,77	0,88	0,77	0,74	0,73
8 OMX	0,76	0,76	0,74	0,60	0,79	0,68	0,77		0,80	0,73	0,78	0,68	0,74	0,81	0,78	0,75
9 DAX30	0,85	0,83	0,82	0,68	0,94	0,78	0,84	0,80		0,78	0,91	0,73	0,79	0,77	0,79	0,74
10 ATX	0,85	0,81	0,79	0,85	0,82	0,74	0,84	0,73	0,78		0,84	0,70	0,85	0,80	0,84	0,77
11 CAC40	0,88	0,83	0,85	0,73	0,98	0,84	0,90	0,78	0,91	0,84		0,84	0,84	0,75	0,76	0,73
12 IBEX 35	0,75	0,69	0,75	0,60	0,89	0,68	0,77	0,68	0,73	0,70	0,84		0,70	0,68	0,68	0,64
13 SPASX200	0,87	0,86	0,83	0,82	0,83	0,79	0,88	0,74	0,79	0,85	0,84	0,70		0,76	0,74	0,73
14 HANGSENG	0,77	0,75	0,74	0,75	0,77	0,66	0,77	0,81	0,77	0,80	0,75	0,68	0,76		0,89	0,74
15 MSCISING	0,79	0,78	0,75	0,78	0,77	0,65	0,74	0,78	0,79	0,84	0,76	0,68	0,74	0,89		0,75
16 Nikkei	0,75	0,74	0,69	0,68	0,74	0,65	0,73	0,75	0,74	0,77	0,73	0,64	0,73	0,74	0,75	
Average	0,84	0,80	0,81	0,73	0,84	0,74	0,82	0,75	0,80	0,80	0,83	0,72	0,80	0,76	0,77	0,72
Overall average	**0,78**															

Source: Case1.xlsx data, own calculations

International stock markets: Correlations 2013-2017

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1 S&P500		0,86	0,96	0,59	0,63	0,71	0,63	0,62	0,64	0,58	0,62	0,53	0,59	0,57	0,66	0,59
2 NASDAQ100	0,86		0,75	0,54	0,67	0,66	0,61	0,62	0,67	0,67	0,65	0,62	0,54	0,63	0,57	0,57
3 DJINDUS	0,96	0,75		0,51	0,55	0,63	0,58	0,55	0,58	0,52	0,54	0,42	0,54	0,51	0,67	0,61
4 SPTSX60	0,59	0,54	0,51		0,55	0,41	0,58	0,59	0,52	0,56	0,55	0,53	0,54	0,47	0,43	0,27
5 DJESTOXX50	0,63	0,67	0,55	0,55		0,66	0,62	0,85	0,94	0,74	0,97	0,90	0,53	0,37	0,39	0,61
6 SMI	0,71	0,66	0,63	0,41	0,66		0,55	0,63	0,60	0,60	0,65	0,63	0,54	0,31	0,38	0,55
7 FTSE100	0,63	0,61	0,58	0,58	0,62	0,55		0,65	0,58	0,56	0,66	0,54	0,51	0,51	0,48	0,27
8 OMX	0,62	0,62	0,55	0,59	0,85	0,63	0,65		0,84	0,69	0,87	0,74	0,61	0,39	0,42	0,57
9 DAX30	0,64	0,67	0,58	0,52	0,94	0,60	0,58	0,84		0,72	0,90	0,79	0,50	0,39	0,40	0,64
10 ATX	0,58	0,67	0,52	0,56	0,74	0,60	0,56	0,69	0,72		0,73	0,74	0,54	0,53	0,40	0,45
11 CAC40	0,62	0,65	0,54	0,55	0,97	0,65	0,66	0,87	0,90	0,73		0,83	0,54	0,35	0,38	0,55
12 IBEX 35	0,53	0,62	0,42	0,53	0,90	0,63	0,54	0,74	0,79	0,74	0,83		0,53	0,41	0,40	0,55
13 SPASX200	0,59	0,54	0,54	0,54	0,53	0,54	0,51	0,61	0,50	0,54	0,54	0,53		0,49	0,50	0,43
14 HANGSENG	0,57	0,63	0,51	0,47	0,37	0,31	0,51	0,39	0,39	0,53	0,35	0,41	0,49		0,76	0,38
15 MSCISING	0,66	0,57	0,67	0,43	0,39	0,38	0,48	0,42	0,40	0,40	0,38	0,40	0,50	0,76		0,41
16 Nikkei	0,59	0,57	0,61	0,27	0,61	0,55	0,27	0,57	0,64	0,45	0,55	0,55	0,43	0,38	0,41	
Average	0,65	0,64	0,60	0,51	0,67	0,57	0,55	0,64	0,65	0,60	0,65	0,61	0,53	0,47	0,48	0,50
Overall average	**0,58**															

Source: Case1.xlsx data, own calculations

International stock markets: Correlation regimes

	1993-97	1998-2002	2003-2007	2008-2012	2013-2017	Full	Rank
S&P500	0,598	0,718	0,682	0,837	0,652	0,722	2
NASDAQ100	0,409	0,616	0,549	0,803	0,641	0,600	13
DJINDUS	0,625	0,698	0,626	0,805	0,595	0,695	5
SPTSX60	0,541	0,647	0,601	0,733	0,509	0,636	9
DJESTOXX50	0,666	0,722	0,693	0,836	0,665	0,735	1
SMI	0,504	0,644	0,597	0,736	0,567	0,621	11
FTSE100	0,579	0,722	0,608	0,821	0,555	0,695	6
OMX	0,566	0,676	0,625	0,745	0,642	0,663	7
DAX30	0,576	0,708	0,658	0,804	0,648	0,700	4
ATX	0,540	0,458	0,530	0,801	0,603	0,601	12
CAC40	0,562	0,710	0,678	0,832	0,652	0,706	3
IBEX 35	0,579	0,672	0,572	0,719	0,612	0,657	8
SPASX200	0,626	0,590	0,560	0,803	0,527	0,633	10
HANGSENG	0,578	0,548	0,406	0,761	0,471	0,585	14
MSCISING	0,533	0,500	0,559	0,765	0,484	0,572	15
Nikkei	0,306	0,468	0,456	0,723	0,496	0,506	16
Period average	**0,549**	**0,631**	**0,588**	**0,783**	**0,582**	**0,645**	

Source: Case1.xlsx data, own calculations

Part 2: Selected references

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International Capital Markets and Investment Practice

Part 3

International asset pricing theories

Prof. Dr. Peter Oertmann
TUM School of Management
Technical University of Munich
peter.oertmann@tum.de

Part 3: International asset pricing theories

a. International parity relations

b. Introduction into the setting of international asset pricing

c. Base-line International CAPM

d. Structure of more general IAPM's

Part 3: Positioning in the lecture

Major fields in asset management

Diversification	Asset allocation
Security selection	Investment strategy implementation
Risk management	Trading and execution

Knowledge base

Stylized facts on global markets Empirical research	**Sources of risk and return** Models and empirical research
Asset pricing Theories, models and empirical tests	**Portfolio construction** Models and empirical tests
Financial economics Models and empirical research	**Time series analysis** Models and empirical procedures

Part 3: International asset pricing theories

Starting point of international asset pricing

- Investors throughout the world use **different numeraire currencies**
- Returns on international investments are affected by exchange rate movements
  - Directly, because they have to be translated from foreign to domestic currency units (numeraire currency units) → Return = Stock return + currency exchange return
  - Indirectly, because asset prices react to shifts in exchange rates
- Asset prices, interest rates, and foreign exchange rates are economically interrelated in a complex manner
- Investment analysis in the international setting requires a distinct understanding of the links between
  - **Foreign exchange rates**
  - **Interest rates**
  - **Inflation rates**

  between countries (international parity relations)

Definitions

Spot exchange rate (S)

→ Spot

- Rate of exchange between two currencies for immediate delivery
- Amount of domestic currency required to buy one unit of foreign currency

Forward exchange rate (F)

→ delivery & exchange in future

- Rate of exchange between two currencies set today for delivery at a specified date in the future
- Amount of domestic currency required at a specified date in the future to buy one unit of foreign currency

Interest rate (R)

- Rate of interest quoted for a certain currency and in accordance with a certain time period for borrowing/lending
- **Interest rate differential**: Difference in interest rates between two countries

Inflation rate (π)

- Rate of consumer price index (CPI) increase over a period
- **Inflation differential**: Difference in inflation rates between two countries

Some EUR spot exchange rates

One Euro costs …	28 April 2024	28 April 2023	28 April 2022	27 April 2018	26 April 2013
USD		1.0981	1.0485	1.2070	1.2999
GBP		0.8805	0.8435	0.8770	0.8400
CHF		0.9839	1.0216	1.1960	1.2273
CNY		7.5979	6.9381	7.6517	8.0139

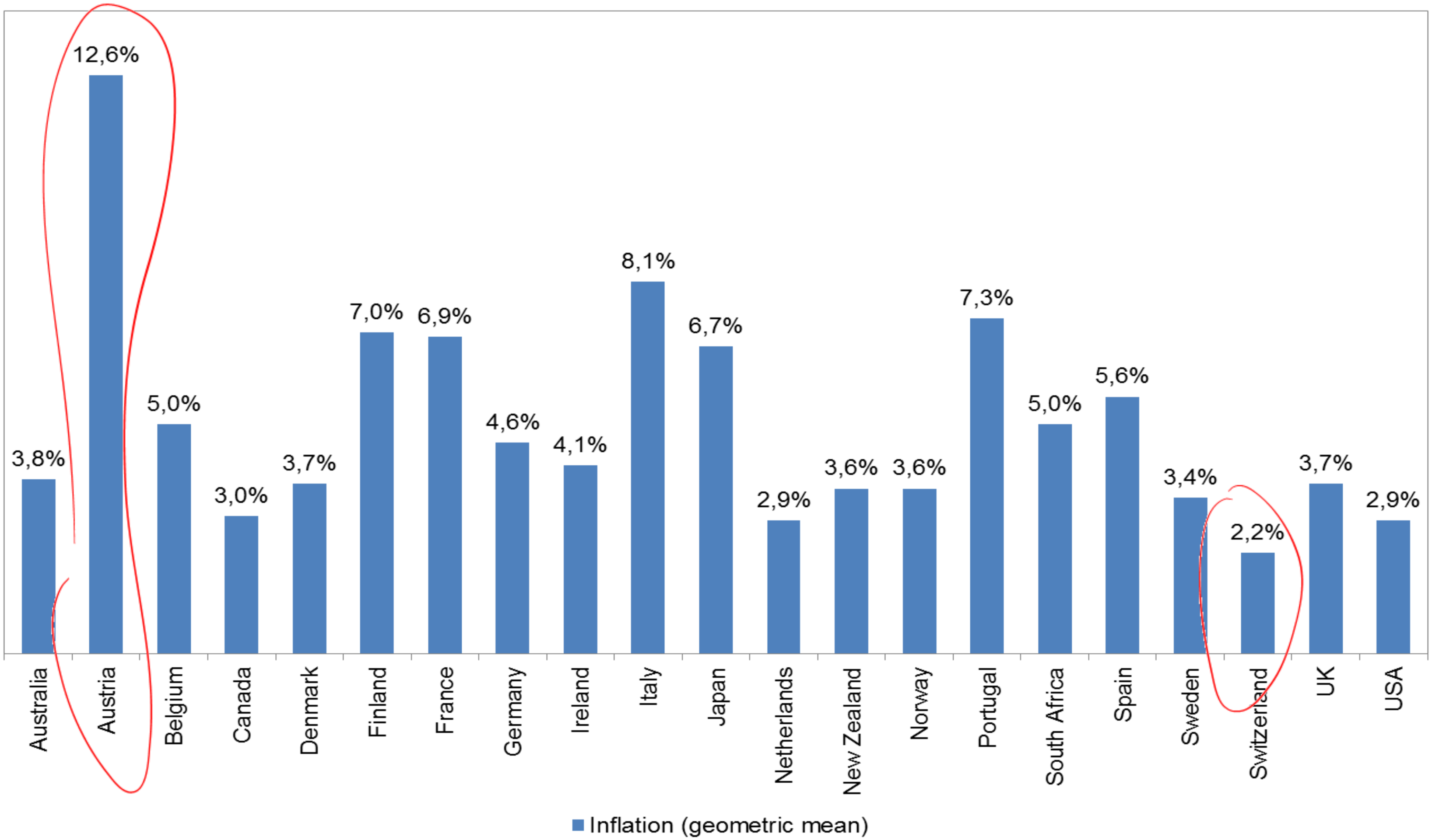
Data: ECB

USD/EUR spot exchange rate 1 Jan 1999 to 31 March 2023

On March 31, 2023, one USD costs 0.9226 EUR

Data: Bloomberg

Long-term inflation rates (1900-2016)

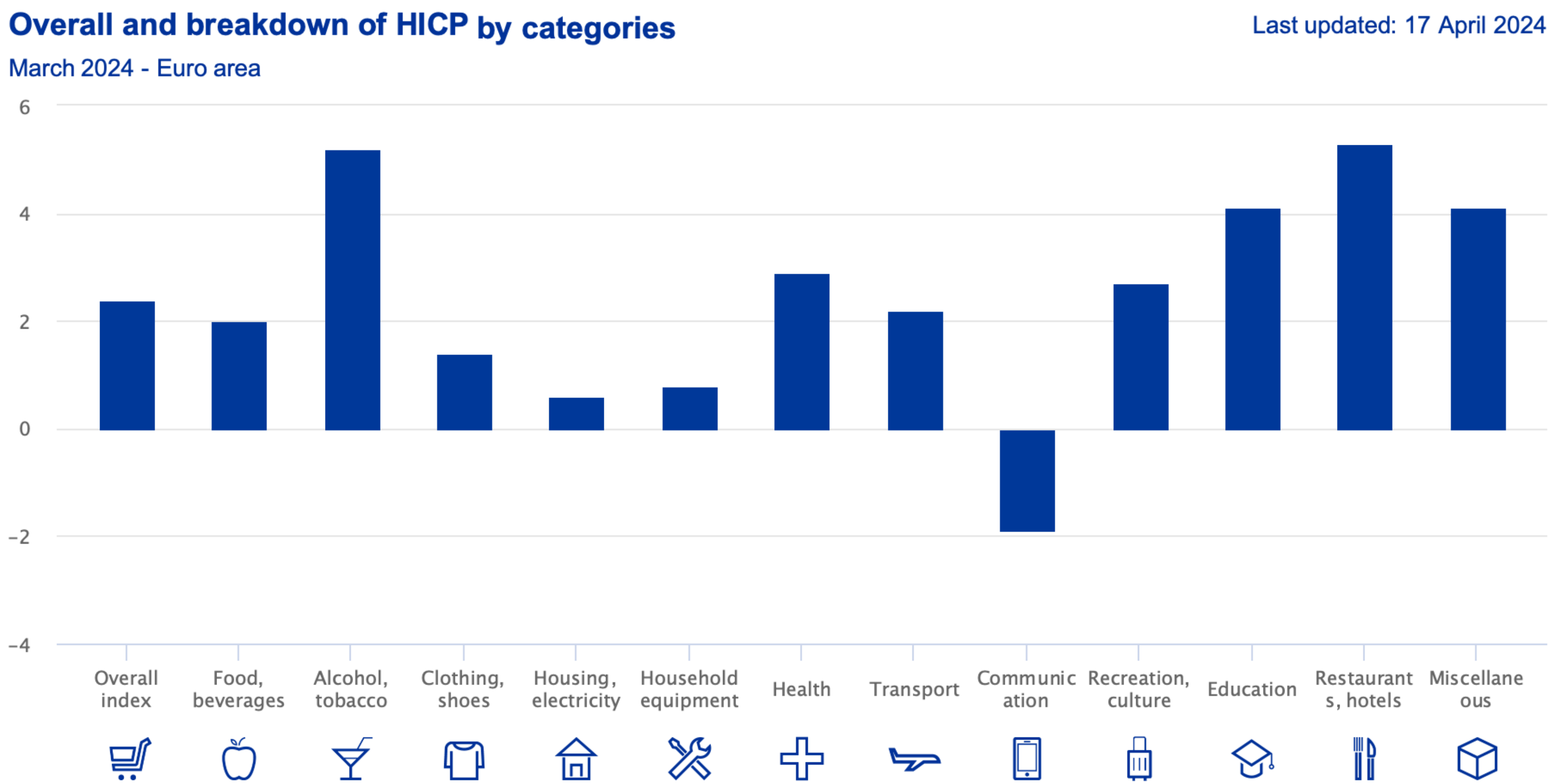


Data: Elroy Dimson, Paul Marsh and Mike Staunton, Credit Suisse Global Investment Returns Yearbook 2017

Inflation in the euro area

Source: ECB, https://data.ecb.europa.eu

Inflation in the euro area (cont.)



Source: ECB, https://data.ecb.europa.eu

Exercise question

On 7 July 2020 the closing price of an Apple stock is 91.03 USD and 1 EUR costs 1.1200 USD, and one year later, on 7 July 2021, the closing price of an Apple stock is 137.27 USD and 1 EUR costs 1.1883 USD.

Calculate the stock return over that one-year period denominated in EUR.

$$\frac{137.27 \cdot 1{,}12}{91{,}03 \cdot 1{,}1883} \approx 42{,}13\%$$

Parity relations of international finance

homogeneous goods (e.g. gold)

* **Commodity price parity CPP** → only applies to gold etc. → real price in two countries is same — Linking real prices of goods across countries

* **Purchasing power parity PPP** → any price levels are same → international asset pricing — Linking spot exchange rates and inflation rates

Fisher relation — Linking interest rates and inflation rates

Foreign exchange expectation relation — Linking forward exchange rates and expected spot rates

Interest rate parity — Linking spot exchange rates, forward exchange rates, and interest rates

* theory, but does not hold in reality

Commodity price parity

Statement: “The real price of an individual good is the same in two countries”

$$P_t^D = S_t \cdot P_t^F$$

where P price of a good

S spot exchange rate (price of foreign currency)

- Instantaneous arbitrage condition: “Law of one price”
- CPP holds in absence of trade barriers for homogeneous goods (e.g., gold, precious metals)

Purchasing power parity

... in absolute terms

Statement: "Average price levels are the same in two countries at any time"

$$\sum_{goods} w_t^D \cdot P_t^D = S_t \cdot \sum_{goods} w_t^F \cdot P_t^F$$

where
- w weight of a good
- P price of a good
- S spot exchange rate (price of foreign currency)
- D " domestic"
- F " foreign"

Purchasing power parity (cont.)

... in relative terms

Statement: “Spot exchange rates between currencies adjust to inflation differentials between the respective countries”

Exact formula

$$1 + s_{t.t+1} = \frac{S_{t+1}}{S_t} = \frac{1 + \pi^D_{t.t+1}}{1 + \pi^F_{t.t+1}}$$

Linear approximation

$$s_{t.t+1} = \frac{S_{t+1} - S_t}{S_t} \approx \pi^D_{t.t+1} - \pi^F_{t.t+1}$$

Purchasing power parity (cont.)

When PPP in relative terms holds ... → appreciation of a currency given depreciation of another

- Real returns on international assets are identical for investors from different countries denominating returns in different currencies
- Exchange rate shifts purely mirror inflation differentials and have no impact on the valuation of assets

Empirical evidence

- PPP is a poor explanation of short-term exchange rate movements (explains 5-10%)
- It takes several years before a PPP deviation is adjusted for in the currency market, because
  - Inflation is not consistently defined across countries
  - Consumption baskets are different
  - Changes in relative prices cause consumption substitution
  - Transaction costs, taxes, and restrictions prevent arbitrage in goods markets

Exercise question

At the beginning of 2023, 0.92 EUR buy 1 USD. For 2023, the OECD forecasts 6.8% inflation in the Eurozone and 3.9% inflation in the US.

Predict the EUR/USD exchange rate at the end of 2023 if PPP holds.

$$r_0^{EUR/USD} = \frac{1}{0{,}92} = 1{,}087$$

$$r_1^{EUR/USD} = \frac{1 \cdot 1{,}039}{0{,}92 \cdot 1{,}068} = 1{,}056$$

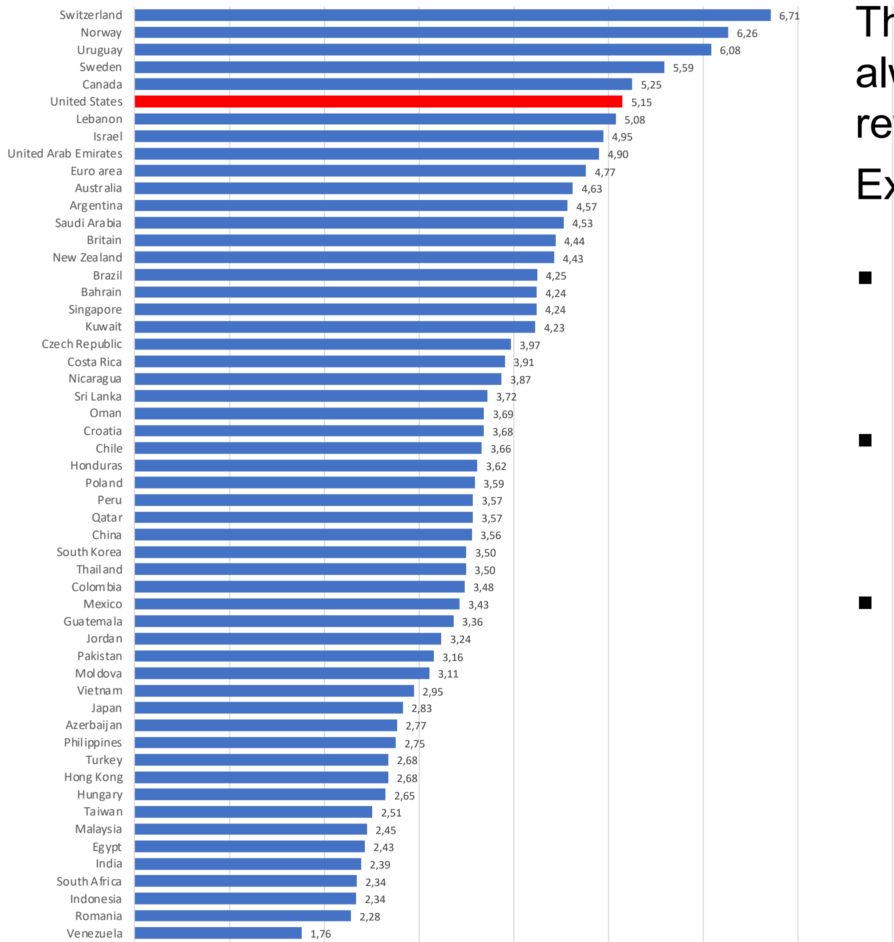
PPP – The Economist's Big Mac Index

What is it?

- Invented by The Economist in 1986
- Lighthearted guide to whether currencies are at their "correct" level, never intended as a precise gauge of currency misalignment
- Based on the theory of purchasing-power parity (PPP), the notion that in the long run exchange rates should move towards the rate that would equalize the prices of a basket of goods and services around the world
- Has become a global standard
- There is also a GDP-adjusted version addressing the criticism that you would expect average burger prices to be cheaper in poor countries than in rich ones because labor costs are lower. PPP signals where exchange rates should be heading in the long run, as a country like China gets richer, but it says little about today's equilibrium rate. The relationship between prices and GDP per person may be a better guide to the current fair value of a currency

Source: www.economist.com

PPP – The Economist's Big Mac Index (cont.)



The local average price of a Big Mac in a country is always compared with the average price in the reference country USA

Example

- A Big Mac costs NOK 62 in Norway. At the current exchange rate of NOK 9.90 for one USD, this is equivalent to USD 6.26
- In the US, the Big Mac costs USD 5.15 resulting in an implied exchange rate of NOK 12.04 for one USD
- The difference between implied and current exchange rates indicates that the NOK is 21.6% overvalued

Source: www.economist.com, data as of July 2022

Exercise question → US is reference

Looking at data from 2018: In the US the average price of a Big Mac in January 2018 is 5.28 USD. At the same time in China it is 20.40 Yuan which is equivalent to 3.17 USD at market exchange rates, and in Switzerland it is 6.50 Swiss francs which is equal to 6.76 USD.

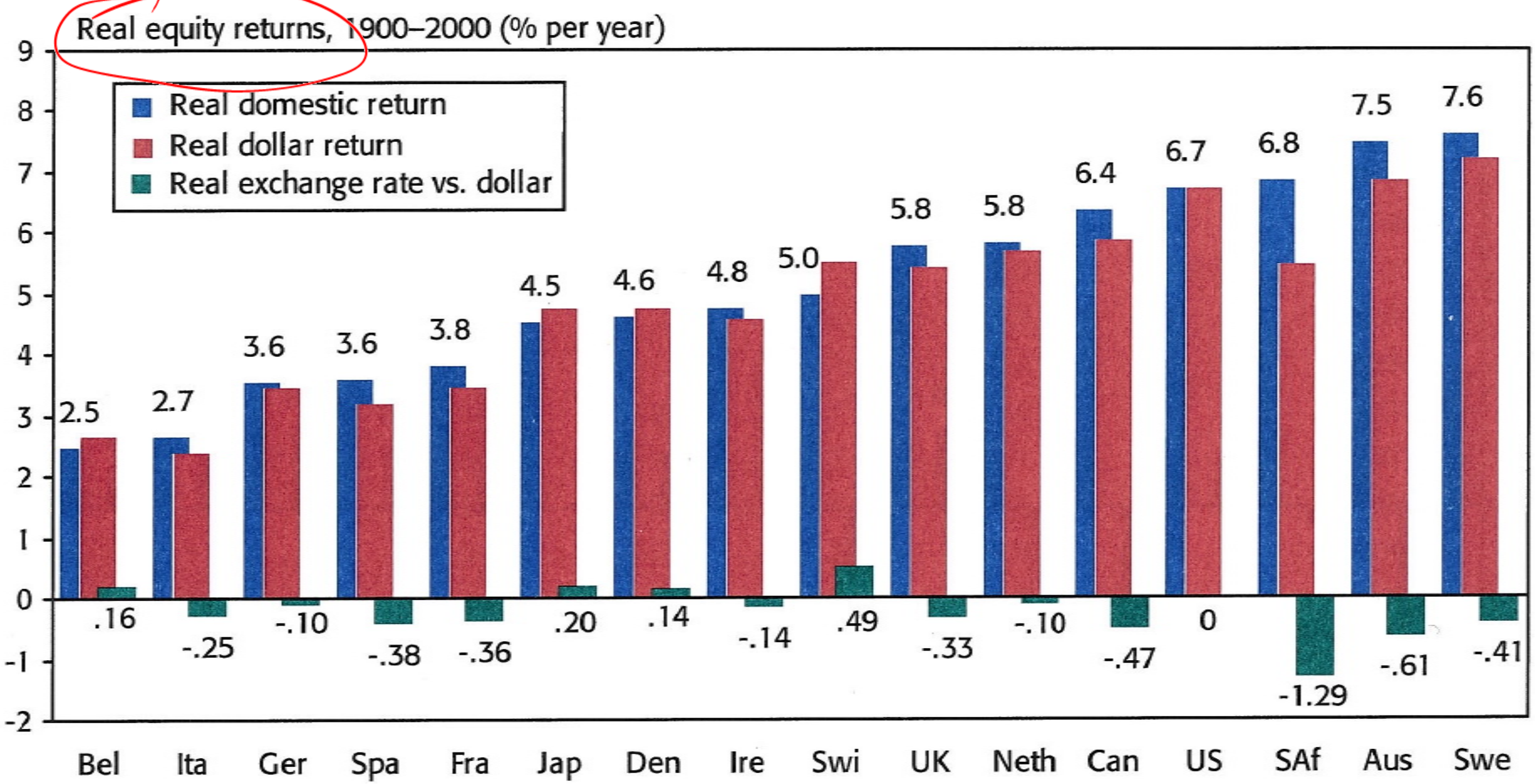
Comment on the relative valuation of the three currencies in accordance with the Big Mac index.

5,28\$ | 20,40 = 3,17\$ | 6,76 \$

reference   undervalued   overvalued

real = return − inflation

PPP – Long-run real equity returns from an USD perspective



Source: Elroy Dimson, Paul Marsh and Mike Staunton, Triumph of the Optimists, 2002

→ On the long term, PPP seems to hold

Fisher relation

Statement: “Fluctuations in interest rates are caused by revisions in expected inflation, when real interest rates are stable over time”

National

Domestic inflation rate

$$(1+r_{nom}) = (1+r_{real}) \cdot (1+E(\pi))$$

International

$$\boxed{\frac{1+r^F_{nom}}{1+r^D_{nom}} = \frac{1+r^F_{real}}{1+r^D_{real}} \cdot \frac{1+E(\pi^F)}{1+E(\pi^D)}}$$

Fisher relation (cont.)

When the international Fisher relation holds ...

- and real interest rates are stable and equal across countries, interest rate differentials across countries are predominantly caused by differences in expected inflation across countries
- and real interest rates between two countries deviate, capital flows would take advantage of these differences

Empirical evidence

- The Fisher relation more or less holds for major currencies
- Real interest rates vary over time
- Real interest rates differ across countries

Foreign exchange expectation relation

Statement: "Forward exchange rates mirror expected future spot rates"

$$F_t = E_t(S_{t+1})$$

⇒ Forward exchange rate = expected future spot rate

where F_t forward exchange rate quoted at time t for delivery at time $t+1$

$E_t(S_{t+1})$ time $t+1$ spot rate expected at time t

Forward premium → Δ

Statement: "The difference between the forward and spot exchange rate mirrors the expected spot exchange rate change"

$$\frac{F_t}{S_t} - 1 = \frac{E(S_{t+1})}{S_t} - 1 = E(s_{t.t+1})$$

→ empirically not relevant

Foreign exchange expectation relation (cont.)

When the foreign exchange expectation relation holds ...

- there is no reward for bearing exchange rate risk
- forward exchange rate contracts can be used to hedge foreign asset positions with no costs (except for transaction costs)

Empirical evidence

- Forward premiums explain only a small portion of observed exchange rate changes

… because

  - Exchange rate changes systematically deviate from expected exchange rate changes
  - Taking exchange rate exposure is rewarded with a (varying) risk premium

Interest rate parity

Statement: “The forward premium for currency exchange mirrors the interest differential between the respective countries”

… implies that

- the return on riskfree investment is equal across countries
- observable interest rate differentials can be used to forecast exchange rate movements

forward premium

Exact formula

$$\frac{F_t}{S_t} = \frac{1+r^D}{1+r^F}$$

Same result

Linear approximation

$$E_t(S_{t+1}) = \frac{F_t}{S_t} - 1 \approx r^D - r^F$$

$1+r^{US}$

$\frac{1}{S_t}$

$\frac{1}{F_t}$

today

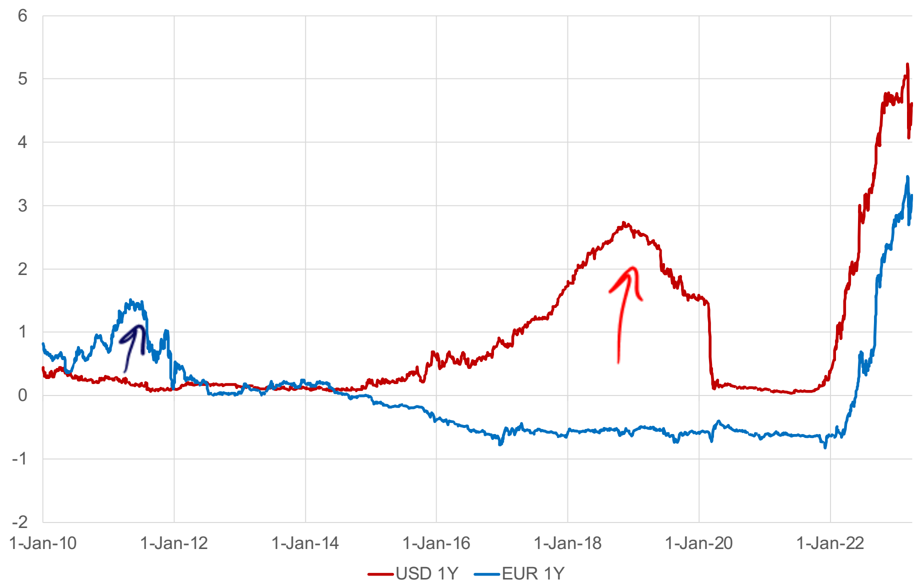
$1+r^{EUR}$

+1 year

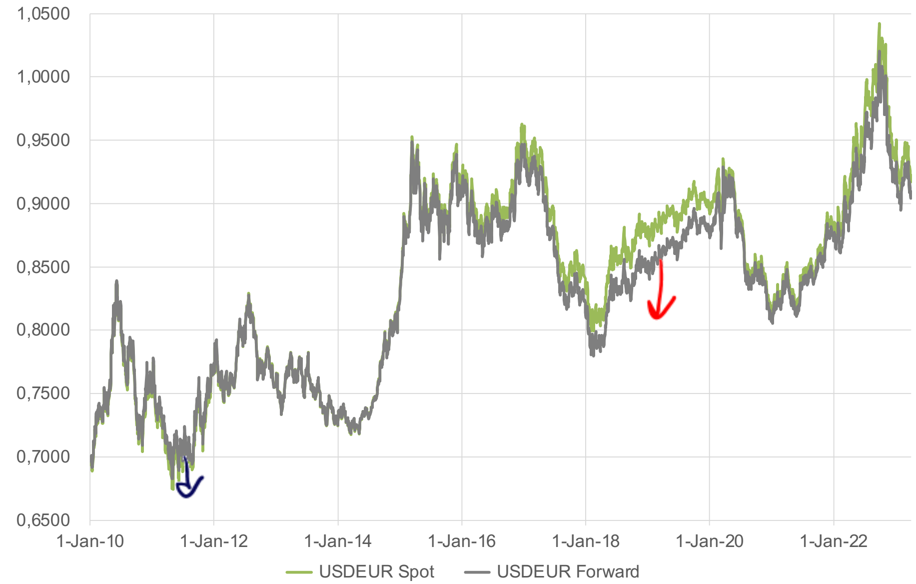
↳ Arbitrage relationship

Interest rate parity – application → forward rates calculated based on spot & interest rates

One-year interest rates in the US and the eurozone – Jan 2010 to Mar 2023



USD/EUR spot rate
and calculated USD/EUR forward rate



if USD > EUR ⇒ forward rate > spot rate

Data: Bloomberg, own calculations

Exercise question

The spot exchange rate between two currencies is 0.80. The domestic interest rate is 1.5% and the foreign interest rate is 3%.

Calculate the forward exchange rate.

$S_0 = 0.80 \quad r^D = 0{,}015 \quad r^F = 0{,}03$

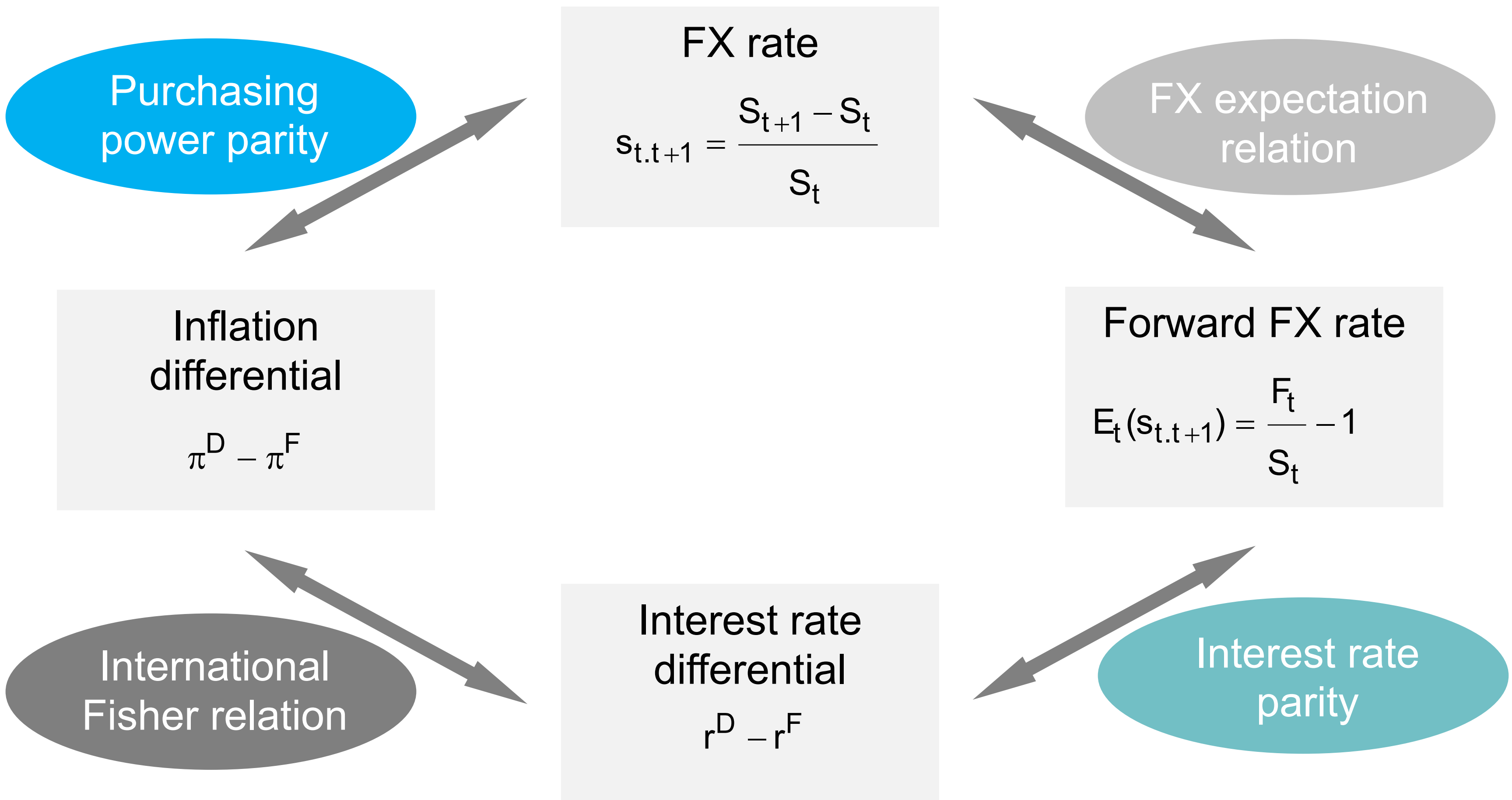
$$\frac{F_t}{S_t} = \frac{1+r^D}{1+r^F}$$

$$\Rightarrow F_t = \frac{1+r^D}{1+r^F} \cdot S_t = 0{,}7883$$

$$\boxed{r^F > r^D \Leftrightarrow F_t < S_t}$$

FX = Foreign exchange

Links between monetary variables

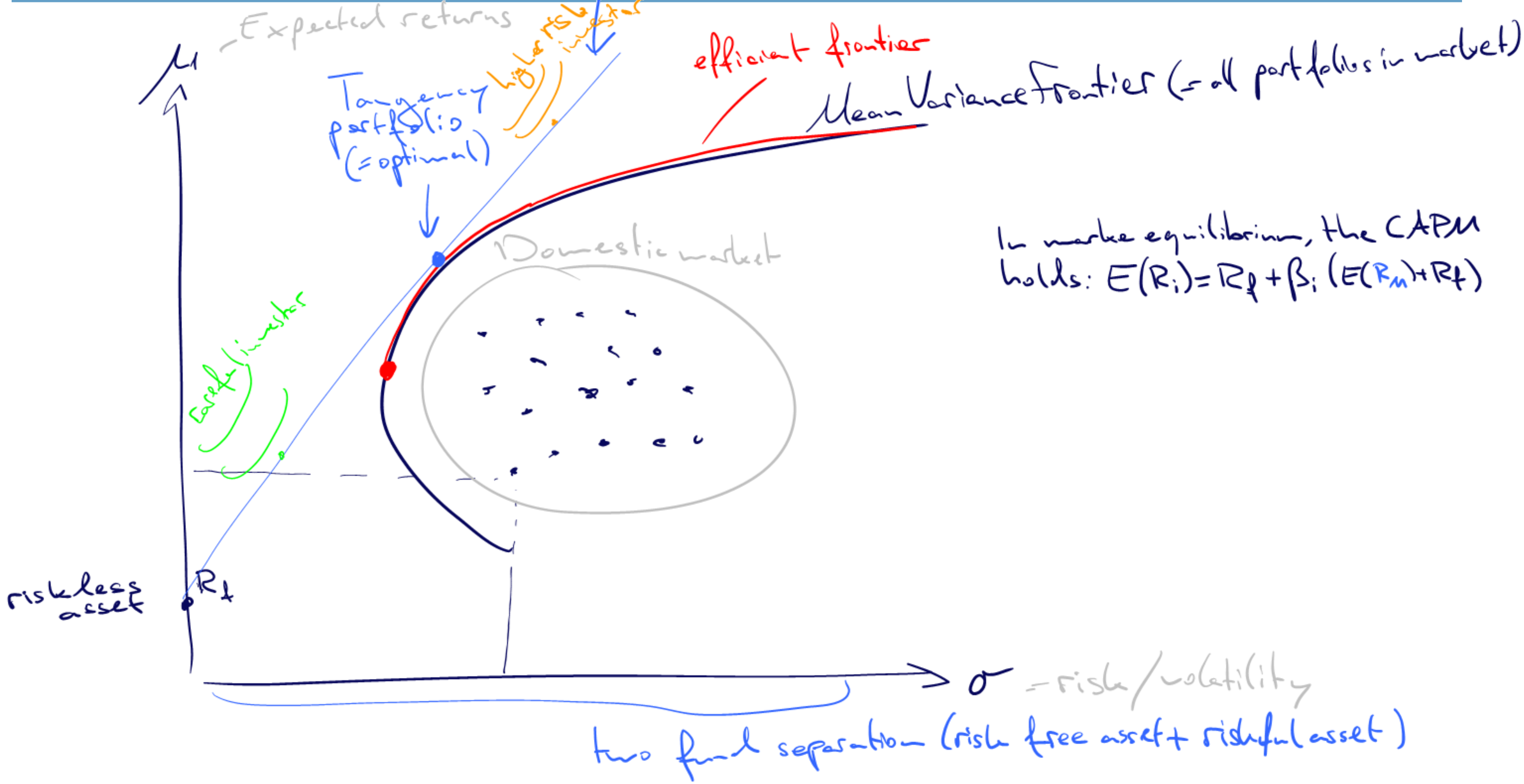


Part 3: International asset pricing theories

a. International parity relations
b. Introduction into the setting of international asset pricing
c. Base-line International CAPM
d. Structure of more general IAPM’s

Capital Market Line $\Longrightarrow$ Tangency Portfolio = Market Portfolio

Recall: Asset pricing in the closed-economy



In market equilibrium, the CAPM holds: $E(R_i) = R_f + \beta_i (E(R_m) - R_f)$

Recall: Asset pricing in the closed-economy (cont.)

Description of the setting

- All investors face the **same investment opportunity set**
- Asset returns are measured in the **same currency** (numeraire), the **same CPI** is used to calculate real returns
- Efficient portfolio diversification brings all investors on the **same efficient frontier**
- Availability of a riskfree investment implies a **clear two-fund separation**: All investors hold a combination of the riskfree asset and the unique market portfolio
- In equilibrium, expected **nominal returns are consistent with the CAPM**

Portfolio choice

Combination of risk-free asset and market portfolio

Asset pricing restriction

$$E(R_i) = R_f + \beta_i \cdot (E(R_M) - R_f)$$

The challenges in international asset pricing → difficult to create "investment universe"

- **PPP does not hold**: Deviations from absolute and relative PPP can be observed at almost all times between almost all countries, affecting the purchasing power of investors differently

  Reasons: Differences across countries concerning ...

  - Composition of national consumption baskets (tastes)
  - Relative prices of goods
  - Time-evolution of relative prices

- **Investment opportunities differ across countries:** Investors around the world face different feasible sets of assets for investment

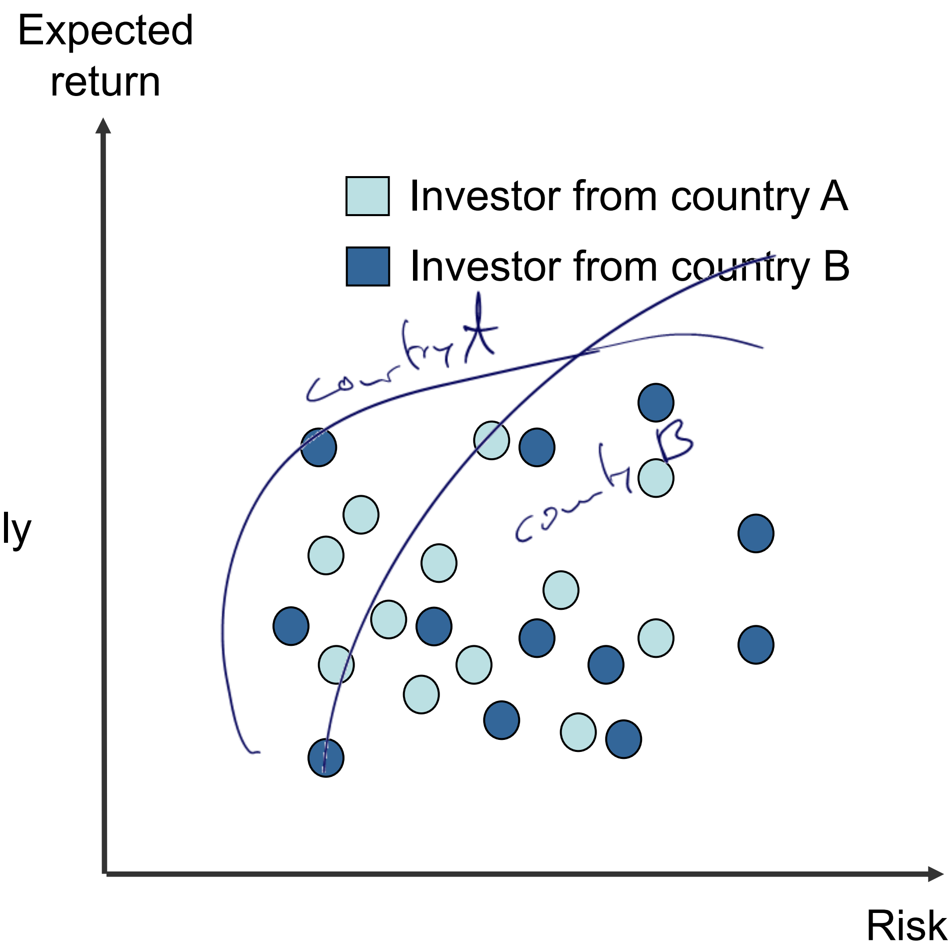
  Reasons: Differences across countries concerning ...

  - Restrictions
  - Capital controls

Implication

Investors in different countries

- are heterogenous regarding
  - Consumption opportunities
  - Investment opportunities
- evaluate real returns from the same internationally traded asset differently
- face different settings for portfolio optimization
- evaluate the cross-section of internationally traded assets differently



Major classes of international asset pricing models

Utility-based equilibrium IAPM's

A Models that assume equal consumption and investment opportunity sets across countries

B Models that consider differences across the national consumption opportunity sets

C Models that assume the existence of barriers to certain international investments

Arbitrage-motivated IAPM's

D Models that assume that exchange rates are driven by the same factors as asset returns

E Models that consider factors in exchange hedged asset returns

Utility-based equilibrium IAPM's

A	Models that assume equal consumption and investment opportunity sets across countries	Stulz (1984, 1994)
B	Models that consider differences across the national consumption opportunity sets	Solnik (1974), Sercu (1980); Fama/Faber (1979); Grauer/Litzenberger/Stehle (1976); Adler/Dumas (1983); Stulz (1981)

Focus of the lecture

Basic

- Stulz (1984, 1994)
- Solnik (1974), Sercu (1980)
- Adler/Dumas (1983)

Base-line international CAPM

More general international asset pricing models

Assumptions on
- Countries
- Investors' consumption
- Investment opportunities
- Exchange rates
- Inflation and PPP
- …

Portfolio choice

Asset pricing restriction

Part 3: International asset pricing theories

a. International parity relations

b. Introduction into the setting of international asset pricing

c. Base-line International CAPM

d. Structure of more general IAPM's

Base-line International CAPM of Stulz 1984

Assumptions („no real differences between investors ...") → All countries equal

- No differences concerning consumption and investment opportunities across countries
- All investors consume the same single good (same tastes)
- Consumption good is available in every country, freely traded across borders and can be used for borrowing or lending
- Real price of the consumption good is always the same in all countries: CPP (PPP) holds all the time
- Perfect markets, no frictions
- No barriers to international investment
- All investors are risk-averse, maximize end-of-period consumption
- Consumption good is used as numeraire to calculate real returns

Base-line International CAPM of Stulz 1984 (cont.)

Consequences

- **Expected real returns are the same** for all investors across different countries
- Existence of multiple **countries can be ignored** completely
- All investors face the **same input parameters for portfolio optimization**

Optimal portfolio choice

Any investor desires a combination of ...

- Risk-free asset
- Portfolio of risky assets that is common to all investors across countries (world market portfolio)

Base-line International CAPM of Stulz 1984 (cont.)

Under the assumed conditions the following pricing restriction holds:

$$E(R_i^{real}) = R_f^{real} + \beta_i^{real} \cdot (E(R_{WM}^{real}) - R_f^{real})$$

(Real-ICAPM)

everything in real instead of nominal terms

where $$\beta_i = \frac{Cov(R_i^{real}, R_{WM}^{real})}{Var(R_{WM}^{real})}$$

$$R_i^{real} = \frac{P_{it} / P_{good,t}}{P_{i,t-1} / P_{good,t-1}} \quad \text{"real asset return"}$$

$$R_{WM}^{real} = \frac{P_{WMt} / P_{good,t}}{P_{WM,t-1} / P_{good,t-1}} \quad \text{"real world market return"}$$

Exercise question

On 20 April 2018 the price of an Apple stock is 172.80 USD and the price of one fresh white bread is 2.52 USD. One year before the stock price was 142.44 USD and the bread price was 2.40 USD.

Calculate the real return on Apple shares.

$$R^{AAPL} = \frac{172.80/2.52}{142.44/2.40} - 1 = 0,1554$$

↳ real return of AAPL is 15.54%

$$\text{Nominal return} = \frac{172.8}{142.44} - 1 = 21,31\%$$

Base-line International CAPM of Stulz 1984 (cont.)

Does the ICAPM also hold in terms of a certain currency?

Yes, but the following additional assumptions must be made

(1) Existence of a risk-free asset denominated in the country's currency, having a zero world market beta

(2) Inflation rate in the country is uncorrelated with nominal returns (inflation risk is not systematic)

Base-line International CAPM of Stulz 1984 (cont.)

Derivation of the ICAPM in nominal terms

Step 1: Rewriting the Real-ICAPM taking a certain currency perspective

r = excess return

$$\underbrace{E\left(\frac{r_i^d}{1+\pi^d}\right)}_{\text{excess real return}} = \beta_i^d \cdot \underbrace{E\left(\frac{r_{WM}^d}{1+\pi^d}\right)}_{\text{excess market return}} \qquad \text{where} \qquad \beta_i^d = \frac{\mathrm{Cov}\left(\frac{r_i^d}{1+\pi^d}, \frac{r_{WM}^d}{1+\pi^d}\right)}{\mathrm{Var}\left(\frac{r_{WM}^d}{1+\pi^d}\right)}$$

$r_i^d = R_i^d - R_f^d$ asset excess return

$r_{WM}^d = R_{WMi}^d - R_f^d$ world market excess return

π^d domestic inflation rate

Base-line International CAPM of Stulz 1984 (cont.)

Derivation of the ICAPM in nominal terms

Step 2: Transformation in accordance with COV-Rules $\{E(xy) = E(x)\cdot E(y) + Cov(x,y)$

$$E\left(r_i^d \cdot \frac{1}{1+\pi^d}\right) = \beta_i^d \cdot E\left(r_{WM}^d \cdot \frac{1}{1+\pi^d}\right)$$

$$\Leftrightarrow \quad \underbrace{Cov\left(r_i^d, \frac{1}{1+\pi^d}\right)}_{\substack{=0 \\ \text{by assumption}}} + E(r_i^d)\cdot E\left(\frac{1}{1+\pi^d}\right) = \beta_i^d \cdot \left\{\underbrace{Cov\left(r_{WM}^d, \frac{1}{1+\pi^d}\right)}_{\substack{=0 \\ \text{by assumption}}} + E\left(r_{WM}^d\right)\cdot E\left(\frac{1}{1+\pi^d}\right)\right\}$$

$$\Leftrightarrow \quad E(r_i^d) = \beta_i^d \cdot E(r_{WM}^d)$$

Base-line International CAPM of Stulz 1984 (cont.)

ICAPM in nominal terms

$$E(R_i^d) = R_f^d + \beta_i^d \cdot (E(R_{WM}^d) - R_f^d)$$

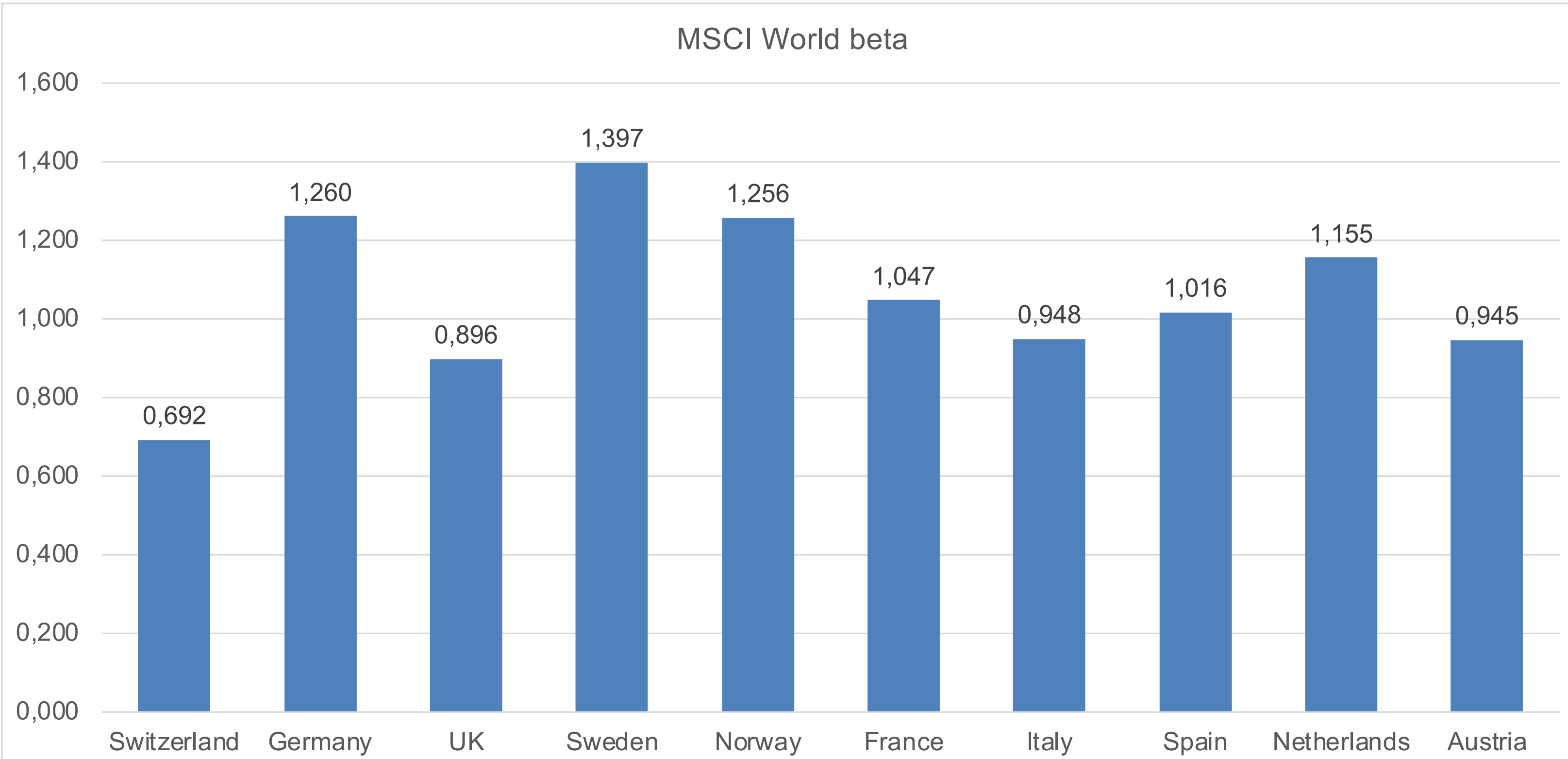
Characteristics

- **Appeal:** Pricing model in terms of returns denominated in a certain country's currency; the currency of any country can be used
- **Critical assumption:** Inflation rate changes do not systematically affect the cross-section of asset returns
- **Practicability:** If the covariance between inflation rate changes and asset returns is small, formula can be used as an approximation

Assumes zero correlation between inflation & asset returns

Base-line International CAPM of Stulz 1984 (cont.)

Use case: Visualizing the market risk of selected European stock markets from the perspective of an investor denominating returns in EUR



Source: Own calculations, data: case2.xlsx

Base-line International CAPM of Stulz 1984 (cont.)

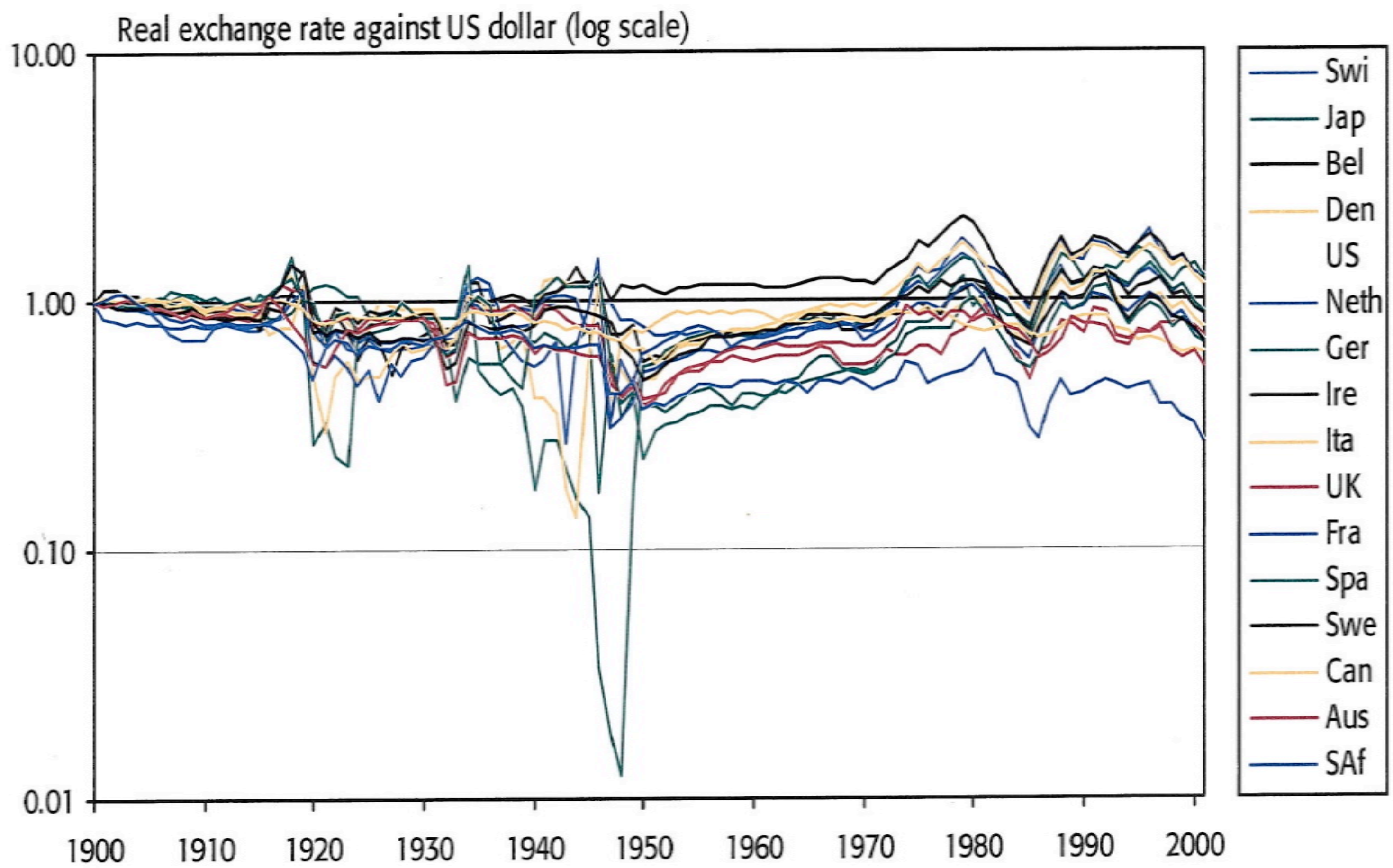
Finally, a critical look

The model does not adequately fit to reality, because

- Investors in different countries do not have the same preferences
- Transportation costs, taxes, tariffs, etc. cause differences in the structure of relative prices across countries
- Prices change differently over time across countries

$\Rightarrow$ **No reason for PPP to hold!**

PPP – holds in the long run but is disturbed over the short term!



Source: Elroy Dimson, Paul Marsh and Mike Staunton, Triumph of the Optimists, 2002

Part 3: International asset pricing theories

Cornerstones of the more general asset pricing setting

Existence of PPP deviations!

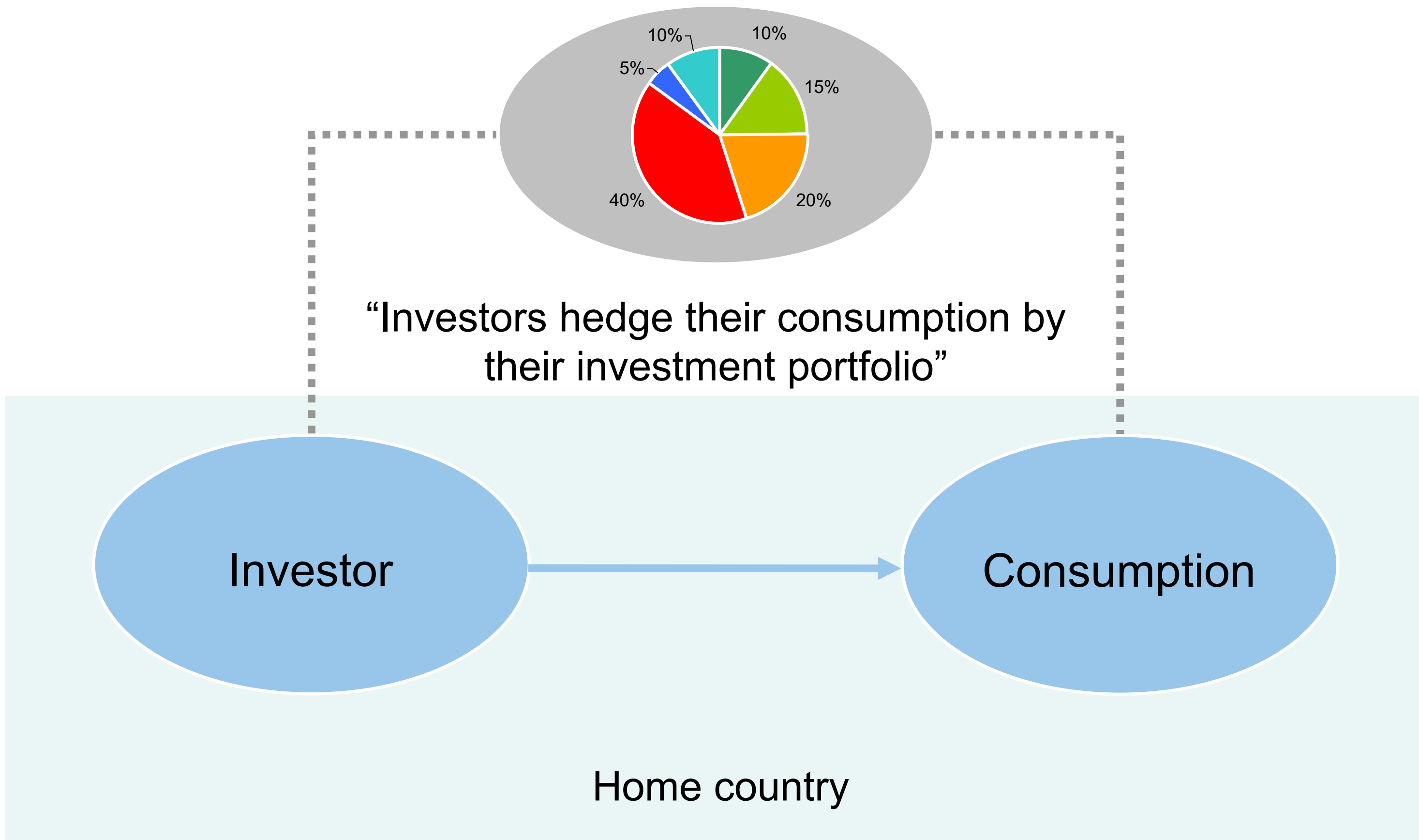
- Consumption opportunity sets change differently across countries
- Investors face exchange rate risk due to unforeseen deviations from PPP
- Shifts in PPP change the risk-return perception of an internationally traded asset differently for investors from different countries

General assumptions

(1) Investors in any country are willing to hedge against unanticipated changes in the price of their specific consumption basket

(2) Investors hedge their consumption by their investment portfolio

The core idea



The hedging property of an asset becomes relevant for pricing

What does that mean?

- The hedging property of an internationally traded asset with respect to consumption depends on which country's perspective is taken
- Investors in different countries have different expected returns for the same internationally traded asset
- Investors in different countries hold different investment portfolios

Challenges for IAPM's

- Portfolio choice in a world with consumption hedging
- Market clearing and equilibrium pricing across heterogeneous investors

Model of Solnik 1974

Assumptions

- Differences in the consumption opportunities across countries: Single consumption good in each country
- No local inflation: Exchange rate shifts mirror pure deviations from PPP
- Segmentation of product markets, no international trade in goods → only stocks & bonds
- Exchange rate shifts are uncorrelated to stock returns
- In each country a risk-free bond exists
- Investment opportunities are the same across countries:
  - Domestic risk-free bond
  - Domestic common stocks
  - Foreign risk-free bonds
  - Foreign common stocks

Model of Solnik 1974 (cont.)

Portfolio choice of every investor in the world

3 components of ideal portfolio

1. **World market portfolio hedged against exchange rate risk** → based on exchange rate expectations
   - International stock positions are hedged by going short in local risk-free bonds (zero-investment portfolio) → eliminates currency risk
   - Fund representing pure market risk

   short

2. **Portfolio of risk-free bonds of all countries (currency risk hedge fund)** → exchange-rate-risk free
   - International bond positions weighted in accordance with currency speculation
   - Fund representing pure currency risk

   long

3. **Risk-free bond of the home country** → risk-free

→ Market positions are hedged by going short in the currency position

Model of Solnik 1974 (cont.)

Asset pricing restriction

$$E(R_i^d) = R_f^d + \beta_i^{d\ell} \cdot (E(R_{WM}^{\ell}) - \overline{R}_f^{\ell})$$

where R^d return denominated in domestic currency

R^{ℓ} return denominated in local currency of the country

Critical assumption

- World stock investments do not carry any exchange rate risk and, hence, no potential for hedging exchange rate risk
- Protection against exchange rate risk is attainable solely by foreign currency bond investments

Model of Solnik 1974 (cont.)

Example of an investment portfolio with market and currency exposures when the reference currency is the EUR

Investment of 30 in US bonds and 20 in US stocks, taking only 30 exposure to USD

Investment of 10 in UK stocks, taking 0 exposure to GBP

	Long positions	Short positions	Net positions
EMU bonds	40		40
EMU stocks	30		30
US bonds	30	-20	10
US stocks	20		20
UK bonds	0	-10	-10
UK stocks	10		10
	130	-30	100

eliminates currency risk

take equity risk

eliminate currency risk

Model of Adler and Dumas 1983

Most important assumptions

- Differences across country-specific consumption baskets
- Stochastic inflation in each country → Domestic bonds are not risk-free

„New“ Implications

- Domestic bond investments are not save in real terms
- Correlations between returns on internationally traded assets and domestic inflation affects the real return of an investment

Model of Adler and Dumas 1983 (cont.)

Portfolio choice of every investor in the world

1. **Universal world market portfolio of risky assets** → long risky assets
   – Same weighting of internationally traded risky assets irrespective of the residence country of the investor
2. **Individual inflation hedge portfolio** → short assets correlated with interest rate
   – Individual weighting of assets such that the nominal return of the portfolio is most highly correlated with the inflation rate in the residence country of the investor

Crucial insights

- Expected return of an asset depends on its usefulness to hedge PPP risk rather than on its world market risk alone
- In equilibrium, expected returns must be consistent with the assets‘ hedging potential in each country as well as the investors‘ willingness to pay for hedging in each country

Model of Adler and Dumas 1983 (cont.)

Asset pricing restriction

domestic   inflation rate

$$E(R_i^d) = \underbrace{R_f^d}_{1} + \underbrace{\lambda_{WM} \cdot Cov(R_i^d, R_{WM}^d)}_{2} + \underbrace{\sum_{j=1}^{L} \lambda_{\pi j} \cdot Cov(R_i^d, \pi_j)}_{3}$$

Market risk ⟸ Risk premium World Market return   ⟶ inflation risk

where		
	λ_{WM}	premium for covariance with the world market
	$\lambda_{\pi j}$	premium for covariance with the jth country's inflation

Characteristics

- Multi-beta pricing model
- World market risk as well as inflation risk are priced

Overview

Portfolio Choice in different IAPM's

Stulz (1984)

↳ similar to CAPM

Risk-free asset

World market portfolio

Solnik (1974)

Risk-free bond of home country

World market portfolio hedged against exchange rate risk

↳ exchange speculation portfolio

Portfolio of risk-free bonds of all countries

Adler/Dumas (1983)

Universal world market portfolio

Individual inflation hedge portfolio

Part 3: Selected references

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International Capital Markets and Investment Practice

Part 4

Rational asset pricing and multifactor models

Prof. Dr. Peter Oertmann
TUM School of Management
Technical University of Munich
peter.oertmann@tum.de

Part 4: Rational asset pricing and multifactor models

a. The idea of rational asset pricing
b. International Arbitrage Pricing Theory (IAPT)
c. Specification of a global multifactor asset pricing model
d. Empirical study: Sources of Risk in Emerging Markets
e. Case: Economic risks of European stock markets
f. Exercise: Application of a factor model

Part 4: Positioning in the lecture

Major fields in asset management

Diversification	Asset allocation
Security selection	Investment strategy implementation
Risk management	Trading and execution

Knowledge base

Stylized facts on global markets Empirical research	**Sources of risk and return** Models and empirical research
Asset pricing Theories, models and empirical tests	**Portfolio construction** Models and empirical tests
Financial economics Models and empirical research	**Time series analysis** Models and empirical procedures

Part 4: Rational asset pricing and multifactor models

a. The idea of rational asset pricing
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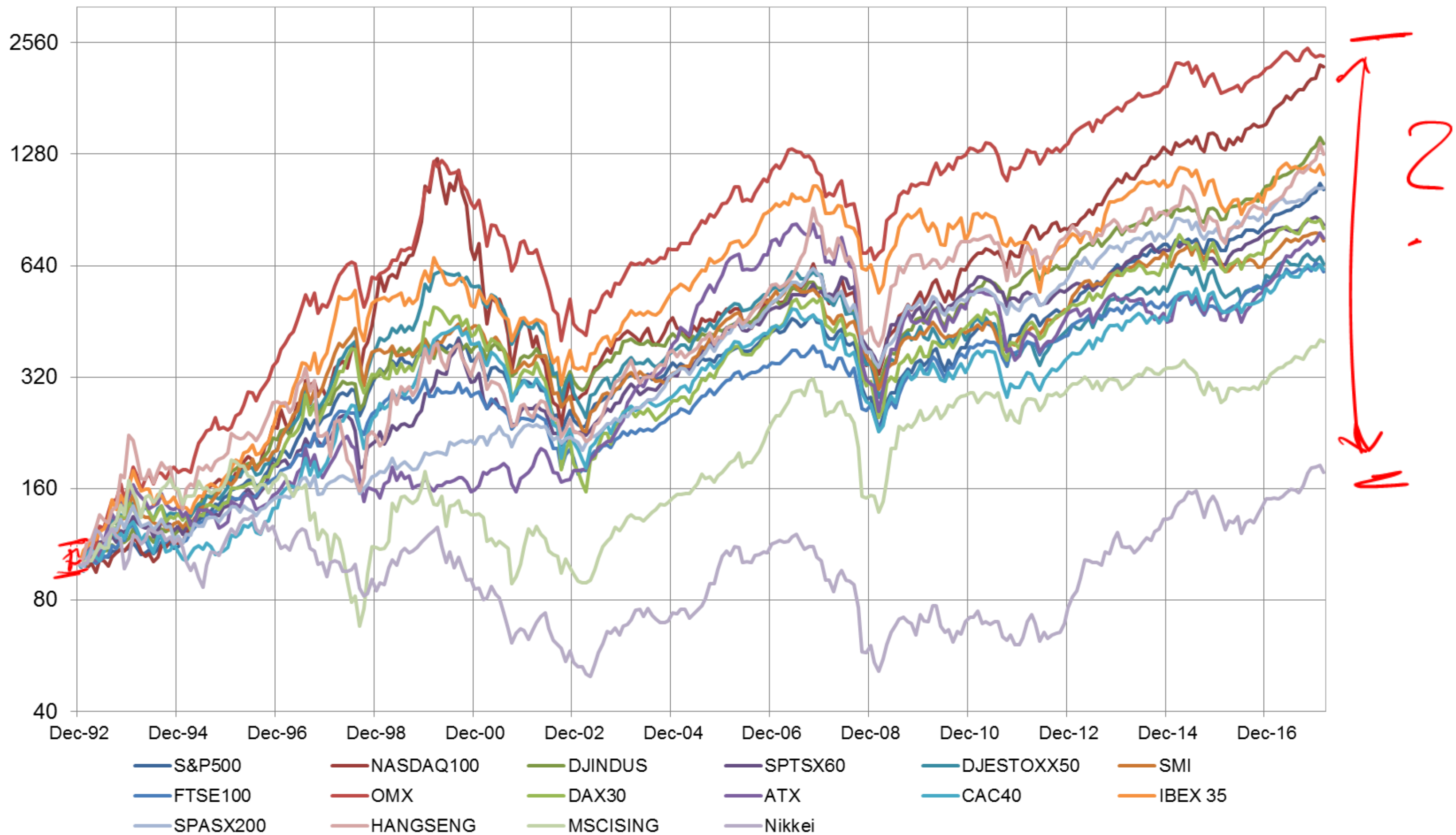
What moves the capital markets?



The idea of rational asset pricing

Experience

- Asset prices react to economic news
- A variety of unanticipated events influence asset prices, and some events have a more pervasive effect on asset prices than others
- The co-movements of asset prices suggest the existence of common exogenous driving forces

unknown

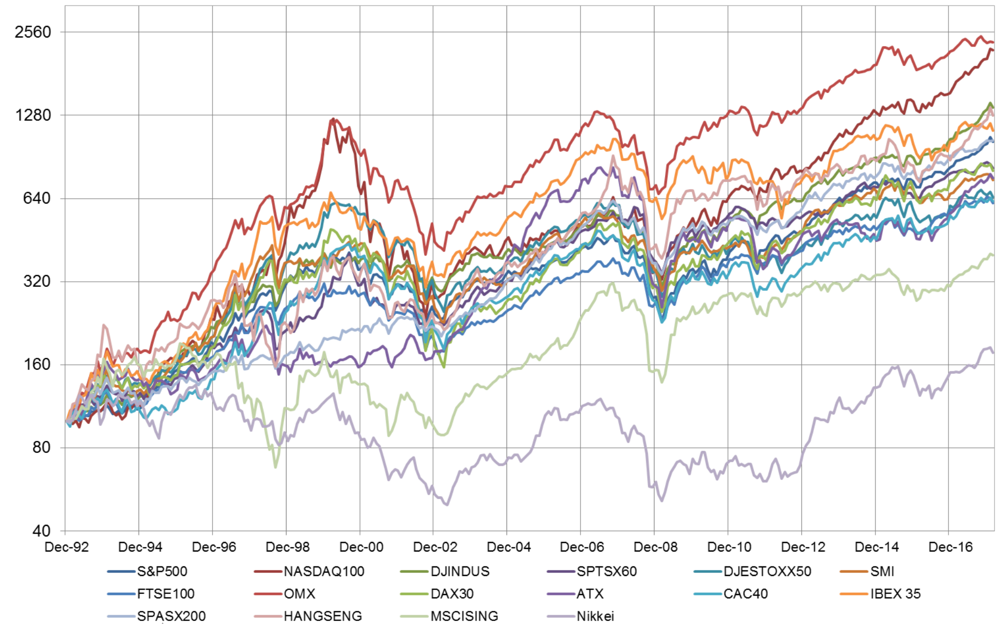
Theory

- Asset prices depend on their exposures to (latent) state variables that describe the economy and are likely sources of systematic investment risk
- Foundation: Merton (1973); Cox, Ingersoll and Ross (1985); Ross (1976)

Empirical approach

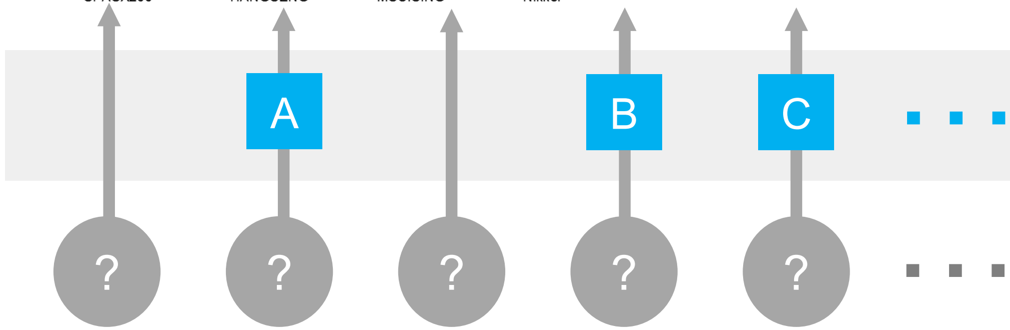
- Economic variables are used as proxies for the latent variables
- Seminal work: Chen, Roll and Ross (1986)

Asset prices are exposed to variables describing the economy



Evolution of asset prices

- Long-term returns
- Return volatilities
- Cross-sectional dispersion



Economic proxy variables

Latent state variables that describe the economy

Chen, Roll and Ross (1986) – Starting point

Stock prices can be written as expected discounted dividends:

$$P = \frac{E(c)}{k}$$

where c is the dividend stream and k is the discount rate. This implies:

$$\frac{dP}{P} + \frac{c}{P} = \frac{d[E(c)]}{E(c)} - \frac{dk}{k} + \frac{c}{P}$$

It follows (trivially) that the systematic forces that influence returns are those that change discount factors, k, and expected cash flows, E(c).

Chen, Roll and Ross (1986) – Proxies for state variables

A **Industrial production**
- Monthly growth rate industrial production (MP)
- Yearly growth rate in industrial production (YP)

B **Inflation**
- Unanticipated inflation (UI)
- Change in expected inflation (DEI)

change in spread between Baa
and AAA gov. bonds

C **Risk premium:** Unanticipated change in the risk premium (Baa and under return minus long-term government bond return) (UPR)

D **Term structure:** Unanticipated change in the term structure (long-term government bond return minus Treasury-bill rate) (UTS)

E **Stock market**
- Return on the value-weighted NYSE index (VWNY)
- Return on the equally weighted NYSE index (EWNY)

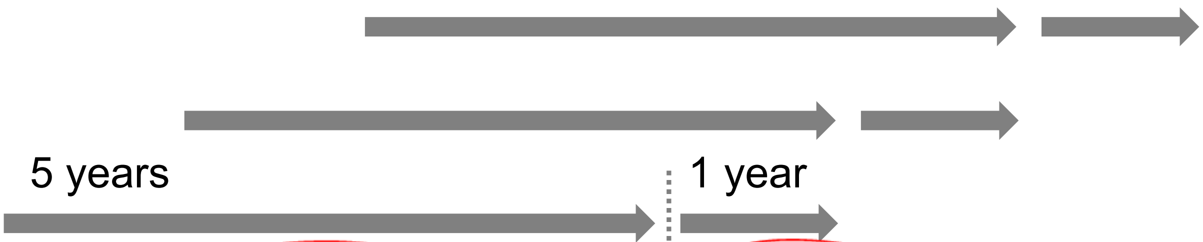
F **Innovation in real per capita consumption**

G **Oil price**

$$P = \frac{E(c)}{k}$$

Chen, Roll and Ross (1986) – How risk premiums are determined

Application of the Fama-MacBeth (1973) approach



Time-series regression of asset returns on economic state variables

Cross-sectional regression of monthly asset returns on state variable betas

Estimating state variable exposures (betas)

Generating a times-series of estimated risk premiums

t-test

Testing the time-series mean for significance

Chen, Roll and Ross (1986) – Empirical results

Priced sources of risk Main drivers

A Industrial production

C Risk premium

D Term structure

Strong evidence

B Unanticipated inflation

B Change in expected inflation

Weak evidence

Not priced

E Stock market

F Innovation in real per capita consumption

G Oil price

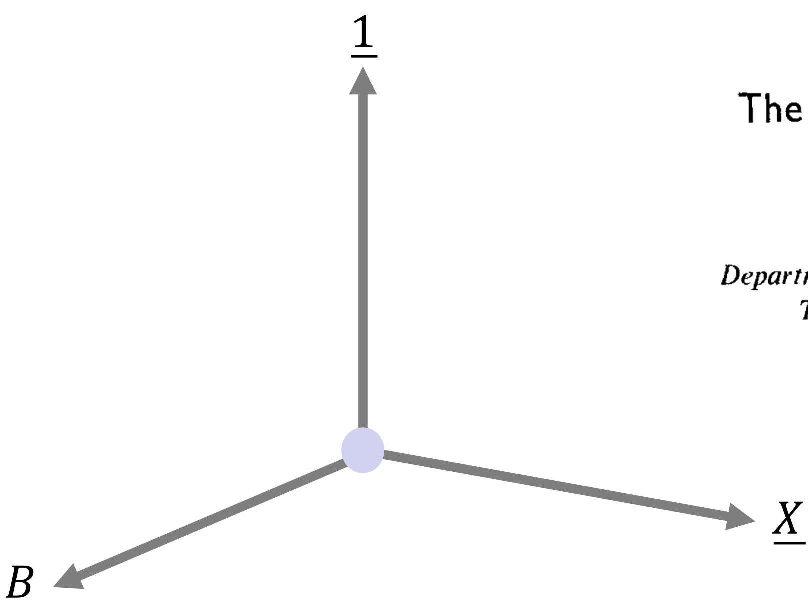
„Perhaps the most striking result is that even though a stock market index, such as the value-weighted New York Stock Exchange index, explains a significant portion of the time-series variability of stock returns, it has an insignificant influence on pricing (i.e., on expected returns) when compared against the economic state variables“
CRR, 1986, p. 402

Part 4: Rational asset pricing and multifactor models

a. The idea of rational asset pricing
b. International Arbitrage Pricing Theory (IAPT)
c. Specification of a global multifactor asset pricing model
d. Empirical study: Sources of Risk in Emerging Markets
e. Case: Economic risks of European stock markets

The (domestic) APT → Arbitrage Pricing Theory

The starting point is a zero-investment arbitrage portfolio that is analysed in the framework of a multifactor model. It is assumed that this portfolio has no systematic and no unsystematic risk and therefore an expected return of zero. This results in orthogonality conditions as the basis for the APT valuation equation.



The Arbitrage Theory of Capital Asset Pricing

STEPHEN A. ROSS*

Departments of Economics and Finance, University of Pennsylvania, The Wharton School, Philadelphia, Pennsylvania 19174

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Note: The derivation in the lecture follows Oertmann (1996): Strands of the Arbitrage Pricing Theory

Derivation of APT:

Return on any asset can be explained by:

$$R_i = E(R_i) + \beta_{i1}\delta_1 + \dots + \beta_{ik} + \delta_k + \varepsilon_i \quad \forall i = 1, \dots, n$$

$E(\delta_j) = 0 \; ; \; j = 1, \dots, k$

$E(\varepsilon_i) = 0 ; \; i = 1, \dots, k$

$Var(\varepsilon_i) = \sigma_{\varepsilon_i}^2 \leq \sigma_\varepsilon^2$

$Var(\varepsilon_i, \varepsilon_j) = \sigma_{ij} = 0$

(aka strict factor model)

Assumptions

Matrix notation

$$\Longrightarrow \quad R = E + B \cdot \delta + \varepsilon$$

Arbitrary portfolio is formed $x = (x_1, \dots, x_n)$

A) $\boxed{x^T I = 0}$

Arbitrage Portfolio
= zero investment portfolio

$\Longrightarrow$ Return on Portfolio:

$$R_p = x^T R$$

$$= x^T E + x^T B \delta + x^T \varepsilon$$

We assume that the portfolio does not have systematic risk: B) $\boxed{x^T B = 0}$

We assume that it is possible to eliminate all unsystematic risk! $x^T \varepsilon = 0$

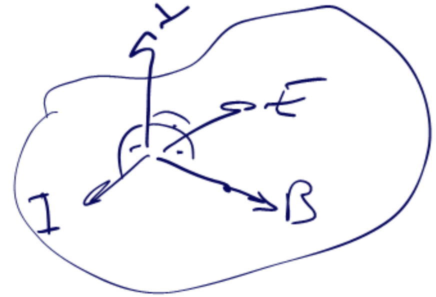
For a portfolio with no systematic and unsystematic risk, the expected return must be zero: $R_p = x^T E + \underbrace{x^T B \delta}_{=0} + \underbrace{x^T \varepsilon}_{=0} \stackrel{!}{=} 0 \Longleftarrow$

$\Longrightarrow$ C) $x^T E = 0$

Now x is orthogonal to: I (A)

B (B)

E (C)



So: $E = I \cdot \lambda_0 + B \cdot \lambda$

where $\lambda = (\lambda_1, \dots, \lambda_k)$

$$\underbrace{\Rightarrow E(R_i) = \underbrace{\lambda_0}_{r_f} + \sum_{j=1}^{k} \lambda_j \cdot \beta_{ij}}_{\text{APT pricing equation}} \quad \forall i = 1, \dots, k$$

systematic risk premium

International APT

Starting point

- Variation of asset returns on international capital markets is driven by common global systematic risk factors (→ multifactor factor model as return generating process)
- Long-term expected returns of internationally traded assets include premiums for global factor risk (→ multifactor pricing restriction)
- Differences in the global factor risk profiles across assets account for differences in expected returns across assets

Theoretical frameworks to derive multifactor pricing restrictions

- IAPM of Adler and Dumas (1983)
- International APT (IAPT) of Solnik (1983) and Ikeda (1991)

International APT (cont.)

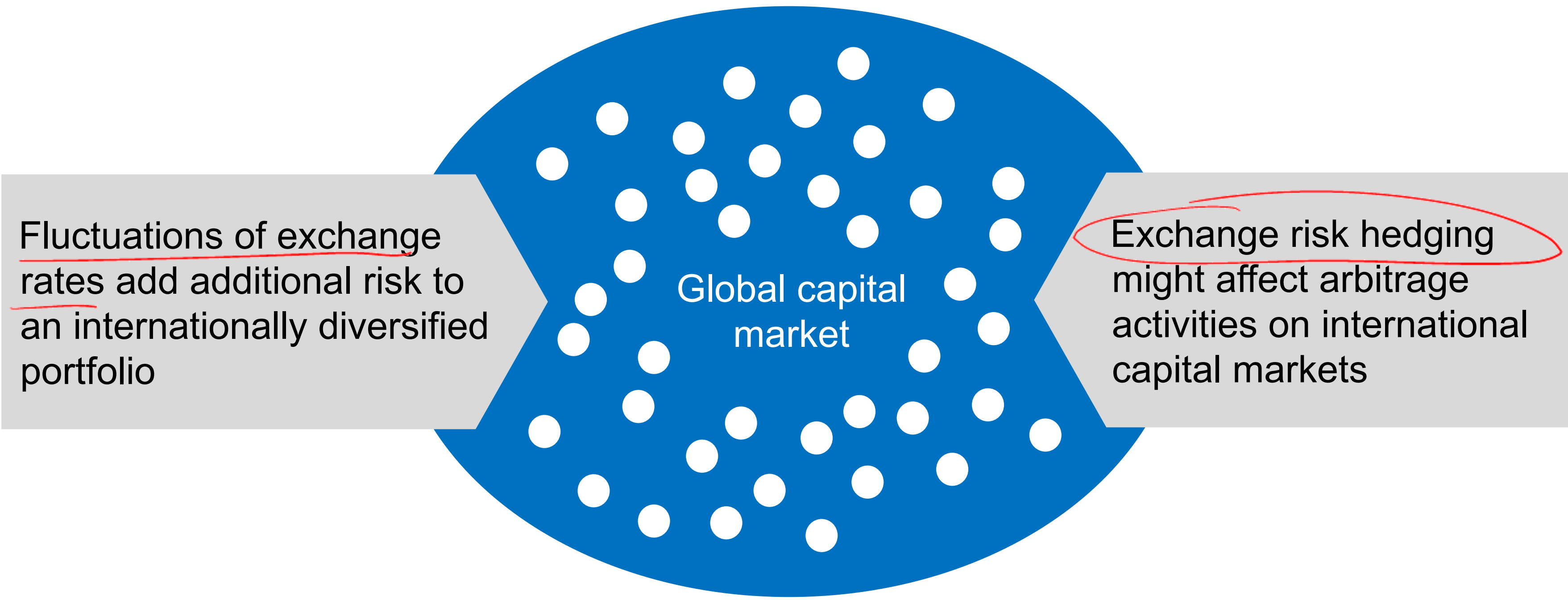
k-factor model generating international asset returns

local currency

$$R_i^i = E\left(R_i^i\right) + \beta_{i1}^i \cdot \delta_1 + \beta_{i2}^i \cdot \delta_2 + \cdots + \beta_{ik}^i \cdot \delta_k + \varepsilon_i^i \qquad \forall\, i = 1, \ldots, n$$

where	R_i^i	return on an asset in country i denominated in local currency
	$E\left(R_i^i\right)$	expected return on asset i
	δ_j	change of global factor j, j=1,..., k
	β_{ij}^i	sensitivity of the return on asset i to changes of global factor j
	ε_i^i	idiosyncratic return on asset i

What might disturb arbitrage pricing in the international environment?



Conditions for arbitrage pricing in an international setting

Idea of arbitrage pricing

In a large capital market, it is possible to construct arbitrage portfolios that do not have any systematic or unsystematic risk in the sense of a given factor structure, i.e. the cross-section of available assets is large enough to permit diversification of idiosyncratic risk

Technical and economic prerequisites

1. The risk stemming from exchange rate changes must be diversifiable like any other unsystematic risk (technical)
2. An arbitrage portfolio that is riskless in any given currency must be riskless in any other currency (technical)
3. The factor structure assumed to drive asset returns must be invariant to the choice of a currency (economic)

How do exchange rate changes enter the model?

IAPT of Ikeda (1991)

Exchange rates changes do not include a systematic component

$$S_i^d = \mathrm{E}(S_i^d) + \vartheta_i^d$$

IAPT of Solnik (1983)

Exchange rates follow the same k-factor model as do international asset returns

$$S_i^d = \mathrm{E}(S_i^d) + b_{i1}^d \cdot \delta_1 + \cdots + b_{ik}^d \cdot \delta_k + \vartheta_i^d$$

Implications $\Rightarrow$ β includes asset returns including factor risk of exchange rate

- Factor betas of asset returns embody both the factor risk of local asset returns and the factor risk of the respective exchange rate change
- Factor structure is invariant to the currency that is chosen to denominate asset returns

IAPT of Solnik 1983

k-factor model for asset returns denominated in domestic currency

$= d$

$$R_i^d = E\left(R_i^d\right) + \beta_{i1}^d \cdot \delta_1 + \beta_{i2}^d \cdot \delta_2 + \cdots + \beta_{ik}^d \cdot \delta_k + \varepsilon_i^d \qquad \forall\, i = 1, \ldots, n$$

where

R_i^d	return on an asset in country i denominated in domestic (d) currency
$E\left(R_i^d\right)$	expected return on asset i
δ_j	change of global factor j, j=1,..., k
β_{ij}^d	sensitivity of the return on asset i to changes of global factor j
ε_i^d	idiosyncratic return on asset i

Under the prevailing assumptions the asset pricing restriction is derived in the same way as for the (domestic) APT.

IAPT of Solnik 1983 (cont.)

International multifactor asset pricing restriction

$$E\left(R_i^d\right) = R_f^d + \beta_{i1}^d \cdot \lambda_1^d + \beta_{i2}^d \cdot \lambda_2^d + \cdots + \beta_{ik}^d \cdot \lambda_k^d$$

where

$E\left(R_i^d\right)$ expected return on asset i denominated in domestic (d) currency

$=$

R_f^d domestic risk-free interest rate

$+$

β_{ij}^d sensitivity of the return on asset i to changes of global factor j

$\cdot$

λ_j^d risk premium for exposure to global factor j, j=1,..., k

and

$$\beta_{ij}^d = \frac{COV\left(R_i^d, \delta_j\right)}{VAR\left(\delta_j\right)}$$

IAPT of Solnik 1983 (cont.)

Components of expected returns

$$E\left(R_i^d\right) = \underbrace{R_f^d}_{\text{Time premium}} + \underbrace{\beta_{i1}^d \cdot \lambda_1^d + \beta_{i2}^d \cdot \lambda_2^d + \cdots + \beta_{ik}^d \cdot \lambda_k^d}_{\text{Factor risk premiums}}$$

Factor risk premiums
Reward investors expect for taking exposure to global systematic factor risks

Time premium
Reward investors expect for investing capital over time

Structure of the international asset pricing restriction

Cross-sectional variation is explained by cross-sectional variation

$$\begin{bmatrix} E(R_1) \\ E(R_2) \\ \vdots \\ E(R_i) \\ \vdots \\ E(R_n) \end{bmatrix} = R_f + \begin{bmatrix} \beta_{11} \\ \beta_{21} \\ \vdots \\ \beta_{i1} \\ \vdots \\ \beta_{n1} \end{bmatrix} \cdot \lambda_1 + \begin{bmatrix} \beta_{12} \\ \beta_{22} \\ \vdots \\ \beta_{i2} \\ \vdots \\ \beta_{n2} \end{bmatrix} \cdot \lambda_2 + \cdots + \begin{bmatrix} \beta_{1k} \\ \beta_{2k} \\ \vdots \\ \beta_{ik} \\ \vdots \\ \beta_{nk} \end{bmatrix} \cdot \lambda_k$$

Mechanics

- Global risk premiums (factor prices) λ are the same across international investments
- Cross-sectional differences in expected asset returns (left-hand side) are explained by cross-sectional differences in the assets' factor betas (right-hand side)

Application 1: Exploring asset return volatility

Volatility drivers

- explain the variance of asset returns (on an asset-by-asset basis)
- can be identified by estimating the beta coefficients in the multifactor model

$$R_i^d = E\left(R_i^d\right) + \beta_{i1}^d \cdot \delta_1 + \beta_{i2}^d \cdot \delta_2 + \cdots + \beta_{ik}^d \cdot \delta_k + \varepsilon_i^d$$

↳ regressing asset returns on factor changes

Beta significant	Beta not significant
Volatility driver – factor with a measurable impact on the return variation of an asset	Factor with no systematic influence

Application 2: Exploring long-term asset returns

Value drivers

- explain the cross-sectional differences (variation) of asset returns
- can be identified by estimating the lambda coefficients in the asset pricing constraint

$$\begin{bmatrix} E(R_1) \\ E(R_2) \\ \vdots \\ E(R_i) \\ \vdots \\ E(R_n) \end{bmatrix} = R_f + \begin{bmatrix} \beta_{11} \\ \beta_{21} \\ \vdots \\ \beta_{i1} \\ \vdots \\ \beta_{n1} \end{bmatrix} \cdot \lambda_1 + \begin{bmatrix} \beta_{12} \\ \beta_{22} \\ \vdots \\ \beta_{i2} \\ \vdots \\ \beta_{n2} \end{bmatrix} \cdot \lambda_2 + \cdots + \begin{bmatrix} \beta_{1k} \\ \beta_{2k} \\ \vdots \\ \beta_{ik} \\ \vdots \\ \beta_{nk} \end{bmatrix} \cdot \lambda_k$$

Lambda significant

Value driver – factor with a measurable impact on the cross-sectional variance of asset returns (priced factor)

↳ the most of the times also volatility driver

Lambda not significant

Unsystematic factor (...but it may be a volatility driver)

Part 4: Rational asset pricing and multifactor models

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e. Case: Economic risks of European stock markets
f. Exercise: Application of a factor model

Empirical study: Identifying common factors for stocks and bonds

Starting point

- An **unconditional beta pricing model** is used to examine the structure of returns and expected returns across 17 stock markets and 8 bond markets.
- The valuation framework is **consistent with the APT** developed by Ross (1976), Huberman (1982), Chamberlain (1983), Chamberlain and Rothschild (1983), Ingersoll (1984), and others. A theoretical foundation for using the APT in an international context is given by Solnik (1983).

Set up of the model

1. **Multiple risk factors** have an impact on variances as well as on long-term averages of returns of international assets
2. Only **global factors** are sources of systematic risk
3. A set of **observable economic factors** is a valid representation of the factor structure driving asset returns

Source: Oertmann (1997), documented in Zimmermann/Drobetz/Oertmann (2002), Chapter 5

The sample of international assets

- **17 international stock markets** represented by total return indices as provided by Morgan Stanley Capital International (MSCI). The MSCI stock indices included represent about 60 percent of the world stock market capitalization
- **8 international bond markets** represented by total return indices as provided by Salomon Brothers

reference currency d

	Swiss Francs		Local Currency	
	Mean (% Annual)	SD (% Annual)	Mean (% Annual)	SD (% Annual)
World stock markets	5.807	17.546	5.036	13.960
World bond markets	4.157	9.878	3.715	6.157

Note: Means and standard deviations are annualized values, calculated on the basis of continuously compounded monthly excess returns over the period from 1982.02 to 1995.02. For the excess returns denominated in Swiss francs, the one-month Eurocurrency interest rate for Swiss francs is applied as the risk-free rate. Excess returns calculated in local currency are based on local risk-free interest rates.

Source: Zimmermann/Drobetz/Oertmann (2002), Chapter 5, Table 5.1

Predetermined global factors in the study

- Seven global factors ("factor candidates")
- Aggregate information on potential global sources of systematic risk
- Swiss franc perspective
- The set of predetermined global risk factors includes
  1. Change in G-7 inflation rates (ING7C) → GDP weighted
  2. Change in G-7 industrial production indices (IPG7C)
  3. Change in G-7 long-term interest rates (ILG7C)
  4. Change in G-7 short-term interest rates (ISG7C)
  5. Change in the price of the G-7 currencies measured in Swiss francs (CHG7C)
  6. Dow Jones commodity price index change (DJCIC)
  7. Excess return on the world stock market (WDSTR)

Predetermined global factors in the study – some statistics

autocorrelation

	Change			Correlations between Total Factor Changes						
	Mean (% Annual)	SD (% Annual)	AC(1)	WDSTR	ING7C	IPG7C	ISG7C	ILG7C	CHG7C	DJCIC
WDSTR	5.807	17.546	−0.146	1.000	−0.078	−0.154	−0.118	−0.211	0.507	0.000
ING7C	3.587	0.757	0.319		1.000	−0.029	0.107	0.249	0.176	−0.032
IPG7C	2.423	2.120	−0.118			1.000	0.207	0.139	−0.016	0.090
ISG7C	−6.848	14.135	0.143				1.000	0.552	0.094	0.110
ILG7C	−4.733	10.200	0.403					1.000	0.095	0.074
CHG7C	−1.601	5.584	0.090						1.000	−0.091
DJCIC	1.021	9.530	−0.097							1.000

Notes: WDSTR = World stock market excess return denominated in Swiss francs; ING7C = G7 inflation rate change; IPG7C = Change in industrial production in the G7 countries; ISG7C = Change in the level of G7 short-term interest rates; ILG7C = Change in the level of G7 long-term interest rates; CHG7C = Change in the price of a trade-weighted basket of the G7 currencies measured in Swiss francs; DJCIC = Change in the Dow Jones commodity price index. SD = Standard deviation; and AC(1) = First-order autocorrelation. The sample period runs from 1982.02 to 1995.02.

Source: Zimmermann/Drobetz/Oertmann (2002), Chapter 5, Table 5.3

Objectives and empirical design of the study

Step 1 **Identification of volatility drivers**

The association between monthly changes of global economic factors and contemporaneous excess returns on stock and bond markets is investigated in the setting of factor model regressions.

Step 2 **Identification of value drivers**

An additional analysis attends to the question whether some of the global factors that have been identified to be related to the variance of international asset returns do also affect the expected returns on these assets.

The investigation concentrates on those factors that show up with an influence on both stock and bond markets in the preliminary regression analysis (Step 1).

Both an empirical version of the international CAPM and a multifactor pricing model are estimated.

Step 1 – Return generating process and factor model

k=7

7-factor model for stock and bond returns

The following regression is assumed to explain the relation between excess returns, expected excess returns, denominated in Swiss francs (CHF), and the factors inherently affecting the excess returns on international stock and bond markets:

(1a) $$\underbrace{r_{it}^{CHF}}_{\text{access return on asset}} = E\left(r_i^{CHF}\right) + \beta_{i1}^{CHF} \cdot \delta_{1t} + \beta_{i2}^{CHF} \cdot \delta_{2t} + \cdots + \beta_{i7}^{CHF} \cdot \delta_{7t} + \varepsilon_{it}^{CHF}$$

Empirical version:

(1b) $$r_{it} = a_i + \beta_{i1} \cdot \delta_{1t} + \beta_{i2} \cdot \delta_{2t} + \cdots + \beta_{i7} \cdot \delta_{7t} + \varepsilon_{it}$$

for $\mathrm{i} = 1, \ldots, 17$ (stock markets), $\mathrm{i} = 1, \ldots, 8$ (bond markets)

Step 1 – Factor model regressions

Regression of stock and bond market excess returns on the predetermined global risk factors

WDSTR stands for the world stock market excess return denominated in Swiss francs; ING7C is the G-7 inflation rate change; IPG7C is the change in industrial production in the G-7 countries; ISG7C denotes the change in the level of G-7 short-term interest rates, ILG7C is the change in the level of G-7 long-term interest rates; CHG7C is the change in the price of a trade-weighted basket of the G-7 currencies measured in Swiss francs; DJCIC stands for the change in the Dow Jones commodity price index. The SUR system of equations is (model 5):

$$r_{it} = a_i + \beta_{i1} \cdot \delta_{1t} + \beta_{i2} \cdot \delta_{2t} + \ldots + \beta_{i7} \cdot \delta_{7t} + \varepsilon_{it}, \; i = 1, ..., 17 \text{ (stock markets)}; \; i = 1, ..., 8 \text{ (bond markets)}$$

t-statistics are reported underneath the coefficients (factor betas). 'a' / 'b' indicates a coefficient that looses/attains significance when the regressions are run with an outlier adjustment; the procedure to adjust for outliers drops any observation for which the residual is larger than 2 standard errors in a preliminary regression. D.W. is the Durbin-Watson test statistic; R^2 denotes the coefficient of determination; adj R^2 is adjusted for degrees of freedom. All explanatory variables represent innovations.

		Global risk factor betas									
Stock markets	Intercept	WDSTR	ING7C	IPG7C	ISG7C	ILG7C	CHG7C	DJCIC	D.W.	R^2	adj R^2
Australia	0.003	1.084	-1.864	-0.717	0.025	0.350 [a]	2.655	0.672	2.221	0.490	0.465
	0.624	*7.908*	*-0.637*	*-0.730*	*0.151*	*1.391*	*7.449*	*3.292*			
Austria	0.005	0.410	-3.201	1.294 [a]	0.127	-0.236	1.456	0.310	1.625	0.164	0.124
	1.040	*2.963*	*-1.084*	*1.305*	*0.760*	*-0.928*	*4.046*	*1.505*			
Belgium	0.009	0.786	-4.403	0.802 [b]	-0.131 [b]	-0.166	1.362	0.314	1.748	0.529	0.506
	2.931	*9.060*	*-2.379*	*1.291*	*-1.242*	*-1.044*	*6.035*	*2.431*			
Canada	0.000	0.873	-5.409	-0.664	-0.056	-0.088	2.303	0.386	1.964	0.662	0.646
	0.032	*10.672*	*-3.103*	*-1.135*	*-0.565*	*-0.588*	*10.383*	*3.176*			
Denmark	0.004	0.510	-1.039	-0.392	-0.087	-0.457	1.601	0.239	1.864	0.342	0.311
	1.075	*5.165*	*-0.493*	*-0.554*	*-0.730*	*-2.518*	*6.232*	*1.630*			
France	0.006	0.829	-2.504	0.445 [b]	-0.015	-0.637	1.553	0.407	1.863	0.511	0.488
	1.664	*8.701*	*-1.233*	*0.652*	*-0.135*	*-3.643*	*6.273*	*2.871*			

explain 34.1% of variation

Step 1 – Factor model regressions (cont.)

significant

		Global risk factor betas									
Stock markets - cont.	Intercept	WDSTR	ING7C	IPG7C	ISG7C	ILG7C	CHG7C	DJCIC	D.W.	R^2	adj R^2
Germany	0.005 [b]	0.635	-4.026	0.453	0.002	-0.391	1.583	0.258 [a]	1.857	0.341	0.310
	1.411	*5.853*	*-1.739*	*0.582*	*0.015*	*-1.962*	*5.608*	*1.597*			
Hong Kong	0.006 [b]	1.168	-4.908	-1.362	0.007	0.387	2.792	0.161	1.831	0.364	0.334
	0.974	*6.477*	*-1.276*	*-1.055*	*0.036*	*1.171*	*5.956*	*0.598*			
Italy	0.002	0.782	-8.590	0.632	-0.037	-0.340	1.606	0.323	1.934	0.325	0.293
	0.420	*5.819*	*-2.998*	*0.657*	*-0.228*	*-1.379*	*4.598*	*1.615*			
Japan	0.005 [a]	1.221	-1.880 [b]	-1.261	0.124	-0.361 [a]	0.953	0.162	1.652	0.577	0.557
	1.289	*11.661*	*-0.842*	*-1.681*	*0.981*	*-1.882*	*3.506*	*0.298*			
Netherlands	0.010	0.761	-3.697	-0.192	-0.010	-0.234	1.630	0.189	1.824	0.622	0.604
	3.642	*10.668*	*-2.429*	*-0.376*	*-0.117*	*-1.788*	*8.787*	*1.784*			
Norway	0.004 [b]	1.142	0.944	-0.037	-0.045	0.263	2.004	0.416	1.808	0.473	0.448
	0.846	*9.020*	*0.349*	*-0.041*	*-0.294*	*1.133*	*6.089*	*2.207*			
Spain	0.004	0.910	-1.794	-0.769	0.196	-0.555	2.058	0.351	1.834	0.445	0.419
	0.996	*7.857*	*-0.726*	*-0.927*	*1.397*	*-2.611*	*6.837*	*2.037*			
Sweden	0.007	0.994	-3.838 [a]	-0.718 [b]	0.125	-0.073	2.003	0.158	1.937	0.463	0.438
	1.758	*8.569*	*-1.552*	*-0.864*	*0.893*	*-0.344*	*6.646*	*0.919*			
Switzerland	0.006	0.769	-3.757	-0.959	-0.017	-0.280	1.117	0.267	1.832	0.530	0.508
	2.311	*10.452*	*-2.393*	*-1.819*	*-0.193*	*-2.073*	*5.838*	*2.445*			
United Kingdom	0.005	0.881	-2.433	-0.569	-0.157	-0.106 [b]	2.016	0.161	1.958	0.617	0.599
	1.612	*10.816*	*-1.402*	*-0.977*	*-1.593*	*-0.713*	*9.527*	*1.332*			
United States	0.004	0.959	-3.173	-1.553	-0.049	-0.129 [b]	2.281	0.190 [a]	1.745	0.775	0.765
	1.911	*14.599*	*-2.266*	*-3.299*	*-0.618*	*-1.076*	*13.362*	*1.947*			

Step 1 – Factor model regressions (cont.)

		Global risk factor betas									
Bond markets	Intercept	WDSTR	ING7C	IPG7C	ISG7C	ILG7C	CHG7C	DJCIC	D.W.	R^2	adj R^2
Canada	0.003	0.318	-2.342	-0.139	-0.151 [a]	-0.289	1.814	0.013	1.953	0.492	0.468
	1.186	*4.327*	*-1.489*	*-0.263*	*-1.687*	*-2.135*	*9.448*	*0.127*			
France	0.004	0.045	0.692	0.139	-0.033	-0.331	0.715	0.024 [b]	2.195	0.381	0.352
	2.588	*1.116*	*0.802*	*0.481*	*-0.671*	*-4.451*	*6.798*	*0.413*			
Germany	0.002	-0.061	-0.478 [b]	0.135	-0.021	-0.307	0.653	0.012	1.876	0.415	0.388
	2.234	*-1.833*	*-0.667*	*0.562*	*-0.523*	*-4.990*	*7.475*	*0.251*			
Japan	0.005	0.218	-0.394	0.236	-0.025	-0.301	0.681	0.048	1.774	0.246	0.210
	2.219	*3.611*	*-0.305*	*0.543*	*-0.344*	*-2.699*	*4.311*	*0.533*			
Netherlands	0.002	-0.034	-0.327	0.041	-0.058	-0.251	0.629	0.035	1.774	0.414	0.386
	2.317	*-1.071*	*-0.477*	*0.182*	*-1.503*	*-4.245*	*7.520*	*0.740*			
Switzerland	-0.000	0.007	-0.768	0.008	-0.030	-0.128	0.089	0.067	1.464	0.212	0.175
	-0.197	*0.341*	*-1.653*	*0.053*	*-1.147*	*-3.192*	*1.578*	*2.092*			
United Kingdom	0.002	0.098 [a]	-0.045	0.188	-0.215	-0.273	1.465	0.011	1.612	0.403	0.375
	0.936	*1.494*	*-0.032*	*0.396*	*-2.676*	*-2.248*	*8.492*	*0.115*			
United States	0.002	0.277	-0.015	-0.427	-0.139	-0.361	1.733	-0.014	1.676	0.615	0.597
	1.261	*4.746*	*-0.012*	*-1.019*	*-1.969*	*-3.358*	*11.364*	*-0.169*			

Step 1 – Performing Wald tests

Hypothesis 1 "The factor betas are equal to zero for all the markets"

$$H_0\colon \beta_{ij} = 0$$

for i = 1, ..., 17 (stock markets); i = 1, ..., 8 (bond markets)

Hypothesis 2 "The factor betas are jointly equal across the markets"

$$H_0\colon \beta_{ij} = \beta_j$$

for i = 1, ..., 17 (stock markets); i = 1, ..., 8 (bond markets)

Step 1 – Wald tests impose cross-sectional restrictions on betas

		Global risk factor betas									
Bond markets	Intercept	WDSTR	ING7C	IPG7C	ISG7C	ILG7C	CHG7C	DJCIC	D.W.	R^2	adj R^2
Canada	0.003	0.318	-2.342	-0.139	-0.151 [a]	-0.289	1.814	0.013	1.953	0.492	0.468
	1.186	*4.327*	*-1.489*	*-0.263*	*-1.687*	*-2.135*	*9.448*	*0.127*			
France	0.004	0.045	0.692	0.139	-0.033	-0.331	0.715	0.024 [b]	2.195	0.381	0.352
	2.588	*1.116*	*0.802*	*0.481*	*-0.671*	*-4.451*	*6.798*	*0.413*			
Germany	0.002	-0.061	-0.478 [b]	0.135	-0.021	-0.307	0.653	0.012	1.876	0.415	0.388
	2.234	*-1.833*	*-0.667*	*0.562*	*-0.523*	*-4.990*	*7.475*	*0.251*			
Japan	0.005	0.218	-0.394	0.236	-0.025	-0.301	0.681	0.048	1.774	0.246	0.210
	2.219	*3.611*	*-0.305*	*0.543*	*-0.344*	*-2.699*	*4.311*	*0.533*			
Netherlands	0.002	-0.034	-0.327	0.041	-0.058	-0.251	0.629	0.035	1.774	0.414	0.386
	2.317	*-1.071*	*-0.477*	*0.182*	*-1.503*	*-4.245*	*7.520*	*0.740*			
Switzerland	-0.000	0.007	-0.768	0.008	-0.030	-0.128	0.089	0.067	1.464	0.212	0.175
	-0.197	*0.341*	*-1.653*	*0.053*	*-1.147*	*-3.192*	*1.578*	*2.092*			
United Kingdom	0.002	0.098 [a]	-0.045	0.188	-0.215	-0.273	1.465	0.011	1.612	0.403	0.375
	0.936	*1.494*	*-0.032*	*0.396*	*-2.676*	*-2.248*	*8.492*	*0.115*			
United States	0.002	0.277	-0.015	-0.427	-0.139	-0.361	1.733	-0.014	1.676	0.615	0.597
	1.261	*4.746*	*-0.012*	*-1.019*	*-1.969*	*-3.358*	*11.364*	*-0.169*			

$\beta_{i1} = 0$ .... $\beta_{i7} = 0$

main volatility drivers

Step 1 – Wald test results

Chi-Square Test Statistics and p-Values

	Global Risk Factors						
	WDSTR	ING7C	IPG7C	ISG7C	ILG7C	CHG7C	DJCIC
Stock Markets							
Hyp 1 (17 df)	997.151	33.493	51.180	11.711	47.202	514.536	33.103
p-value	*0.000* *	*0.009* *	*0.000* *	*0.817*	*0.000* *	*0.000* *	*0.011* *
Hyp 2 (16 df)	77.919	15.271	26.227	11.710	29.516	57.928	15.087
	0.000 *	*0.505*	*0.051* *	*0.764*	*0.021* *	*0.000* *	*0.518*
Bond Markets							
Hyp 1 (8 df)	51.305	8.961	2.384	18.189	46.249	311.617	6.223
	0.000 *	*0.346*	*0.966*	*0.019* *	*0.000* *	*0.000* *	*0.622*
Hyp 2 (7 df)	47.833	7.521	2.384	13.166	20.042	243.340	3.354
	0.000 *	*0.377*	*0.956*	*0.068* *	*0.005* *	*0.000* *	*0.850*

* able to reject H_0

Source: Zimmermann/Drobetz/Oertmann (2002), Chapter 5, Table 5.4

Step 1 – Major conclusions (cont.)

Volatility Drivers	Pricing Impact on: 17 Stock Markets	8 Bond Markets	Joint
Inflation	No	No	No
Output	Yes	No	No
Commodity prices	No	No	No
Stock market	Yes	Yes	Yes
Short interest	No	Yes	No
Long interest	Yes	Yes	Yes
Currency	Yes	Yes	Yes

Three of the seven predetermined global risk factors systematically affect the returns of both stock and bond investments. Hence, these variables represent inherent forces, or at least some of the forces, causing the frequently observable co-movement between international stock and bond markets.

Source: Zimmermann/Drobetz/Oertmann (2002), Chapter 5, Table 5.5

Applications of factor profiles in portfolio management

Fundamental analysis: Factor exposures and the explanatory power of factor models provide valuable information on the economic determinants of volatility. This enables an efficient allocation of resources in the data gathering and transformation process of financial analysis.

Pricing potential: Cross-sectional differences in expected returns can be related to risk factors if their respective factor exposures differ across assets (and are different from zero).

Diversification: The cross-sectional patterns of factor risk profiles provide valuable information on the diversification effects across the markets. A well-diversified portfolio takes into consideration not only the idiosyncratic risk of individual assets, but also the various risk factors and the factor exposures provide the necessary information.

Hedging: Factor exposures are the basis for minimum-variance hedging strategies.

Step 2 – Unconditional beta pricing tests

The asset pricing restriction

Assuming the factor model (1) sufficiently characterizes the process generating international stock and bond market returns, it is postulated that the cross-section of long-term expected returns of the markets is described by the subsequent beta pricing relationship:

(2) $$E(r_i) = \lambda_1 \cdot \beta_{i1} + \lambda_2 \cdot \beta_{i2} + \cdots + \lambda_k \cdot \beta_{ik} \qquad \forall\, i = 1, \dots, n$$

Combining equations (1) and (2) yields the following empirically testable non-linear relationship between market returns, factors changes, and factor rewards:

(3) $$r_{it} = \sum_{j=1}^{k} \lambda_j \cdot \beta_{ij} + \sum_{j=1}^{k} \beta_{ij} \cdot \delta_{jt} + \varepsilon_{it} \qquad \forall\, i = 1, \dots, n$$

Step 2 – Unconditional beta pricing tests (cont.)

Estimating assets' factor betas and global risk premiums simultaneously

Model (3) is the starting point for the unconditional beta pricing test. This model is implemented via the following system of restricted seemingly unrelated regression equations:

$$\begin{pmatrix} r_{1t} \\ \vdots \\ r_{nt} \end{pmatrix} = \overbrace{\lambda_1 \cdot \begin{pmatrix} \beta_{11} \\ \vdots \\ \beta_{n1} \end{pmatrix} \cdot \ldots \cdot \lambda_k \cdot \begin{pmatrix} \beta_{1k} \\ \vdots \\ \beta_{nk} \end{pmatrix}}^{\text{Asset pricing restriction}} + \overbrace{\begin{pmatrix} \beta_{11} \cdots \beta_{1k} \\ \vdots \\ \beta_{n1} \cdots \beta_{nk} \end{pmatrix} \cdot \begin{pmatrix} \delta_{1t} \\ \vdots \\ \delta_{kt} \end{pmatrix} + \begin{pmatrix} \varepsilon_{1t} \\ \vdots \\ \varepsilon_{nt} \end{pmatrix}}^{\text{Factor model}}$$

This system of equations is estimated for a cross-section of asset returns including the 17 stock markets and 8 bond markets. Hence, we assume a priori that international stock and bond markets are integrated with respect to the pricing of global risks.

Step 2 – Unconditional beta pricing tests (cont.)

Global Risk Premia					
International CAPM		3-Factor Model			
λ_j (Monthly %)	GMM χ^2 Statistic (*p*-Value)	λ_j (Monthly %)			GMM χ^2 Statistic (*p*-Value)
WDSTR		WDSTR	ILG7C	CHG7C	
0.526	24.893	0.259	–0.352	0.084	21.956
8.205	(0.411)	*2.144*	*–1.406*	*0.904*	(0.462)

Note: The reported coefficients, the monthly risk premia (factor prices), are estimated simultaneously with factor betas (not reported here) using GMM. The GMM test statistic for the model's goodness-of-fit is chi-square distributed with 24 (22) degrees of freedom for the international CAPM (3-factor model). The sample period is from 1982.02 to 1995.02.

Source: Zimmermann/Drobetz/Oertmann (2002), Chapter 5, Table 5.6

Conclusions of the study

Step 1 - Identification of volatility drivers

- International stock market returns seem to be influenced by a broader variety of global risk factors than international bond market returns.
- Stock markets may have four to five persistent driving forces, whereas interest rate factors and shifts in global exchange rates predominantly affect the returns in bond markets.
- Three of the seven predetermined global risk factors systematically affect the returns of both stock and bond investments: the excess return on the world market portfolio, the change in global long-term interest rates, and the change in the price of the G7 ex- change rate basket. Hence, these variables seem to represent the inherent forces that cause the frequently observable co-movement between international stock and bond market returns.

$\Rightarrow$ Risk premiums vary over time

Conclusions of the study (cont.)

Step 2 - Identification of value drivers

- The single-factor CAPM identifies a significantly positive premium for the exposure to world market risk in the long-term returns of both stock and bond markets. For some markets, however, such a model leaves relatively large pricing errors.
- The three-factor model seems to provide a more distinctive picture of the value drivers in both stock and bond market returns. The estimation results indicate that average returns of both asset classes include rewards for interest rate risk in addition to the market premium. There also is weak evidence that exchange rate risk is priced across international assets.

Part 4: Rational asset pricing and multifactor models

Empirical study: Sources of risk in emerging markets

Setup

- Specification of a multifactor model to explore risks in emerging markets, following the approach of Harvey (1995)
- Sample
  - 25 emerging markets (MSCI EM plus Argentina, Jordan, Pakistan)
  - 23 developed markets (MSCI world)
  - Period from December 30, 1992 to March 31, 2010
  - Analyses in EUR and local currencies
- Factors
  - World stock market return (WDRET)
  - Change in long-term interest rates (INTR)
  - Return on S&P Goldman Sachs Commodity Index Industrial Metals (CMDTY)
  - Change in the external value of the euro (CRNCY)
  - Emerging market return, orthogonal to WDRET (EMF)

Source: Kirner, Franziska (2010), Sources of Risk in Emerging Markets, diploma thesis at TUM School of Management

Return statistics – Emerging markets

Country	Starting Date	Mean return p.a.	Volatility p.a.	Monthly Returns min	Monthly Returns max	Monthly Returns median	Auto correlation	Skewness	(Excess) Kurtosis
Argentina	1992.12	6.08%	39.91%	-43.69%	43.04%	1.65%	0.05	-0.60	2.26
Brazil	1992.12	18.44%	41.45%	-48.08%	35.08%	2.75%	0.07	-0.70	1.94
Chile	1992.12	10.14%	25.66%	-35.20%	18.41%	0.50%	0.11	-0.60	2.32
China	1992.12	-1.99%	39.29%	-54.38%	39.58%	1.01%	0.05	-0.48	2.84
Colombia	1992.12	16.31%	33.62%	-27.76%	29.05%	1.90%	0.20	-0.20	0.55
Czech Republic	2000.12	20.91%	24.73%	-29.19%	18.61%	2.14%	0.20	-0.74	2.42
Egypt	2000.12	20.38%	32.91%	-30.47%	32.79%	1.33%	0.29	-0.14	1.05
Hungary	2000.12	11.85%	33.27%	-46.42%	27.85%	2.74%	0.29	-1.08	4.69
India	1992.12	9.77%	31.78%	-27.09%	24.65%	0.92%	0.13	-0.22	-0.06
Indonesia	1992.12	6.39%	47.80%	-54.11%	45.74%	1.18%	0.18	-0.54	2.45
Israel	1992.12	7.26%	26.65%	-23.52%	25.85%	2.04%	0.12	-0.39	0.80
Jordan	1992.12	4.72%	20.36%	-26.42%	19.81%	0.11%	0.23	-0.11	2.38
Korea	1992.12	7.22%	39.70%	-39.76%	54.71%	0.43%	0.08	0.13	2.84
Malaysia	1992.12	5.01%	33.69%	-37.97%	39.85%	1.06%	0.09	-0.16	3.41
Mexico	1992.12	9.41%	34.09%	-41.08%	19.70%	1.86%	0.15	-1.21	3.16
Morocco	2000.12	10.41%	19.75%	-18.88%	18.81%	0.82%	-0.02	-0.15	1.45
Pakistan	1992.12	4.62%	43.43%	-78.33%	33.05%	0.34%	0.05	-1.37	8.20
Peru	1992.12	17.17%	34.04%	-41.23%	31.85%	1.83%	-0.03	-0.63	2.42
Philippines	1992.12	0.63%	33.56%	-36.57%	35.13%	0.51%	0.15	0.04	1.79
Poland	1992.12	14.32%	45.98%	-43.66%	77.38%	2.05%	0.11	0.56	5.55
Russia	2000.12	15.05%	37.30%	-38.00%	22.16%	2.98%	0.30	-0.68	0.76
South Africa	1992.12	8.78%	27.31%	-37.26%	16.86%	1.28%	0.06	-1.00	2.49
Taiwan	1992.12	4.42%	33.00%	-27.09%	39.63%	-0.12%	0.05	0.43	1.44
Thailand	1992.12	0.86%	41.74%	-44.15%	37.96%	1.04%	-0.04	-0.37	2.02
Turkey	1992.12	13.55%	57.19%	-52.07%	54.85%	3.01%	0.06	-0.33	0.22
Sample Average		9.67%	35.13%						
MSCI EM	1992.12	8.43%	25.68%	-34.98%	16.48%	1.68%	0.19	-0.93	2.29
MSCI World	1992.12	6.53%	16.45%	-15.14%	10.92%	0.84%	0.14	-0.60	0.19

Return statistics – Developed markets

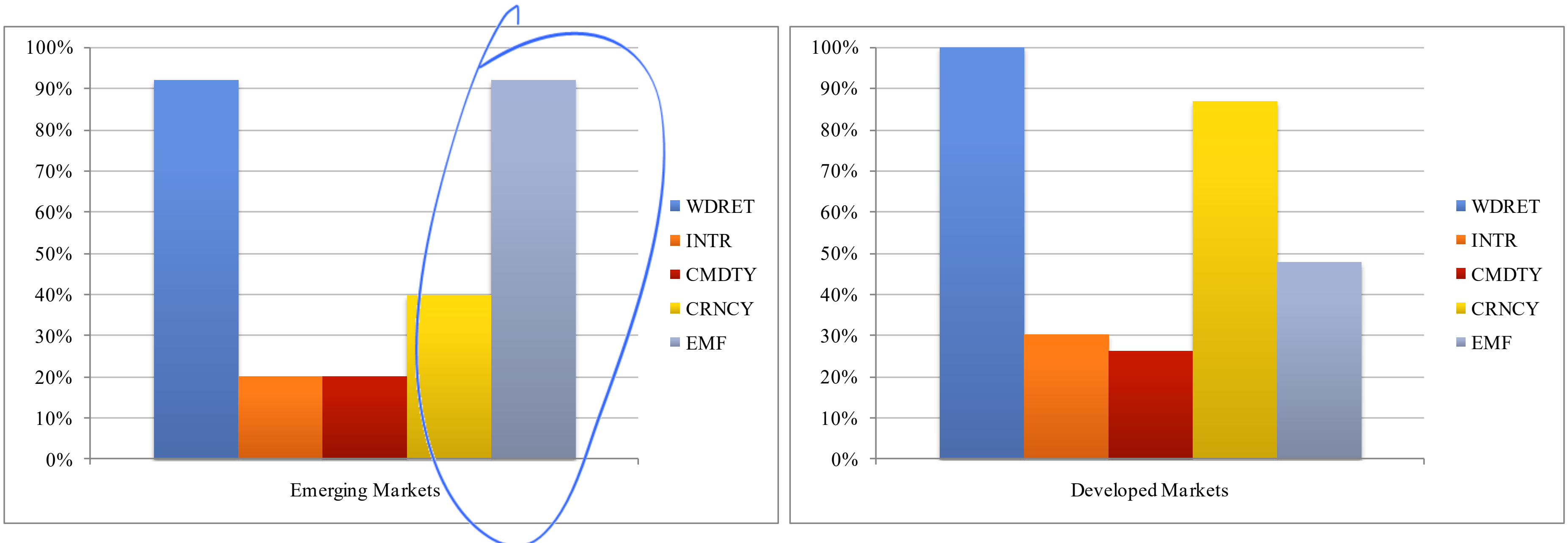
Country	Starting Date	Mean return p.a.	Volatility p.a.	Monthly Returns min	Monthly Returns max	Monthly Returns median	Auto correlation	Skewness	(Excess) Kurtosis
Australia	1992.12	11.17%	20.50%	-19.22%	14.29%	1.41%	0.03	-0.50	0.41
Austria	1992.12	4.53%	23.18%	-36.04%	17.59%	1.04%	0.25	-1.59	6.61
Belgium	1992.12	6.30%	20.80%	-35.27%	14.47%	1.35%	0.27	-2.08	8.11
Canada	1992.12	11.05%	22.07%	-25.40%	14.00%	1.22%	0.12	-0.71	1.13
Denmark	1992.12	11.93%	19.33%	-19.44%	17.04%	1.44%	0.05	-0.63	1.37
Finland	1992.12	15.73%	34.49%	-37.09%	28.43%	1.58%	0.19	-0.39	1.40
France	1992.12	7.64%	19.34%	-17.41%	12.71%	1.48%	0.11	-0.54	0.48
Germany	1992.12	7.95%	22.42%	-28.67%	19.02%	1.50%	0.05	-0.84	2.40
Greece	1992.12	8.29%	29.95%	-35.50%	36.54%	0.89%	0.15	-0.20	2.65
Hong Kong	1992.12	8.31%	28.18%	-36.64%	27.78%	1.10%	0.08	-0.15	2.47
Ireland	1992.12	2.48%	22.29%	-25.47%	14.76%	1.33%	0.23	-1.04	1.74
Italy	1992.12	7.36%	23.22%	-16.69%	19.85%	0.92%	0.00	0.01	0.28
Japan	1992.12	0.78%	20.64%	-15.94%	15.43%	0.03%	0.18	0.05	-0.07
Netherlands	1992.12	8.75%	19.99%	-20.37%	13.16%	1.55%	0.09	-1.05	1.88
New Zealand	1992.12	7.21%	22.50%	-23.21%	16.81%	1.40%	-0.06	-0.58	1.06
Norway	1992.12	10.71%	26.24%	-33.34%	14.67%	1.80%	0.14	-1.34	4.06
Portugal	1992.12	7.99%	20.92%	-22.28%	15.78%	0.95%	0.12	-0.51	1.58
Singapore	1992.12	6.59%	27.30%	-24.01%	23.35%	1.12%	0.08	-0.42	1.64
Spain	1992.12	12.03%	22.19%	-25.20%	16.07%	1.41%	0.05	-0.59	1.46
Sweden	1992.12	12.53%	26.76%	-21.18%	22.90%	1.32%	0.08	-0.39	0.80
Switzerland	1992.12	10.33%	15.92%	-17.85%	12.68%	1.24%	0.19	-0.73	1.63
UK	1992.12	6.61%	15.82%	-12.04%	12.07%	1.10%	0.20	-0.55	0.09
US	1992.12	7.11%	17.72%	-15.82%	12.89%	0.67%	0.10	-0.44	0.25
Sample Average		8.41%	22.69%						
MSCI EM	1992.12	8.43%	25.68%	-34.98%	16.48%	1.68%	0.19	-0.93	2.29
MSCI World	1992.12	6.53%	16.45%	-15.14%	10.92%	0.84%	0.15	-0.60	0.19

Five-factor model results – Emerging markets

	Start Date	Const.	WDRET	INTR	CMDTY	CRNCY	EMF	R^2	adj. R^2	DW
Argentina	1992.12	-0,0042	1,2295 ***	-5,5831 *	0,2012 *	-0,3759	0,9571 ***	0,4295	0,4153	2,16
Brazil	1992.12	0,0078	1,6665 ***	2,4265	0,0031	-0,3190	1,1631 ***	0,6175	0,6079	2,26
Chile	1992.12	0,0020	0,8374 ***	0,6689	0,0921	0,3533 **	0,7623 ***	0,6003	0,5903	2,03
China	1992.12	-0,0092	1,0326 ***	-3,8404	0,0001	-0,0128	1,3267 ***	0,4406	0,4267	2,02
Colombia	1992.12	0,0079	0,7049 ***	2,9625	0,1192	0,1677	0,6512 ***	0,2683	0,2501	1,89
Czech Republic	2000.12	0,0096	1,0910 ***	-7,3720 ***	0,0095	-0,5034 ***	0,6691 ***	0,5950	0,5757	1,99
Egypt	2000.12	0,0083	1,1127 ***	-9,7124 **	0,0595	-0,0064	0,7878 ***	0,3557	0,3250	1,78
Hungary	2000.12	0,0033	1,3493 ***	-3,0746	0,0788	-1,0956 ***	0,5255 ***	0,5515	0,5301	1,88
India	1992.12	0,0025	0,9167 ***	2,0946	0,0005	0,0558	0,8834 ***	0,4206	0,4062	2,20
Indonesia	1992.12	-0,0034	1,3723 ***	-4,6440	0,0471	-0,2452	1,3230 ***	0,3956	0,3806	1,88
Israel	1992.12	0,0009	0,9824 ***	1,6568	-0,0130	-0,0310	0,2006 **	0,3825	0,3671	1,93
Jordan	1992.12	-0,0009	0,2580 ***	-0,3170	0,1074	0,5090 ***	0,1189	0,1699	0,1493	1,62
Korea	1992.12	-0,0006	1,1970 ***	5,6802 *	0,1326	0,1259	0,7811 ***	0,4240	0,4097	2,14
Malaysia	1992.12	-0,0016	0,8574 ***	-1,6169	-0,1254	0,5418 **	1,0807 ***	0,4075	0,3928	2,10
Mexico	1992.12	-0,0001	1,4639 ***	-3,1905	-0,0448	0,2649	0,9363 ***	0,6667	0,6584	1,93
Morocco	2000.12	0,0031	0,0722	0,1820	0,1970 **	0,0376	0,1680	0,0862	0,0426	2,23
Pakistan	1992.12	-0,0042	0,2058	-1,9902	0,3693 **	1,3019 ***	0,8603 ***	0,2251	0,2058	2,21
Peru	1992.12	0,0062	0,9635 ***	-4,1699	0,1786 *	-0,4377 *	0,9773 ***	0,4546	0,4411	2,13
Philippines	1992.12	-0,0065	0,9506 ***	-2,2626	0,0312	0,4696 **	0,8705 ***	0,4168	0,4023	2,02
Poland	1992.12	0,0051	1,7144 ***	-4,1520	-0,2494 *	-0,4877	0,9445 ***	0,3848	0,3695	1,96
Russia	2000.12	-0,0011	1,3645 ***	-2,2289	0,0093	-0,5256 *	1,3156 ***	0,5599	0,5389	1,80
South Africa	1992.12	0,0004	1,0348 ***	-0,5535	0,0836	-0,1714	0,8041 ***	0,6206	0,6112	1,99
Taiwan	1992.12	-0,0034	1,0537 ***	0,8610	0,0842	0,3768 *	0,9338 ***	0,5403	0,5289	2,14
Thailand	1992.12	-0,0093	1,2630 ***	-8,2838 **	0,1392	0,1038	1,2394 ***	0,4861	0,4733	2,13
Turkey	1992.12	0,0026	1,9131 ***	0,0846	0,0075	-0,0996	1,0086 ***	0,3733	0,3577	2,12

Risk exposure of emerging and developed markets

Percentage of emerging and developed markets with significant exposure to the five risk factors examined



↳ Risk not captured in "classical factors"

Five-factor model: summary regression output

Summary regression output for emerging and developed markets

Multi-factor regression		WDRET	INTR	CMDTY	CRNCY	EMF	adj. R^2
EM		1.0643	-1.8550	0.0607	-0.0001	0.8516	41.83%
	(t-stat)	*7.6068*	*-0.5415*	*0.5814*	*0.0724*	*6.306*	-
	min	0.0722	-9.7124	-0.2494	-1.0956	0.1189	4.26%
	max	1.9131	5.6802	0.3693	1.3019	1.3267	65.84%
	median	1.0537	-1.9902	0.0595	-0.0064	0.8834	40.97%
	***	92%	4%	0%	16%	88%	
	**	92%	12%	8%	28%	92%	
	*	92%	20%	20%	40%	92%	
DM		1.0840	0.0414	0.0019	-0.3770	0.1499	61.97%
	(t-stat)	*16.7824*	*-0.0549*	*0.1504*	*-2.9223*	*1.9913*	-
	min	0.7828	-5.7539	-0.1411	-0.8337	-0.1079	36.38%
	max	1.5973	4.8840	0.1175	0.3933	0.7811	91.53%
	median	1.1042	0.1819	-0.0013	-0.4830	0.0423	62.02%
	***	100%	9%	4%	61%	35%	
	**	100%	17%	17%	83%	39%	
	*	100%	30%	26%	87%	48%	

Part 4: Rational asset pricing and multifactor models

Case – the setup

Data ("Case2.xls")

- Monthly total return index data over the 1st decade of the 21st century, from January 2000 to December 2009, denominated in EUR, is provided for
  - 10 European stock markets
  - 4 global risk factors

Tasks

- Analyze the relationships between the returns of the stock markets and the changes of the global factors. Perform the following regressions for each market:
  - Market return on the MSCI World index return (single factor model)
  - Market return on the 4 global factors (4-factor model)
- Report regressions coefficients, t statistics, and R squares in a table and in a chart.
- Comment your results!

Case – the results

β β

	Single Factor Model			4 Factor Model					
	MSCI World	Constant	R Squared	FX USD/EUR	EUR 10Y Rate	CRB Index	MSCI World	Constant	R Squared
Switzerland	**0,692**	**0,003**	**0,631**	**0,206**	**0,062**	**-0,114**	**0,743**	**0,003**	**0,673**
	14,210	1,403		2,696	1,199	-2,366	13,992	1,562	
Germany	**1,260**	**0,002**	**0,726**	**0,609**	**0,140**	**-0,165**	**1,365**	**0,002**	**0,808**
	17,681	0,631		6,126	2,082	-2,637	19,775	0,636	
UK	**0,896**	**0,001**	**0,826**	**0,100**	**0,098**	**0,033**	**0,861**	**0,001**	**0,839**
	23,652	0,370		1,638	2,377	0,862	20,402	0,288	
Sweden	**1,397**	**0,003**	**0,652**	**0,575**	**0,035**	**-0,040**	**1,492**	**0,002**	**0,695**
	14,865	0,659		3,918	0,351	-0,428	14,638	0,414	
Norway	**1,256**	**0,010**	**0,555**	**0,929**	**0,339**	**0,423**	**1,118**	**0,006**	**0,749**
	12,123	2,069		7,167	3,860	5,173	12,417	1,720	
France	**1,047**	**0,002**	**0,786**	**0,489**	**0,058**	**-0,053**	**1,124**	**0,001**	**0,854**
	20,834	0,892		7,068	1,231	-1,209	23,402	0,653	
Italy	**0,948**	**0,001**	**0,630**	**0,539**	**-0,040**	**0,087**	**1,019**	**-0,001**	**0,710**
	14,187	0,446		5,458	-0,604	1,405	14,869	-0,188	
Spain	**1,016**	**0,007**	**0,646**	**0,547**	**-0,091**	**-0,114**	**1,184**	**0,006**	**0,741**
	14,663	2,034		5,533	-1,369	-1,837	17,257	1,950	
Netherlands	**1,155**	**0,002**	**0,763**	**0,456**	**0,054**	**-0,033**	**1,220**	**0,001**	**0,809**
	19,504	0,664		5,152	0,909	-0,584	19,836	0,396	
Austria	**0,945**	**0,006**	**0,372**	**1,152**	**0,155**	**0,324**	**0,953**	**0,002**	**0,607**
	8,360	1,153		7,724	1,533	3,441	9,198	0,451	

explains more

Source: Own calculations

Part 4: Rational asset pricing and multifactor models

a. Motivation of multifactor models
b. International Arbitrage Pricing Theory (IAPT)
c. Specification of a global multifactor asset pricing model
d. Empirical study: Sources of Risk in Emerging Markets
e. Case: Economic risks of European stock markets
f. Exercise: Application of a factor model

Exercise: Application of a factor model

Risk factors	Factor 1	Factor 2	Factor 3
Volatility	16,0%	10,0%	12,0%
Risk premium	4,0%	-0,2%	0,6%

Stock markets	Volatility	Factor exposures		
USA	20%	0,90	-0,80	0,60
Germany	25%	1,20	-0,60	0,80
Hong Kong	30%	1,40	0,40	0,70

Risk-free rate	1,5%

Exercise: Application of a factor model

1. How do German stocks react to a 10% increase in factor 2?

$$R_{Ger} = \underbrace{-0.6}_{\text{exposure}} \cdot \underbrace{0.1}_{\text{increase}} = -0.06 = -6\%$$

2. Is it possible to hedge “factor 2 risk” by a portfolio of stock markets?

Yes, as factor 1 & 3 are positive

e.g.: $0 = w_{US} \cdot (-0.8) + w_{DE} \cdot (-0.6) + w_{HK} \, 0.4$

$\rightarrow$ e.g. $w_{US} = \frac{2}{3}$, $w_{HK} = \frac{1}{3}$, $w_{DE} = 0$

Exercise: Application of a factor model

3. What portion of the German stock market's variance is captured by factor 1?

$$\cancel{\frac{\text{local } \sigma^2}{\text{total } \sigma^2} = \frac{16\%}{25\%}}$$

$$\sigma^2(R_{DE}) = \sigma^2\left(r_f + \sum \beta_{ij}\Delta_j + \varepsilon_i\right) = 0 + \sum_{j=1}^{k} \beta_{ij}^2 \, \sigma^2(\Delta_j) + \sigma^2(\varepsilon_i)$$

$$\Rightarrow \quad \frac{1.2^2 \cdot 0.16^2}{0.25^2} = 0.589$$

4. What portion of the US stock market's variance is captured by factor 2?

$$\frac{(-0.8)^2 \cdot 0.1^2}{0.2^2} = 0.16$$

Exercise: Application of a factor model

5. What portion of the Hong Kong stock market's variance is explained by the model?

$$\frac{1.4^2 \cdot 0.16^2 + 0.4^2 \cdot 0.1^2 + 0.7^2 \cdot 0.12^2}{0.3^2} = 0.653$$

Exercise: Application of a factor model

6. What is the expected return for the US stock market?

$$E(R_{us}) = 1{,}5\% + 0{,}9 \cdot 4\% + (-0.8) \cdot (-0.2\%) + 0.6 \cdot 0.6\% = 5{,}62\%$$

Part 4: Selected references

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International Capital Markets and Investment Practice

Part 5

Forecasting returns and conditional asset pricing

Prof. Dr. Peter Oertmann
TUM School of Management
Technical University of Munich
peter.oertmann@tum.de

Part 5: Forecasting returns and conditional asset pricing

a. Economic conditions and asset returns
b. Specification of a forecasting model
c. Exploring the predictable variation of stock and bond market returns
d. Introduction into conditional asset pricing models
e. Predicting the time-variation of risk premiums
f. Global market integration

Part 5: Positioning in the lecture

Major fields in asset management

- Diversification
- Asset allocation
- Security selection
- Investment strategy implementation
- Risk management
- Trading and execution

Knowledge base

- **Stylized facts on global markets** – Empirical research
- **Sources of risk and return** – Models and empirical research
- **Asset pricing** – Theories, models and empirical tests
- **Portfolio construction** – Models and empirical tests
- **Financial economics** – Models and empirical research
- **Time series analysis** – Models and empirical procedures

Part 5: Forecasting returns and conditional asset pricing

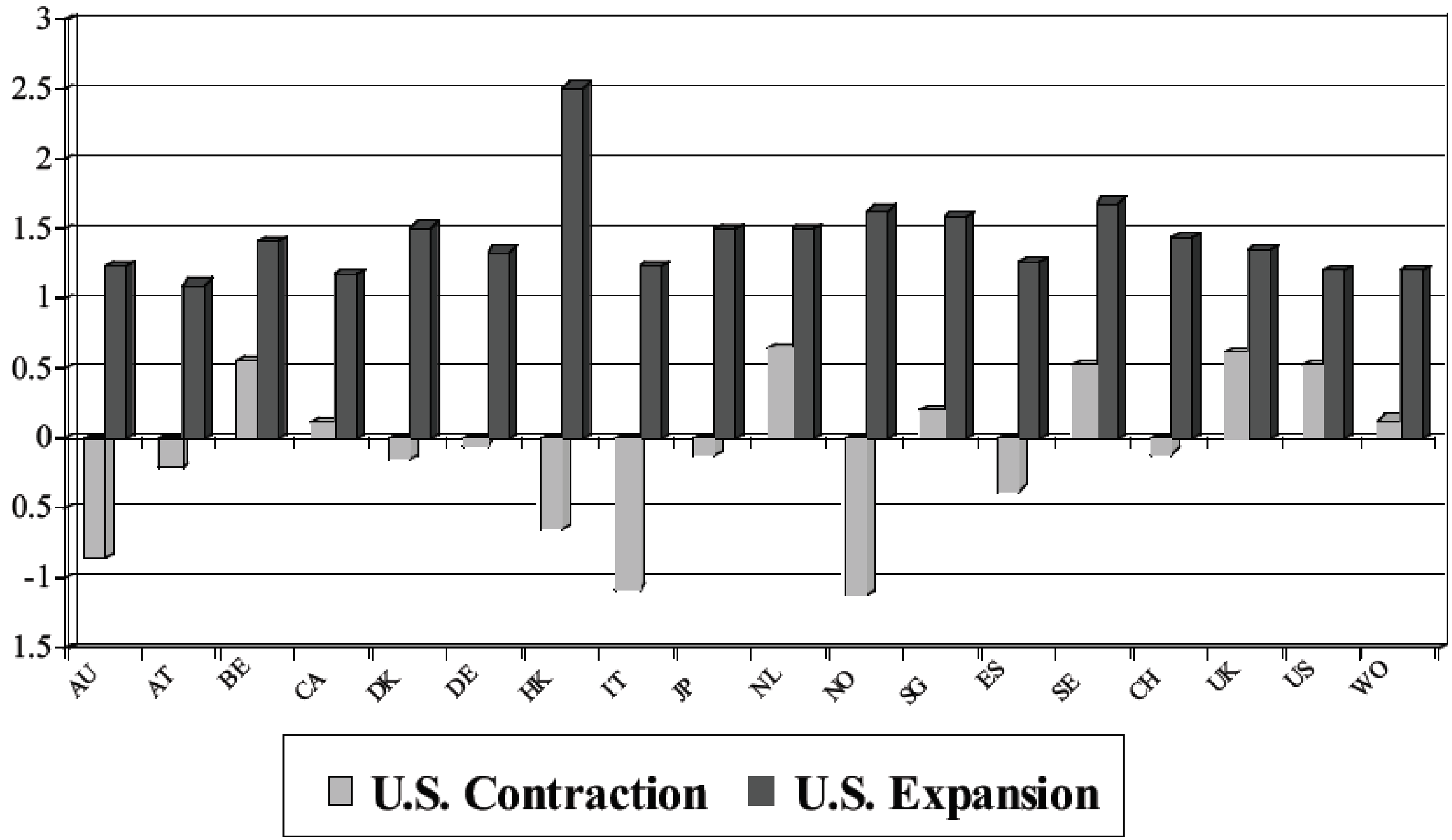
Foundations of equity return predictability

Starting point

- It is difficult to predict equity returns
  - Equity returns are highly volatile
  - Markets are highly efficient
- The price of a stock is the present value of expected future cash flows (DDM)
- Fundamental sources of stock return predictability are the components of the DDM since they are somewhat related to the business cycle

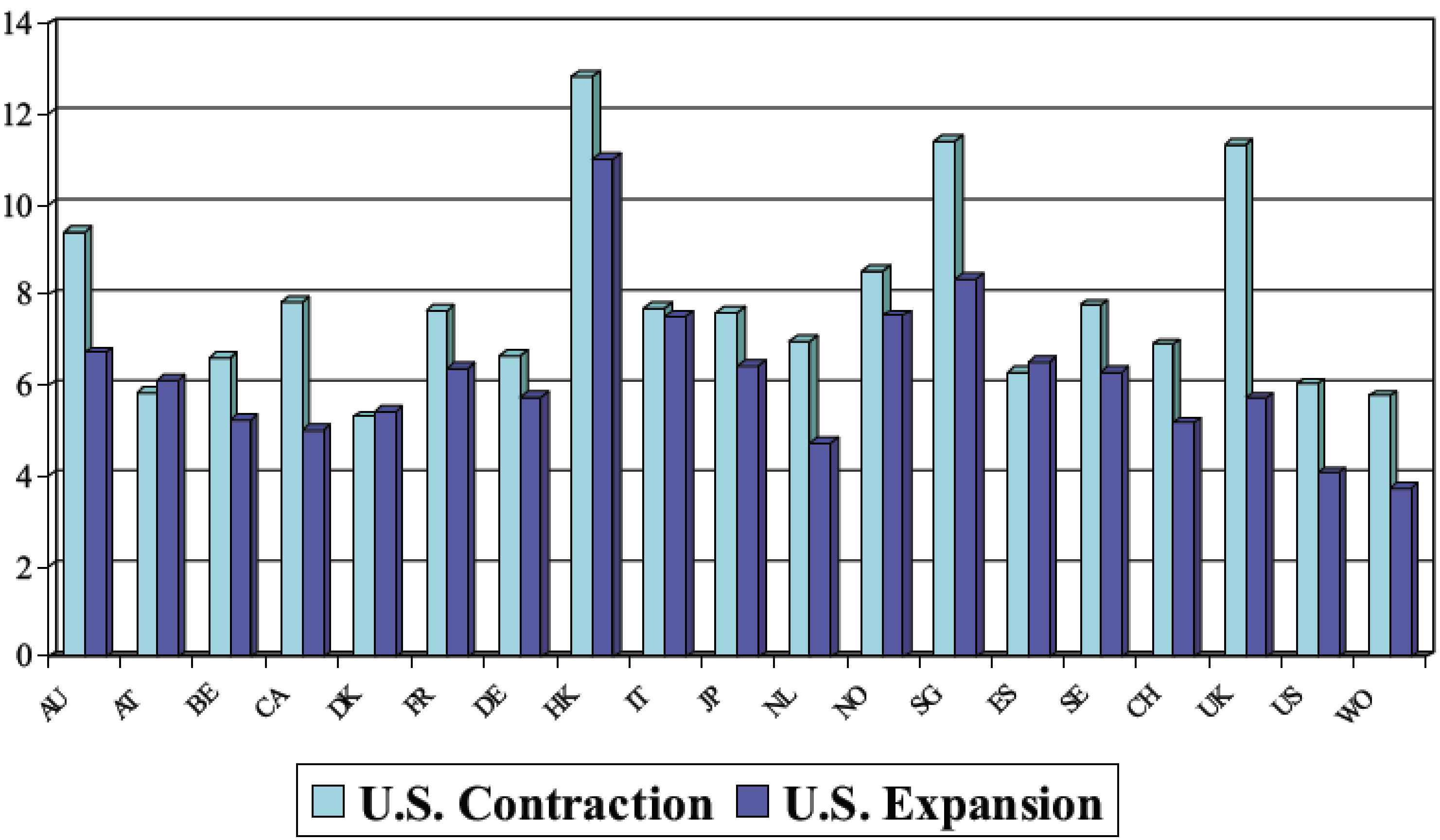
Note: A similar argument can be found in Dahlquist/Harvey (2001)

Equity performance and the business cycle – returns



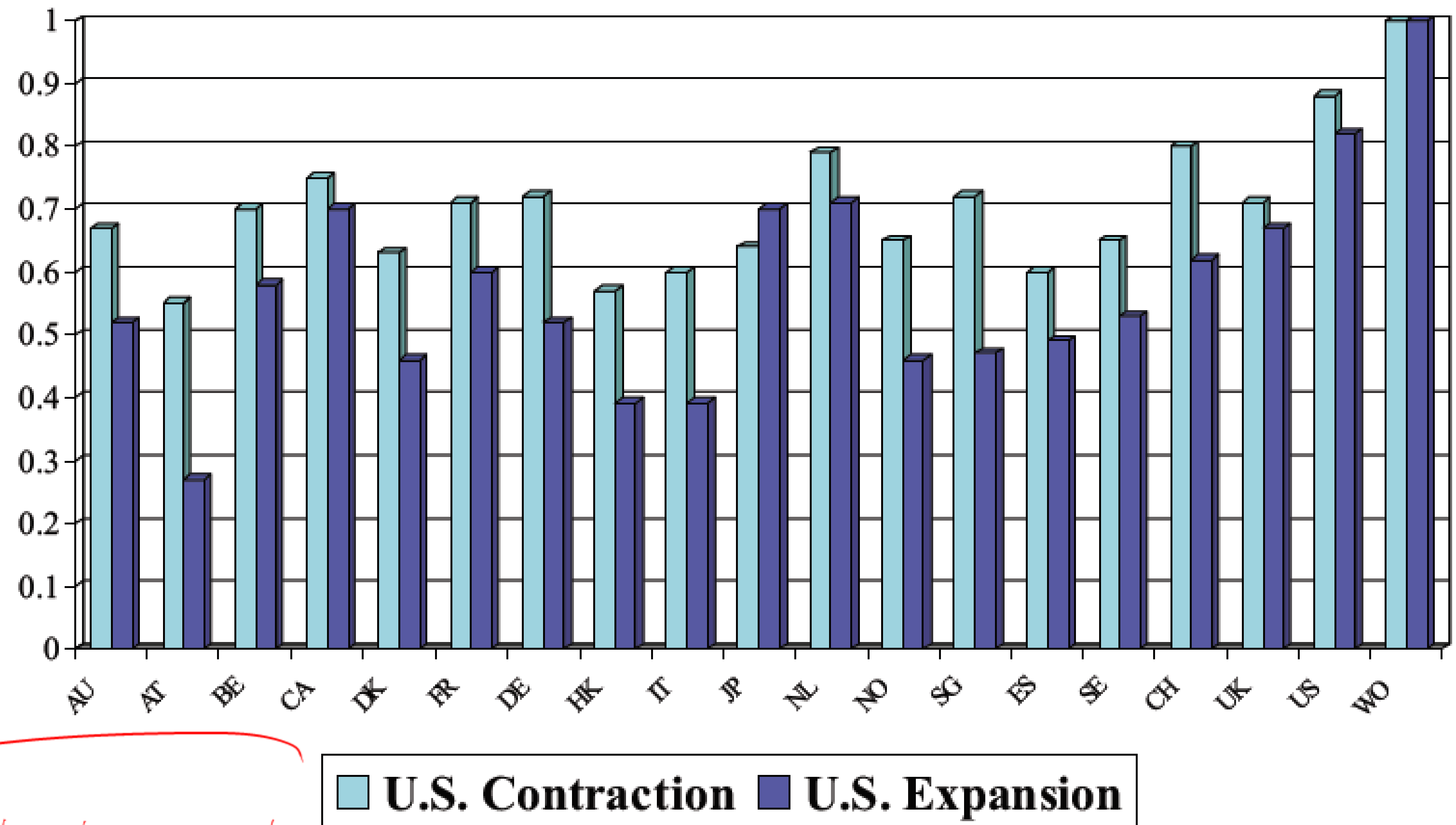
Source: MSCI data, January 1970 to December 2000, Dahlquist/Harvey (2001)

Equity performance and the business cycle – volatility



Source: MSCI data, January 1970 to December 2000, Dahlquist/Harvey (2001)

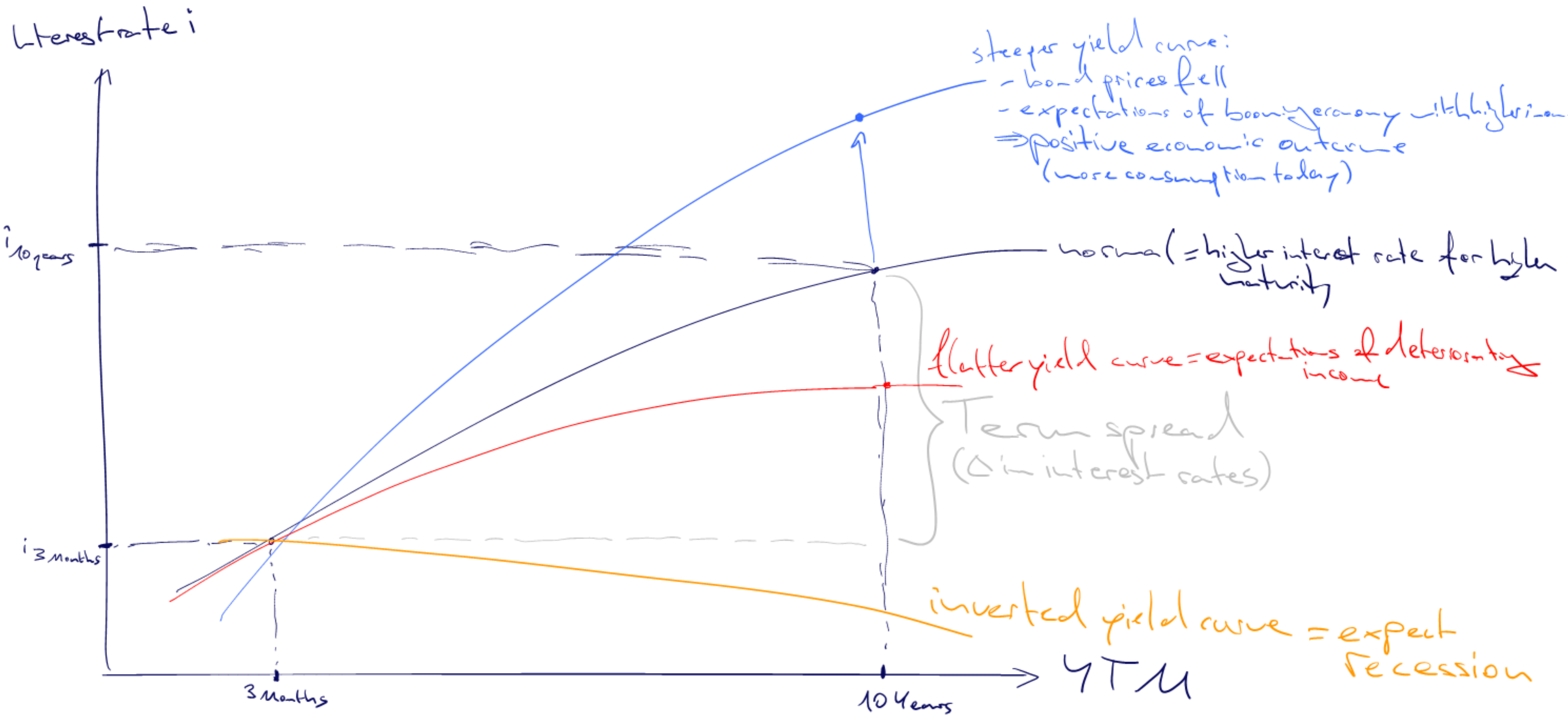
Equity performance and the business cycle – correlation with world



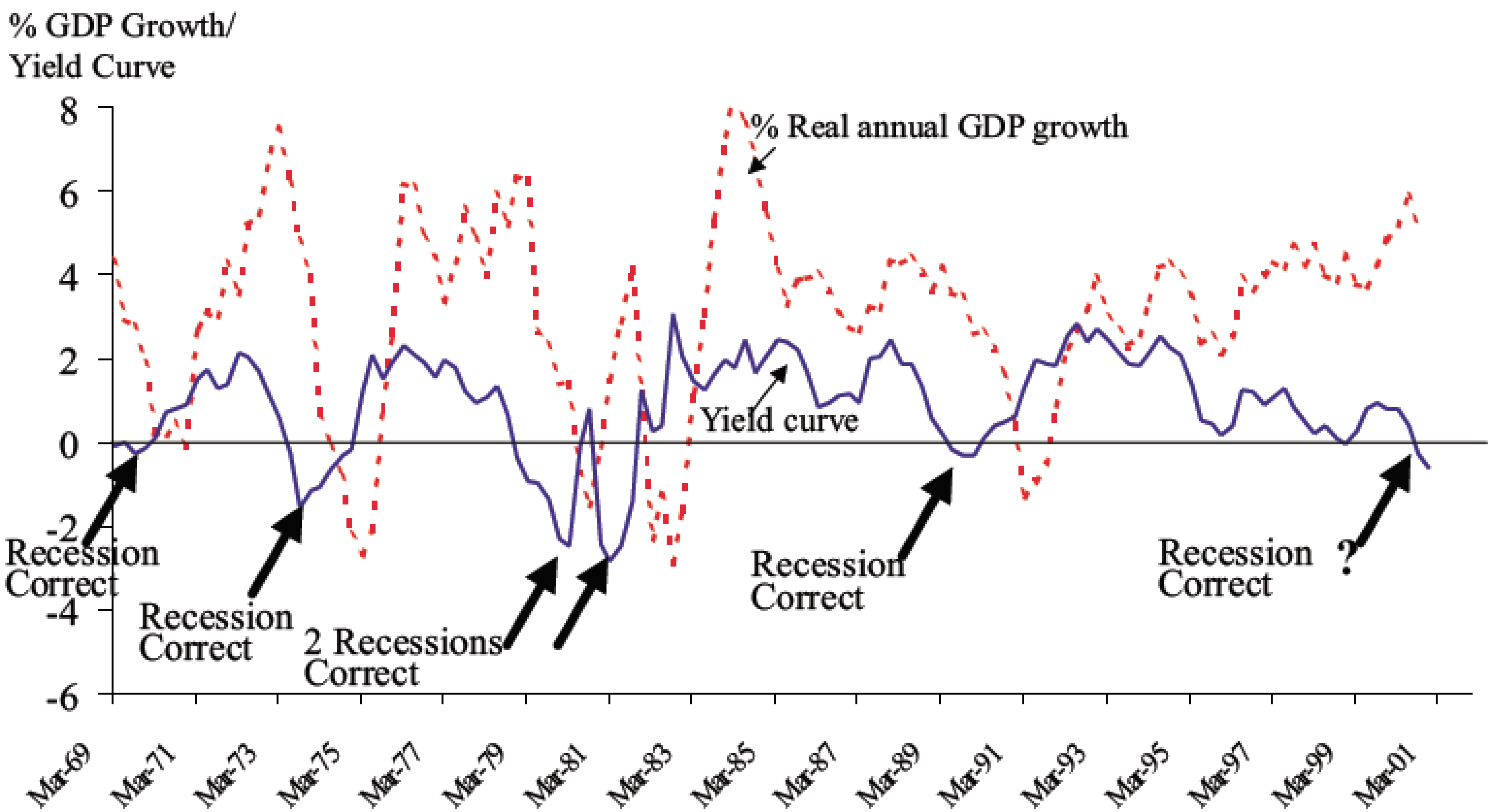
In U.S. Contraction periods we observe: – lower avg returns
– higher volatility
– higher correlation with world market

Source: MSCI data, January 1970 to December 2000, Dahlquist/Harvey (2001)

Mechanics of the yield curve

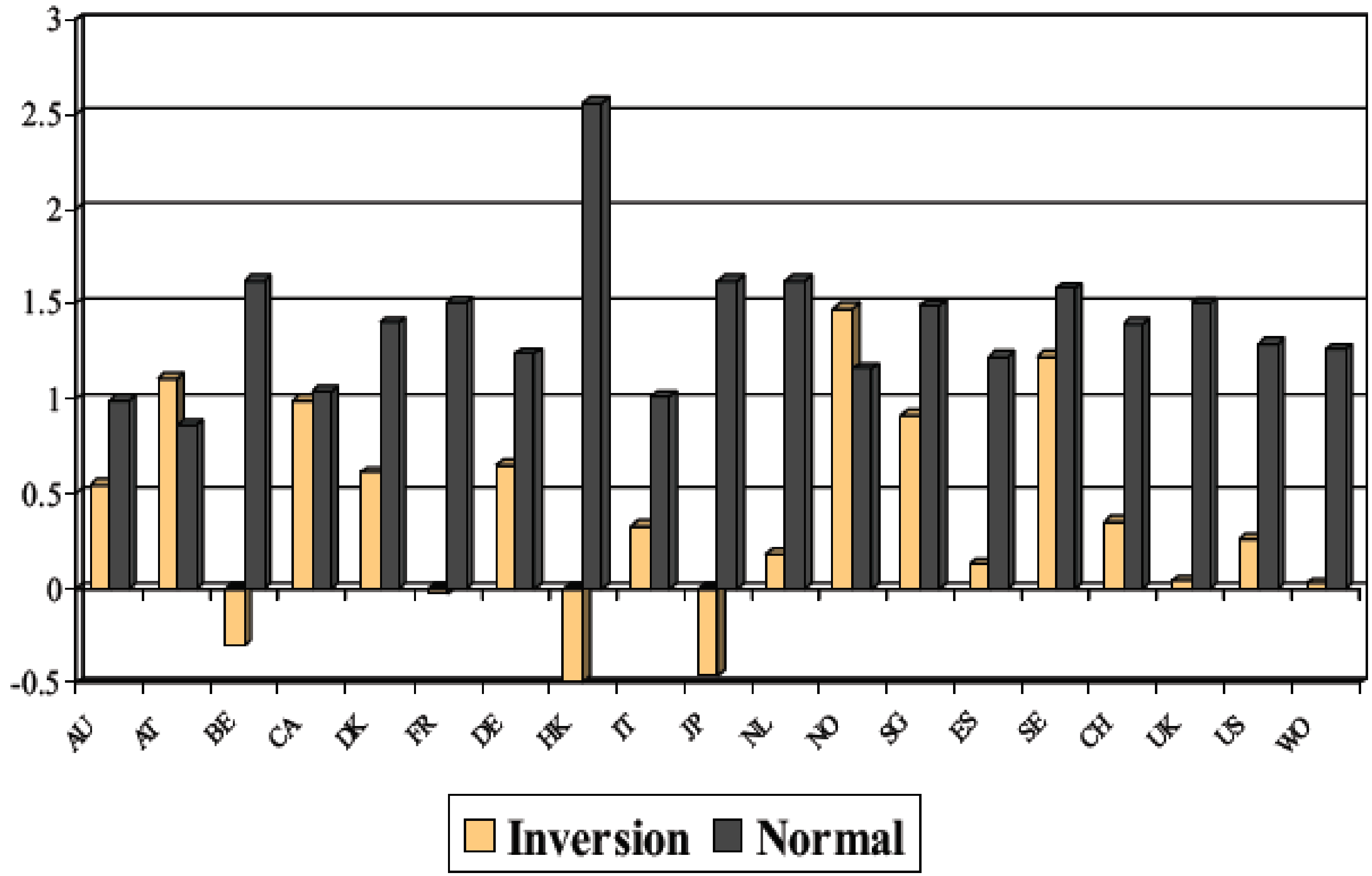


The TERM spread reflects economic growth expectations



Source: Dahlquist/Harvey (2001)

Average monthly stock returns and the US yield curve



Source: MSCI data, January 1970 to December 2000, Dahlquist/Harvey (2001)

Empirical findings of Dahlquist and Harvey (2001)

- In the US, average equity returns during recessions are about one third of the level during expansions
- It is impossible to hide from a U.S. recession
- In almost every country there is a huge difference between expansion and recession average returns, i.e. other countries seem to be more sensitive to the US business cycle than the US equity return
- Volatility is greater during US recessions in almost every country
- Correlations are higher in US recessions

Can the Term spread predict output growth and recessions?

Study of Wheelock/Wohar, FED of St. Louis

Research questions

- Does the yield spread forecast output growth?
- Does it forecast recessions?

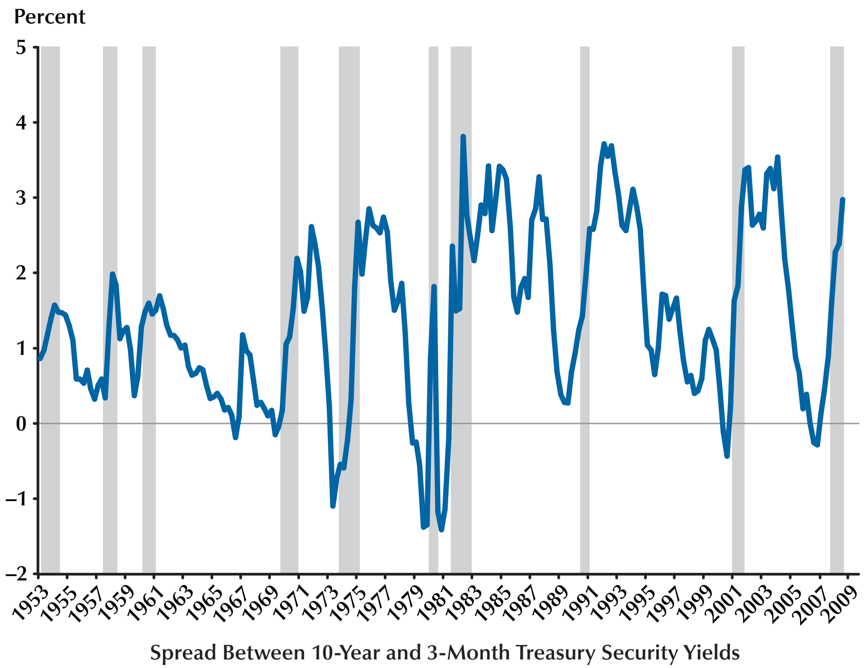
Findings (quotes)

- The answer to both questions is a qualified "yes"
- USA: Every U.S. recession since 1953 was preceded by a large decline in the yield on 10-year Treasury securities relative to the yield on 3-months Treasury securities, and several recessions were preceded by an inversion of the yield curve.
- Germany: Germany experienced recessions beginning in 1966, 1974, 1980, 1991, 2000, and 2008. All but the 1966 recession were preceded by a sharp decline in long-term Treasury security yields relative to short-term yields that resulted in a flat or inverted yield curve. The only inversion that was not followed by a recession occurred in 1970.
- UK: (similar findings)

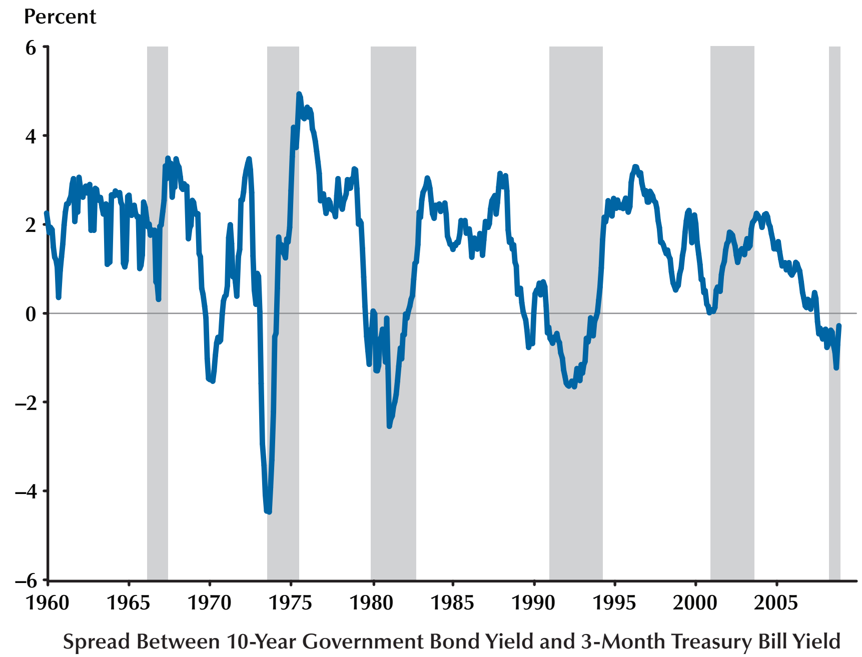
Source: Wheelock/Wohar (2009)

A look at the data

US term spread and recessions 1953-2008



German term spread and recessions 1960-2008



Source: Wheelock/Wohar (2009)

Correlation of GDP growth and term spreads

Lagged term spread

	Term						
	t	$(t-1)$	$(t-2)$	$(t-3)$	$(t-4)$	$(t-5)$	$(t-6)$
United States	–0.0449	0.0999	0.2557	0.3605	0.4141	0.3957	0.3196
p-values →	(0.5047)	(0.1379)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
Germany	–0.0003	0.1641	0.2991	0.3689	0.3845	0.3649	0.3421
	(0.9970)	(0.0455)	(0.0002)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
United Kingdom	0.0723	0.1816	0.2486	0.3025	0.3379	0.3166	0.2607
	(0.3319)	(0.0144)	(0.0008)	(0.0001)	(0.0001)	(0.0001)	(0.0005)

significant

Future term spread

	Term						
	t	$(t+1)$	$(t+2)$	$(t+3)$	$(t+4)$	$(t+5)$	$(t+6)$
United States	–0.0449	–0.1428	–0.2374	–0.2994	–0.3372	–0.3538	–0.3421
	(0.5047)	(0.0335)	(0.0004)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
Germany	–0.0003	–0.1722	–0.3414	–0.4424	–0.4548	–0.4545	–0.4110
	(0.9970)	(0.0357)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
United Kingdom	0.0723	–0.0364	–0.1366	–0.2116	–0.2306	–0.2204	–0.2261
	(0.3319)	(0.6244)	(0.0652)	(0.0040)	(0.0017)	(0.0001)	(0.0021)

NOTE: U.S. data are for 1953:Q1–2008:Q4; German data are for 1973:Q1–2008:Q2 (West Germany, 1973-1991); U.K. data are for 1958:Q1–2008:Q2. Numbers in parentheses represent p-values.

Source: Wheelock/Wohar (2009)

Fama and French (1989) → comovements of stock and bond markets

Research questions

- Do the expected returns on bonds and stocks move together? In particular, do the same variables forecast bond and stock returns?
- Is the variation in expected bond and stock returns related to business conditions? Are the relations consistent with intuition, theory, and existing evidence on the exposures of different assets to changes in business conditions?

Approach

$$r(t, t+T) = \alpha(T) + \beta(T) \cdot X(t) + \varepsilon(t, t+T)$$

- Regressions of stock and bond excess returns, measured over periods from t to t+T, on a common set of explanatory variables X known at time t
- T = one month, one quarter, one year, and two to four years
- Asset classes: Stock portfolios (NYSE, EW, VW), bond portfolios with different Moody's credit ratings

Source: Fama/French (1989)

Fama and French (1989) – explanatory variables

- **Dividend yield** =Proxy for fundamental valuation of the stock market
  - D(t)/P(t) on the value-weighted NYSE portfolio
  - Foundation: Dow (1920), Ball (1978), Rozeff (1984), Shiller (1984), …
- **Term spread** =Proxy for expected business conditions
  - Difference between the time t yield on the Aaa bond portfolio and the one-month bill rate, TERM(t)
  - Earlier work: Fama (1976, 1984), Keim/Stambaugh (1986), …
- **Default spread** =Proxy for credit risk/current health of the economy
  - Difference between the time t yield on a portfolio of 100 corporate bonds and the Aaa yield, DEF(t)
  - Earlier work: Fama (1986), Keim/Stambaugh (1986)

Source: Fama/French (1989)

Fama and French (1989) – regression results 1941–1987

Slopes, t-statistics, and R^2 from multiple regressions of excess returns on the term spread ($TERM$) and the value-weighted dividend yield (D/P) or the default spread (DEF); 1941–1987.[a]

					value weighted	Portfolios	equally weighted							
T	Aaa	Aa	A	Baa	LG	VW	EW	Aaa	Aa	A	Baa	LG	VW	EW
						$r(t,t+T) = a + bD(t)/P(t) + cTERM(t) + e(t,t+T)$								
			Slopes for D/P								t-statistics for D/P slopes			
M	0.13	0.11	0.11	0.13	0.30	0.40	0.53	2.75	2.58	2.54	2.81	3.82	2.88	2.99
Q	0.36	0.34	0.36	0.42	0.94	1.31	1.78	1.91	1.89	1.97	2.42	3.28	2.93	3.03
1	0.40	0.27	0.74	1.23	3.33	5.49	7.96	0.75	0.47	1.31	2.14	3.91	3.45	3.67
2	1.00	0.62	2.05	3.15	7.67	11.84	16.70	0.87	0.49	1.58	2.56	3.97	4.18	3.87
3	1.41	0.91	2.93	4.34	10.88	15.65	21.22	1.37	0.78	2.27	3.11	3.65	4.94	3.31
4	2.41	1.76	3.87	5.29	12.66	18.48	23.43	3.78	1.94	3.65	3.83	4.21	5.26	3.18
			Slopes for $TERM$								t-statistics for $TERM$ slopes			
M	0.25	0.28	0.31	0.32	0.31	0.48	0.51	2.77	3.55	4.35	4.81	3.32	3.29	2.97
Q	0.62	0.60	0.73	0.75	0.77	1.13	1.17	1.51	1.52	2.07	2.43	1.89	2.17	1.82
1	3.64	3.56	3.87	3.57	3.27	1.64	1.33	4.74	5.07	5.68	5.57	4.10	0.94	0.66
2	4.29	4.18	4.25	4.16	3.71	−1.34	−2.90	3.25	3.48	3.64	4.06	3.04	−0.63	−0.89
3	4.41	3.81	3.83	3.62	2.71	−3.95	−6.35	2.13	2.09	1.95	2.31	2.01	−1.23	−1.27
4	3.73	3.07	3.27	3.51	3.27	−2.40	−2.67	1.11	0.97	1.02	1.40	1.45	−0.75	−0.64
			Regression R^2 = % explained variation											
M	0.04	0.06	0.08	0.08	0.05	0.03	0.03							
Q	0.06	0.05	0.08	0.10	0.10	0.06	0.06							
1	0.39	0.37	0.44	0.41	0.35	0.16	0.18							
2	0.21	0.18	0.24	0.30	0.44	0.36	0.37							
3	0.13	0.08	0.15	0.24	0.46	0.53	0.48							
4	0.09	0.04	0.13	0.25	0.51	0.60	0.50							

Source: Fama/French (1989), Table 3

Fama and French (1989) – regression results 1941–1987

$$r(t, t+T) = a + bDEF(t) + cTERM(t) + e(t, t+T)$$

T	Aaa	Aa	A	Baa	LG	VW	EW	Aaa	Aa	A	Baa	LG	VW	EW
	Slopes for DEF							t-statistics for DEF slopes						
M	0.23	0.27	0.30	0.36	0.84	0.52	0.91	1.87	2.35	2.93	3.08	3.89	1.43	1.77
Q	0.57	0.68	0.80	1.09	2.72	2.18	3.70	1.22	1.49	1.80	2.31	3.25	1.61	1.84
1	1.42	1.11	2.87	4.51	11.15	10.98	18.62	1.08	0.73	1.90	2.79	4.37	2.12	2.79
2	6.25	5.13	9.01	11.73	24.48	24.83	39.56	1.62	1.20	2.24	3.74	5.79	3.01	3.82
3	10.01	8.66	13.83	17.45	36.15	36.07	54.33	1.65	1.31	2.49	5.00	9.42	4.17	4.04
4	13.35	11.16	16.32	19.90	40.18	41.99	57.36	1.85	1.44	2.56	4.26	11.52	3.94	3.78
	Slopes for $TERM$							t-statistics for $TERM$ slopes						
M	0.25	0.27	0.30	0.31	0.29	0.46	0.48	2.64	3.39	4.13	4.52	2.99	3.21	2.83
Q	0.61	0.58	0.71	0.71	0.68	1.09	1.08	1.44	1.44	1.96	2.25	1.64	2.03	1.62
1	3.60	3.53	3.79	3.46	3.03	1.75	1.31	4.59	4.97	5.61	5.55	4.41	0.99	0.61
2	4.05	3.95	4.01	3.94	3.44	−0.89	−2.57	3.26	3.61	3.86	4.89	4.82	−0.38	−0.70
3	3.94	3.33	3.38	3.18	2.19	−3.47	−6.12	1.74	1.69	1.51	1.74	1.28	−0.96	−1.16
4	3.22	2.59	2.85	3.12	2.92	−1.60	−1.97	0.87	0.75	0.81	1.12	1.05	−0.40	−0.49
	Regression R^2													
M	0.04	0.06	0.08	0.08	0.06	0.02	0.02							
Q	0.05	0.05	0.08	0.10	0.11	0.04	0.04							
1	0.40	0.38	0.46	0.45	0.45	0.09	0.13							
2	0.27	0.22	0.32	0.41	0.59	0.21	0.29							
3	0.23	0.16	0.29	0.42	0.70	0.39	0.44							
4	0.21	0.14	0.27	0.43	0.71	0.43	0.42							

[a] The regressions for T = one month (M), one quarter (Q), and one year use nonoverlapping returns. The regressions for two- to four-year returns use overlapping annual observations. The numbers of observations in the regressions are (M) 564, (Q) 188, (1 yr) 47, (2 yr) 46, (3 yr) 45, and (4 yr) 44. The standard errors in the t-statistics for the slopes are adjusted for heteroscedasticity and (for two- to four-year returns) the sample autocorrelation of overlapping residuals with the method of Hansen (1982) and White (1980). See note to table 1 for definition of portfolios.

Source: Fama/French (1989), Table 3

Fama and French (1989) – What can we learn?

Conclusions

- The three variables forecast stock and bond returns
- The variation in expected returns is largely common across securities, and is negatively related to long- and short-term variation in business conditions
- When business conditions are poor, income is low and expected returns on bonds and stocks must be high to encourage substitution from consumption to investment – when times are good and income is high, the market clears at lower levels of expected returns

"The general message is that expected returns are lower when economic conditions are strong and higher when conditions are weak."

buy stocks when conditions are weak
and sell when conditions are strong

Source: Fama/French (1989)

Part 5: Forecasting returns and conditional asset pricing

Modelling asset returns

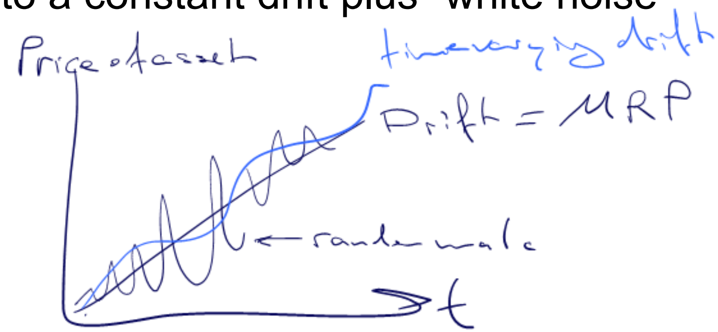
Traditional approach

- Random walk with constant drift
- The price at time t-1 plus a drift is the best forecast for the price at time t

$$P_t = \text{drift} + P_{t-1} + e_t$$

- The return from time t-1 to time t is equal to a constant drift plus “white noise”

$$R_t = \text{drift} + e_t$$



More general approach

- Random walk with time-varying drift
- Lagged information can be used to forecast a part of the drift

$$R_t = d_0 + d_1\left(\underline{Z}_{t-1}\right) + e_t$$

Conditioning information

Full information set

$$\underline{\phi}_{t-1} = (\varphi_{1,t-1}, \varphi_{2,t-1}, \dots, \varphi_{\kappa,t-1}) \in \Re^{\kappa}$$

- all information on the state of the global economy
- publicly available at time t-1

Information set applied for return conditioning

$$\underline{Z}_{t-1} = (Z_{1,t-1}, Z_{2,t-1}, \dots, Z_{h,t-1}) \subset \underline{\phi}_{t-1}$$

- instrumental variables representing the global information set
- observable at time t-1

A simple instrumental forecasting model

Linear regression of observed returns on lagged instruments

$$R_{it} = w_{i0} + w_{i1} \cdot Z_{1,t-1} + w_{i2} \cdot Z_{2,t-1} + \ldots + w_{ik} \cdot Z_{k,t-1} + \varepsilon_{it}$$

where

$Z_{j,t-1}$	level of the jth instrument at time t - 1
w_{ij}	impact of the jth instrument on the return of the ith asset
w_{i0}	constant component of the ith asset return

How to explore predictability

- Analyze estimates and t-values for w-coefficients
- Calculate the R-square

Specifying instrumental variables

Starting point

- Be devotedly aware of the data mining problem → not a good model
- Instruments must make economic sense
- Fundamental model of asset prices is a good "anchor point"

e.g. no weather etc. as instrument

Dividend Discount Model (DDM)

Model to determine the "intrinsic value" of a stock

$$\text{Price}_t = \frac{E(D_{t+1})}{\delta - E(g)}$$

aka Gordon Growth model

where

D_{t+1} next dividend

δ risk adjusted discount factor

g dividend growth rate

Searching for instrumental variables

Variables with impact on

- **Dividends**
  - Expected corporate earnings and cash flows
  - Expected dividend growth
- **Discount factor**
  - Risk free interest rate
  - Risk exposure of the firm
  - Expected risk premium for risk exposure

Economic categories

- Inflation
- Business expectations
- Default risk
- Fundamental valuation of firms
- Microstructure of market
- World market integration
- Political risk
- Momentum
- Investors' sentiment
- …

Inflation

Goal: Specifying an instrumental variable measuring expected inflation

Candidates

- Interest rates
- Term structure of interest rates
- Pricing of inflation-linked bonds
- …

$$\text{Price}_t = \frac{E(D_{t+1})}{\delta - E(g)}$$

Influence on dividends? YES

Influence on discount factor? YES

Business expectations

Goal: Specifying an instrumental variable measuring expected economic growth

Candidates

- Expected GDP growth
- Capacity utilization
- Money supply aggregates
- Housing starts
- Term structure of interest rates
- …

$$\text{Price}_t = \frac{E(D_{t+1})}{\delta - E(g)}$$

Influence on dividends? YES

Influence on discount factor? Possible

Default risk

Goal: Specifying an instrumental variable measuring confidence in corporate solvency

Candidates

- Credit spreads (BBB-AAA)
- Credit insurance premiums
- …

$$\text{Price}_t = \frac{E(D_{t+1})}{\delta - E(g)}$$

Influence on dividends? Possible

Influence on discount factor? YES

Investors’ sentiment

Goal: Specifying an instrumental variable measuring the investors’ attitude towards risk

Candidates

- Market sentiment indices
- Consumer confidence measures
- Put/Call ratio
- …

$$\text{Price}_t = \frac{E(D_{t+1})}{\delta - E(g)}$$

Influence on dividends? Possible

Influence on discount factor? YES

Part 5: Forecasting returns and conditional asset pricing

a. Economic conditions and asset returns
b. Specification of a forecasting model
c. Exploring the predictable variation of stock and bond market returns
d. Introduction into conditional asset pricing models
e. Predicting the time-variation of risk premiums
f. Global market integration

Application of a predictive regression

Foundation: Rational expectations model

$$r_{it} = E\left(r_{it} | \underline{Z}_{t-1}\right) + \varepsilon_{it}$$

Empirical implementation

$$r_{it} = \theta_{i1} + \theta_{i1} \cdot Z_{1,t-1} + \theta_{i2} \cdot Z_{2,t-1} + \cdots + \theta_{i5} \cdot Z_{5,t-1} + \varepsilon_{it}$$

where r_{it} excess return on stock or bond market i over period t

$Z_{j,t-1}$ level of instrumental variable j observed at time t-1

θ_{ij} influence of instrumental variable j on the return on asset i

for i = 1, …, 17 stock markets, i = 1, …, 8 bond markets

Application of a predictive regression – explanatory variables

Global instruments

$$\underline{Z}_{t-1} = (Z_{1,t-1}, Z_{2,t-1}, \cdots, Z_{5,t-1})$$

→ Proxy for fundamental valuation

1. **Global dividend yield (iDYG7):** GDP-weighted average of aggregate DY in the G-7 stock markets, the dividend-to-price (D/P) ratio at time t-1 is the average value of dividends paid from month t-12 to t-1, divided by the respective market index value at t-1.
2. **Global inflation rate (iING7):** GDP-weighted average of inflation rates in the G-7 countries, expressed in a log form. → Proxy for inflation
3. **Global term spread (iTSG7):** GDP-weighted average difference between the yield on long-term government bonds and the 1-month Eurocurrency short-term interest rate for the G-7 countries. → Proxy for expected business conditions
4. **U.S. default spread (iDSUS):** Difference between the yield on U.S. low-grade corporate bonds and the U.S. (default-free) government bond yield with the same maturity. → P.f. expected economic health
5. **TED spread (iTEDS):** Difference between the 3-month Eurodollar rate and the 90-day yield on the U.S. Treasury bill. large => stress in economy / proxy for financial stability

Source: Oertmann (1997)

Regression results – international stock markets

Stock markets	Intercept	Global instrumental variables					D.W.	R^2	adj R^2
		iDYG7	iING7	iTSG7	iDSUS	iTEDS			
Australia	-0.023	4.346 ***	-2.137 ***	-1.390 *	0.807	-2.222 *	2.020	0.043	0.011
	-0.669	*2.072*	*-2.042*	*-1.466*	*0.547*	*-1.377*			
Austria	-0.003	2.357 *	-0.794	-1.485 **	-0.783	-1.577	1.719	0.028	-0.003
	-0.117	*1.379*	*-0.931*	*-1.923*	*-0.652*	*-1.199*			
Belgium	-0.027 *	4.370 ***	-2.157 ***	-1.053 **	-0.321	-0.226	1.741	0.086	0.056
	-1.284	*3.392*	*-3.356*	*-1.807*	*-0.353*	*-0.228*			
Canada	-0.054 ***	3.179 ***	-1.162 *	-0.233	1.050	-0.463	1.943	0.056	0.025
	-2.224	*2.181*	*-1.597*	*-0.354*	*1.024*	*-0.412*			
Denmark	-0.017	1.308	-0.602	-0.503	0.552	0.582	1.923	0.028	-0.003
	-0.764	*0.965*	*-0.890*	*-0.821*	*0.578*	*0.557*			
France	-0.034 *	4.815 ***	-1.901 ***	-1.438 ***	-0.730	-1.819 **	1.911	0.071	0.040
	-1.403	*3.336*	*-2.640*	*-2.204*	*-0.719*	*-1.637*			
Germany	-0.038 *	3.187 ***	-0.838	-0.779	-0.083	-1.564 *	1.863	0.038	0.006
	-1.527	*2.157*	*-1.137*	*-1.167*	*-0.079*	*-1.375*			
Hong Kong	0.003	6.386 ***	-2.840 ***	-2.789 ***	-1.864	-5.371 ***	1.961	0.078	0.048
	0.091	*2.604*	*-2.320*	*-2.515*	*-1.081*	*-2.845*			

...the table continues

Regression results – international stock markets (cont.)

		Global instrumental variables							
Stock markets	Intercept	iDYG7	iNG7	iTSG7	iDSUS	iTEDS	D.W.	R^2	adj R^2
Italy	-0.042 *	5.126 ***	-1.891 ***	-1.324 **	-0.958	-2.403 **	1.996	0.051	0.020
	-1.393	*2.855*	*-2.111*	*-1.631*	*-0.759*	*-1.739*			
Japan	-0.034	4.705 ***	-2.694 ***	-0.939 *	1.246	-0.473	1.992	0.095	0.065
	-1.267	*2.921*	*-3.351*	*-1.289*	*1.099*	*-0.382*			
Netherlands	-0.035 **	3.664 ***	-1.357 ***	-0.823 *	0.183	-1.049	1.919	0.070	0.039
	-1.761	*3.067*	*-2.276*	*-1.525*	*0.218*	*1.141*			
Norway	-0.014	3.949 ***	-2.088 ***	-1.284 *	-0.393	-0.985	1.682	0.033	0.001
	-0.451	*2.054*	*-2.176*	*-1.477*	*-0.291*	*-0.665*			
Spain	-0.005	3.558 ***	-1.836 ***	-1.196 *	-1.772 *	-0.526	1.786	0.036	0.004
	-0.185	*2.069*	*-2.141*	*-1.538*	*-1.465*	*-0.397*			
Sweden	-0.019	1.721	-1.145 *	-0.568	1.802 *	1.159	1.809	0.052	0.020
	-0.683	*1.001*	*-1.335*	*-0.731*	*1.491*	*0.876*			
Switzerland	-0.027 *	2.247 **	-0.678	-0.186	0.478	-1.233 *	1.801	0.035	0.003
	-1.391	*1.907*	*-1.154*	*-0.350*	*0.577*	*-1.359*			
United Kingdom	-0.031 *	3.569 ***	-1.366 ***	-0.990 *	-0.799	-0.551	2.001	0.046	0.014
	-1.355	*2.549*	*-1.956*	*-1.564*	*-0.812*	*-0.511*			
United States	-0.051 ***	3.429 ***	-0.971 *	-0.543	-0.305	-0.368	1.824	0.055	0.023
	-2.215	*2.475*	*-1.406*	*-0.868*	*-0.313*	*-0.345*			

...the table continues

Regression results – international bond markets

		Global instrumental variables							
Bond markets	Intercept	iDYG7	iING7	iTSG7	iDSUS	iTEDS	D.W.	R^2	adj R^2
Canada	-0.052 ***	1.389 *	0.180	0.333	0.063	0.452	2.052	0.072	0.042
	-2.863	*1.286*	*0.334*	*0.683*	*0.083*	*0.544*			
France	-0.016 **	1.133 ***	-0.189	-0.114	-0.617 **	-0.119	2.147	0.051	0.020
	-1.760	*2.079*	*-0.698*	*-0.463*	*-1.609*	*-0.284*			
Germany	-0.021 ***	1.215 ***	-0.266	-0.049	-0.203	-0.061	1.888	0.071	0.040
	-2.696	*2.600*	*-1.143*	*-0.236*	*-0.618*	*0.169*			
Japan	-0.024 ***	1.130 *	-0.350	0.486 *	0.594	-0.026	1.776	0.061	0.030
	-1.929	*1.494*	*-0.929*	*1.422*	*1.117*	*-0.046*			
Netherlands	-0.018 ***	1.008 ***	-0.240	0.017	-0.175	0.197	1.897	0.073	0.042
	-2.539	*2.281*	*-1.089*	*0.087*	*-0.563*	*0.581*			
Switzerland	-0.012 ***	0.441 **	-0.110	0.204 **	0.214	-0.024	1.603	0.078	0.047
	-2.869	*1.679*	*-0.840*	*1.725*	*1.161*	*-0.121*			
United Kingdom	-0.024 *	0.867	0.140	0.136	-0.981 *	0.314	1.735	0.043	0.011
	-1.573	*0.925*	*0.300*	*0.321*	*-1.490*	*0.437*			
United States	-0.045 ***	1.502 **	0.051	0.184	-1.097 **	1.038 *	1.963	0.117	0.088
	-2.950	*1.637*	*0.113*	*0.445*	*-1.701*	*1.469*			

The t-statistics reported underneath the coefficients (factor betas) are heteroskedasticity consistent. * / ** / *** denotes a coefficient estimated on the 20% / 10% / 5% level of significance. D.W. is the Durbin-Watson test statistic; R^2 denotes the coefficient of determination; adj R^2 is adjusted for degrees of freedom. iDYG7 denotes the real GDP-weighted average of the aggregate dividend yields in the G-7 stock markets; iING7 is the G-7 inflation rate; iTSG7 stands for the G-7 term spread; iDSUS is the spread between the US low-grade corporate bond yield and the US government bond yield; iTEDS denotes the spread between the 3-month Eurodollar rate and the 90-day yield on the US T-bill.

Results for stock markets

- Excess returns on international stock markets are to some extent predictable by the global instruments specified.
- R-square:
  - Average: 0.053
  - 0.028 (Austria) to 0.095 (Japan)
  - Relatively high R-square for Belgium (0.086), France (0.071), Hong Kong (0.078), and the Netherlands (0.070)
- Coefficients' signs
  - Global dividend yield (iDYG7): positive
  - Global inflation rate (iING7): negative
  - Global term spread (iTSG7): negative
  - U.S. default spread (iDSUS): mixed signs
  - TED spread (iTEDS): mostly negative

Source: Oertmann (1997)

Results for bond markets

- The predictable variation of international bond market returns seems to be related only to some few of the global instruments prespecified here.
- R-square:
  - Average: 0.071
  - 0.043 (U.K.) to 0.117 (USA)
  - For Canada, Germany, the Netherlands, Switzerland, and the United States, the fraction of return variance captured is larger than with the stock market
- Coefficients' signs
  - Global dividend yield (iDYG7): positive
  - Global inflation rate (iING7): not significant
  - Global term spread (iTSG7): mixed signs
  - U.S. default spread (iDSUS): negative
  - TED spread (iTEDS): not significant

Source: Oertmann (1997)

Part 5: Forecasting returns and conditional asset pricing

a. Economic conditions and asset returns

b. Specification of a forecasting model

c. Exploring the predictable variation of stock and bond market returns

d. Introduction into conditional asset pricing models

e. Predicting the time-variation of risk premiums

f. Global market integration

Asset pricing with time-varying risk premiums

Goal of conditional asset pricing models

- Exploitation of the relationship between business conditions and expected asset returns across the universe of assets
- Application of observable information variables (instruments) to model time-variation in global risk premiums in asset pricing relationships

Some milestone studies

- Keim & Stambaugh (1986)
- Campbell (1987)
- Gibbons & Ferson (1989)
- Harvey (1991), Ferson/Harvey (1991, 1993)
- Ilmanen (1995)

→ Goal: Predict cross sectional variation of returns for a universe of assets

Study of Ferson and Harvey (1991)

Motivation

- Evidence that stock and bond returns are to some extent predictable
- Debate on the reason for that predictability
  - Market inefficiencies? ✗
  - Changes in required returns? ✓
- Attempt to calibrate the relative importance of these two explanations

Approach

- Assuming a rational asset pricing model: Expected returns of assets are related to their sensitivity to changes in the state of the economy
- Sensitivity is measured by the assets' beta coefficients
- For each of the relevant state variables there is a market-wide risk premium (increment to the expected return per unit of beta)
- Focus on the time-series behavior of the risk premiums

↳ Do risk premiums vary over time?

Source: Ferson/Harvey (1991)

Study of Ferson and Harvey (1991) – regression model

Multiple-beta model

$$E(R_{it}|Z_{t-1}) = \gamma_0(Z_{t-1}) + \sum_{j=1}^{K} b_{ij,t-1} \cdot \gamma_j(Z_{t-1})$$

- K state variables
- Time-varying betas and time-varying risk premiums

Cross-section of assets

- Portfolios of common stocks listed on NYSE (10 ”size” portfolios / 12 sector portfolios)
- Long-term government bonds
- Long-term corporate bonds
- Treasury bills

Source: Ferson/Harvey (1991)

Study of Ferson and Harvey (1991) – conclusions

- Much of the predicted variation of monthly excess returns of common stock portfolios is associated with their sensitivity to economic variables
- The risk premium associated with exposure to a stock market index captures the largest component of the predictable variation in stock returns = main source of predictability
- Risk premiums associated with term structure shifts and default spreads are the most important for fixed-income securities
- Time-variation in the premium for beta risk is more important than changes in the betas

"Our findings strengthen the evidence that the predictability of returns is attributable to time-varying, rationally expected returns."

Source: Ferson/Harvey (1991)

Conditioning information in asset pricing

Pricing restriction with time-varying risk premiums

$$E(r_{it}|\underline{\phi}_{t-1}) = \beta_{i1} \cdot \lambda_{1t}(\underline{\phi}_{t-1}) + \beta_{i2} \cdot \lambda_{2t}(\underline{\phi}_{t-1}) + \ldots + \beta_{ik} \cdot \lambda_{kt}(\underline{\phi}_{t-1})$$

variation in risk premiums

where

$E(r_{it}\|\underline{\phi}_{t-1})$	ith asset's excess return expected for period t based on information set at time t - 1
$\lambda_{1t}(\underline{\phi}_{t-1})$	jth factor risk premium expected for period t based on information set at time t - 1
β_{ij}	exposure of the ith asset's return to the jth factor
$\underline{\phi}_{t-1}$	information set at time t - 1

Information ϕ explains the variation in risk premium λ and the variation in λ explains the variation of exp. returns

Conditioning information in asset pricing (cont.)

Modelling time-varying risk premiums

$$\lambda_{jt}(\underline{Z}_{t-1}) = \omega_{j0} + \omega_{j1} \cdot Z_{1,t-1} + \omega_{j2} \cdot Z_{2,t-1} + \ldots + \omega_{jh} \cdot Z_{h,t-1}$$

where $Z_{v,t-1}$ level of the vth instrument at time t - 1

ω_{jv} impact of the vth instrument on the jth risk premium

ω_{j0} constant component of the jth risk premium

Assumption of …

- a linear relationship between instrument levels and risk premium levels
- a constant long-run risk premium mean

Part 5: Forecasting returns and conditional asset pricing

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Recall the result of our unconditional pricing test

Global Risk Premia					
International CAPM		3-Factor Model			
λ_j (Monthly %)	GMM χ^2 Statistic	λ_j (Monthly %)			GMM χ^2 Statistic
WDSTR	(p-Value)	WDSTR	ILG7C	CHG7C	(p-Value)
0.526	24.893	0.259	−0.352	0.084	21.956
8.205	(0.411)	*2.144*	*−1.406*	*0.904*	(0.462)

Note: The reported coefficients, the monthly risk premia (factor prices), are estimated simultaneously with factor betas (not reported here) using GMM. The GMM test statistic for the model's goodness-of-fit is chi-square distributed with 24 (22) degrees of freedom for the international CAPM (3-factor model). The sample period is from 1982.02 to 1995.02.

Source: Oertmann (1997)

Specification of a global conditional beta pricing model

System of pricing equations

instrumental variables

systematic risk factors

$$\underbrace{\begin{pmatrix} r_{1t} \\ \vdots \\ r_{nt} \end{pmatrix}}_{\text{vector of excess returns}} = \underbrace{\underbrace{\begin{pmatrix} \beta_{11} \cdots \beta_{13} \\ \vdots \\ \beta_{n1} \cdots \beta_{n3} \end{pmatrix}}_{\text{factor exposures}} \cdot \underbrace{\begin{pmatrix} \omega_{10} \cdots \omega_{15} \\ \vdots \\ \omega_{30} \cdots \omega_{35} \end{pmatrix} \cdot \begin{pmatrix} Z_{0,t-1} \\ \vdots \\ Z_{5,t-1} \end{pmatrix}}_{\text{time-varying risk premia}}}_{\text{conditionally expected returns}} + \underbrace{\underbrace{\begin{pmatrix} \beta_{11} \cdots \beta_{13} \\ \vdots \\ \beta_{n1} \cdots \beta_{n3} \end{pmatrix}}_{\text{factor exposures}} \cdot \underbrace{\begin{pmatrix} \delta_{1t} \\ \vdots \\ \delta_{3t} \end{pmatrix}}_{\text{factor returns}} + \underbrace{\begin{pmatrix} \varepsilon_{1t} \\ \vdots \\ \varepsilon_{nt} \end{pmatrix}}_{\text{residual returns}}}_{\text{unexpected returns}}$$

- 3 global sources of risk
  - WDSTR, ILG7C, CHG7C
- 5 instruments to model time-variation in the 3 risk premiums
- Joint estimation of factor exposures and ω-coefficients

Source: Oertmann (1997)

Set of instruments

1. **Global dividend yield (iDYG7):** GDP-weighted average of aggregate DY in the G-7 stock markets, the dividend-to-price (D/P) ratio at time t-1 is the average value of dividends paid from month t-12 to t-1, divided by the respective market index value at t-1.
2. **Global inflation rate (iING7):** GDP-weighted average of inflation rates in the G-7 countries, expressed in a log form.
3. **Global term spread (iTSG7):** GDP-weighted average difference between the yield on long-term government bonds and the 1-month Eurocurrency short-term interest rate for the G-7 countries.
4. **U.S. default spread (iDSUS):** Difference between the yield on U.S. low-grade corporate bonds and the U.S. (default-free) government bond yield with the same maturity.
5. **TED spread (iTEDS):** Difference between the 3-month Eurodollar rate and the 90-day yield on the U.S. Treasury bill.

Source: Oertmann (1997)

We are interested in the Ω matrix

Ω coefficients describe the conditional time-variation of global risk premiums

$$\begin{pmatrix} r_{1t} \\ \vdots \\ r_{nt} \end{pmatrix} = \underbrace{\underbrace{\begin{pmatrix} \beta_{11} \cdots \beta_{13} \\ \vdots \\ \beta_{n1} \cdots \beta_{n3} \end{pmatrix}}_{\text{factor exposures}} \cdot \underbrace{\boxed{\begin{pmatrix} \omega_{10} \cdots \omega_{15} \\ \vdots \\ \omega_{30} \cdots \omega_{35} \end{pmatrix}} \cdot \begin{pmatrix} Z_{0,t-1} \\ \vdots \\ Z_{5,t-1} \end{pmatrix}}_{\text{time-varying risk premia}}}_{\text{conditionally expected returns}} + \underbrace{\underbrace{\begin{pmatrix} \beta_{11} \cdots \beta_{13} \\ \vdots \\ \beta_{n1} \cdots \beta_{n3} \end{pmatrix}}_{\text{factor exposures}} \cdot \underbrace{\begin{pmatrix} \delta_{1t} \\ \vdots \\ \delta_{3t} \end{pmatrix}}_{\text{factor returns}} + \underbrace{\begin{pmatrix} \varepsilon_{1t} \\ \vdots \\ \varepsilon_{nt} \end{pmatrix}}_{\text{residual returns}}}_{\text{unexpected returns}}$$

Source: Oertmann (1997)

Ω matrix for stock markets

	Determinants of time-varying factor risk premia $\hat{\lambda}_{jt}(\underline{Z}_{t-1})$ ω-coefficients		
Global instruments	WDSTR	ILG7C	CHG7C
Constant	-0.013	0.039 **	-0.012 *
	-0.785	1.800	-1.329
iDYG7	4.672 ***	1.412	-0.348
	4.583	1.047	-0.616
iNG7	-2.423 ***	-0.806	0.438 *
	-4.581	-1.151	1.494
iTSG7	-1.001 ***	-1.461 ***	-0.049
	-2.153	-2.374	-0.192
iDSUS	0.064	-2.273 ***	-0.269
	0.090	-2.415	-0.683
iTEDS	-2.817 ***	-3.250 ***	0.946 **
	-3.150	-2.745	1.906
GMM chi-square	89.538		
p-value	0.319		

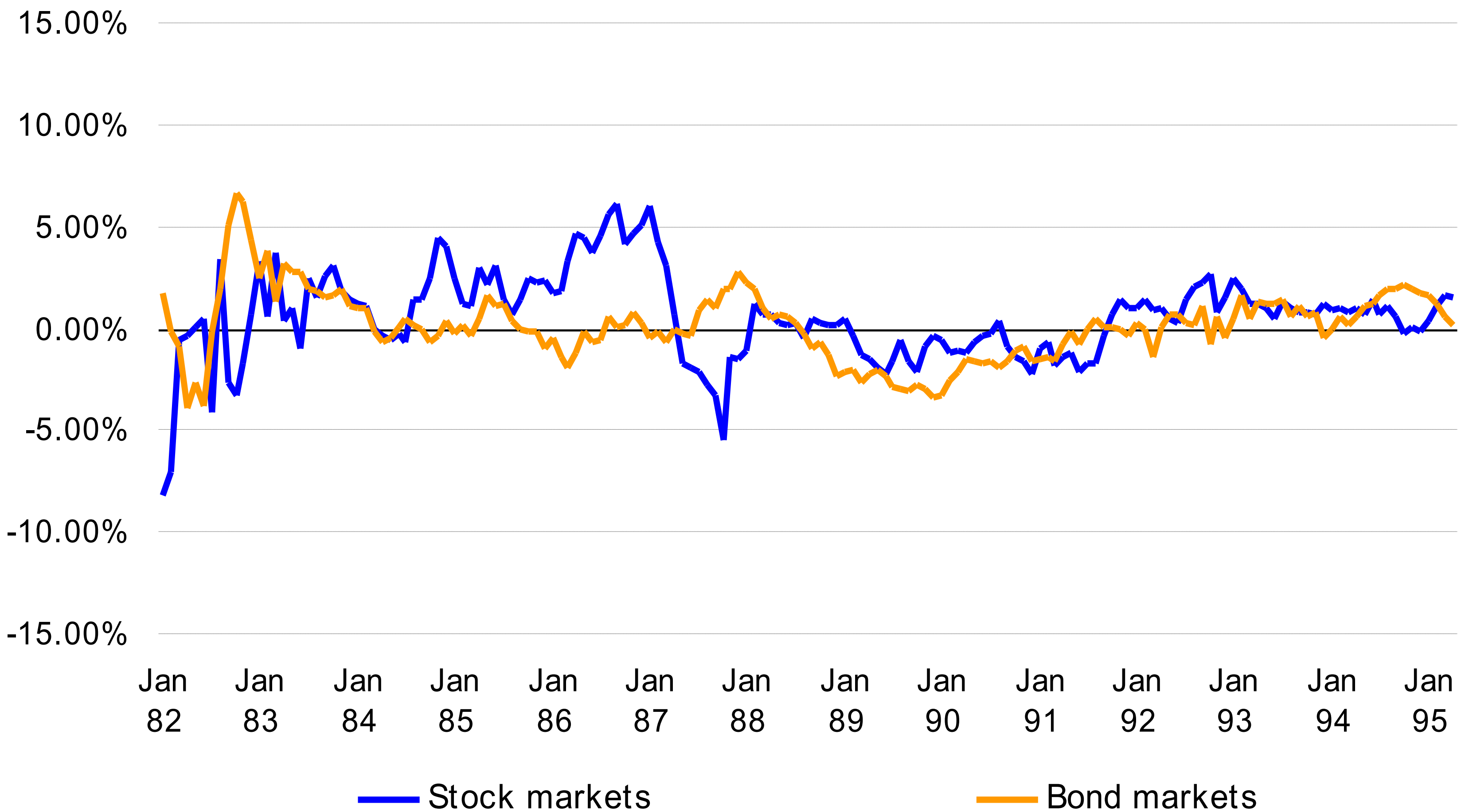
Source: Oertmann (1997)

Ω matrix for bond markets

	Determinants of time-varying factor risk premia $\hat{\lambda}_{jt}(\underline{Z}_{t-1})$ ω-coefficients		
Global instruments	WDSTR	ILG7C	CHG7C
Constant	-0.032	0.072 ***	0.001
	-0.888	*2.420*	*0.135*
iDYG7	-0.535	-2.623 **	0.130
	-0.271	*-1.625*	*0.231*
iNG7	0.223	0.845	0.253
	0.231	*1.068*	*0.916*
iTSG7	1.815 **	-1.328 **	-0.522 **
	1.893	*-1.692*	*-1.903*
iDSUS	2.206 *	-2.670 ***	-1.603 ***
	1.389	*-2.024*	*-3.476*
iTEDS	0.968	0.721	0.533 *
	0.657	*0.597*	*1.263*
GMM chi-square	23.146		
p-value	0.809		

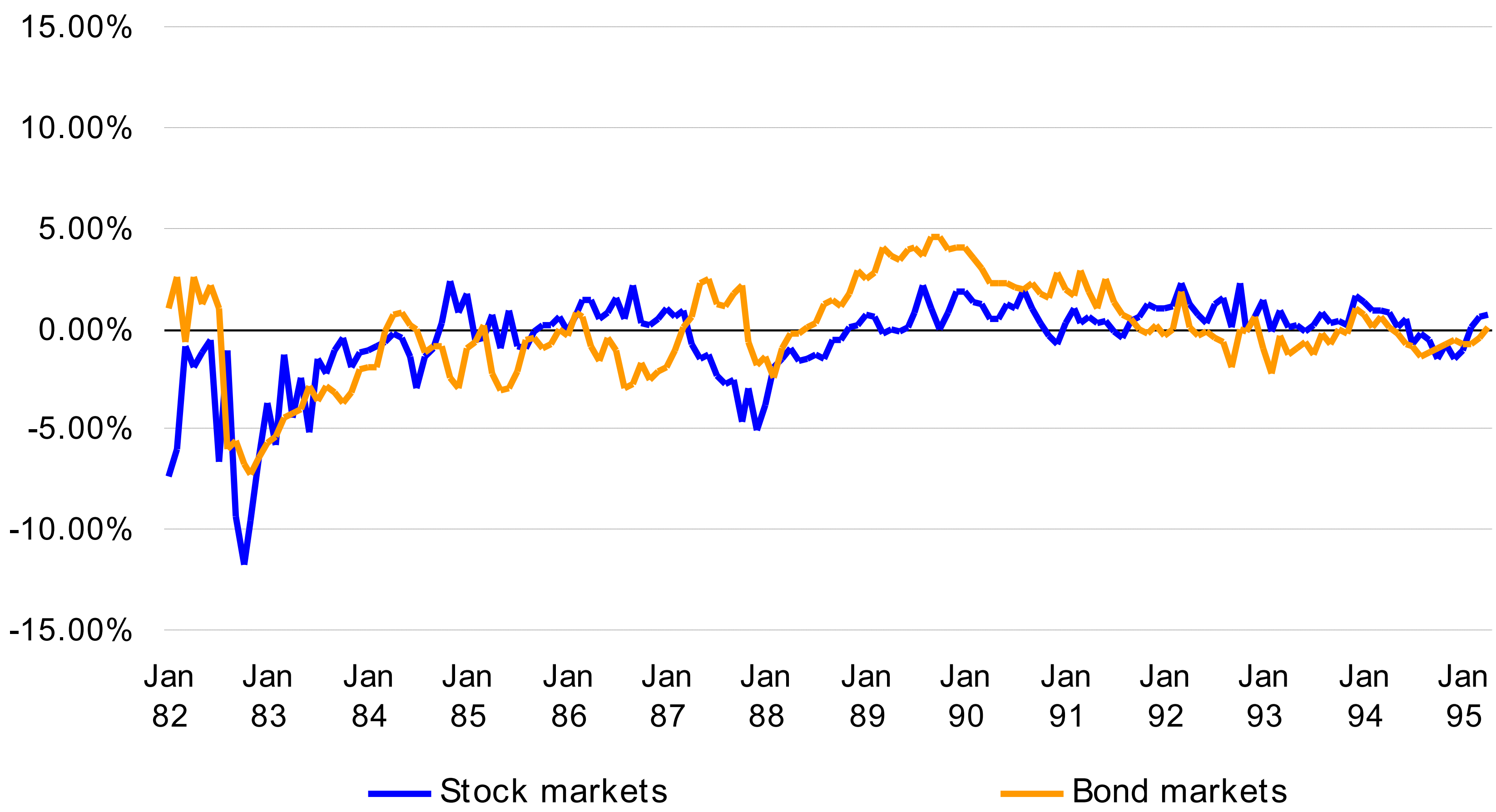
Source: Oertmann (1997)

Time-variation of the world stock market risk premium



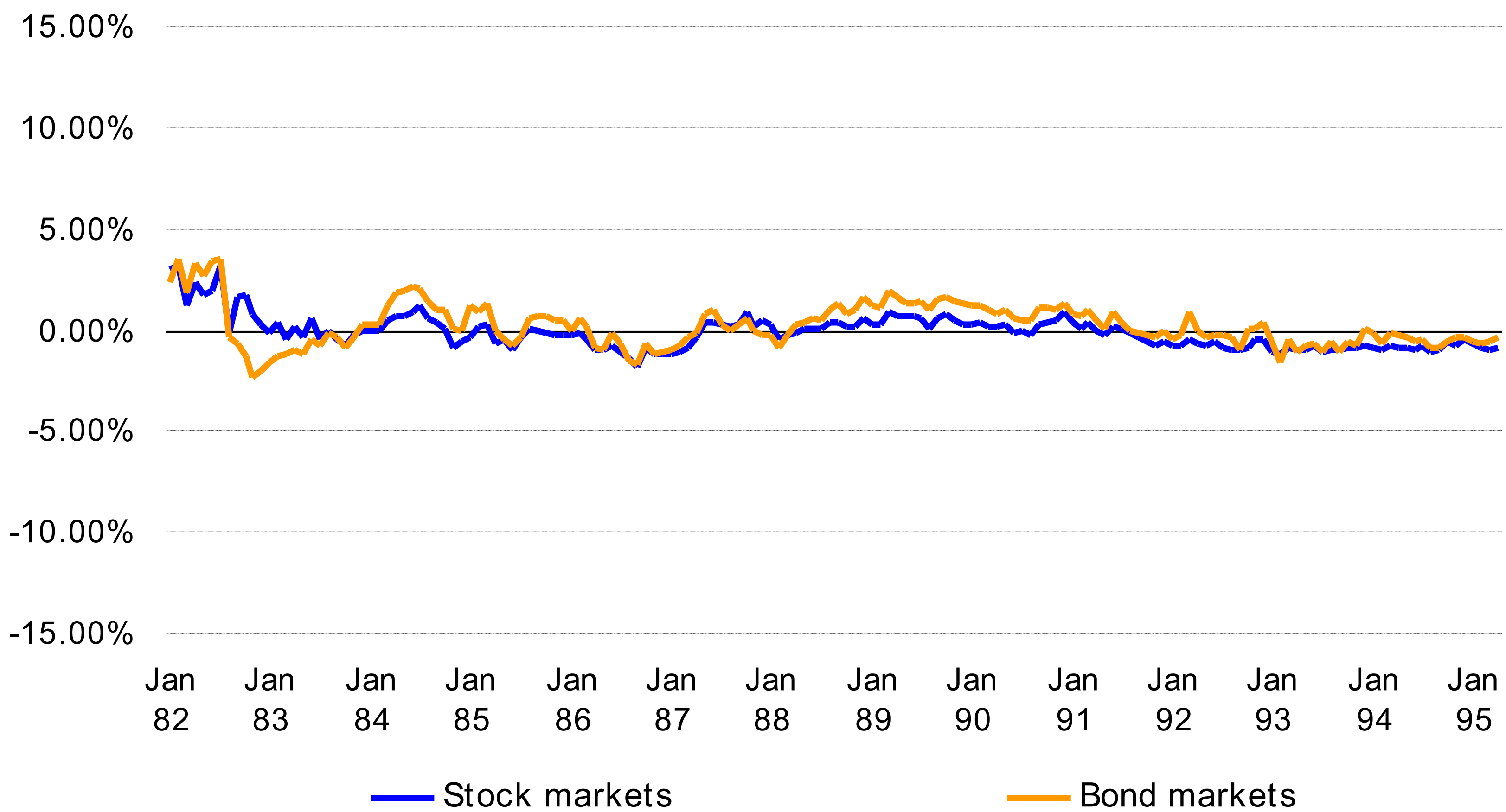
Source: Oertmann (1997)

Time-variation of the global interest rate risk premium



Source: Oertmann (1997)

Time-variation of the global FX risk premium



Source: Oertmann (1997)

Part 5: Forecasting returns and conditional asset pricing

a. Economic conditions and asset returns
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Concept of market integration

Markets are integrated → the same global risk leads to the same expected returns

- if assets with the same risk …
- in terms of an exposure to common systematic global risk factors …
- have the same expected returns …
- irrespective of the market in which they are traded

Interpretation

- Sources of global risk are the same across international markets
- Rewards for global risks are the same in each market
- If the factor risk premiums were different across markets, an investor could increase the expected return of his portfolio without altering her risk exposure by simply investing in those countries that provide higher rewards for the same risk (case of market segmentation)

Integration can be measured

... across

- Countries
- Geographic regions
- Industrial sectors
- Emerging (converging) and developed markets
- Stock and bond markets

How can integration be measured?

Indicative measures

- Correlation between financial market returns
- Volatility spillovers between financial markets
- Factor exposures of financial markets

Theoretically correct measures

- Global risk premiums
  - Significance (= existence)
  - Ability to price (explain) the cross-section of international assets (= pricing error)
- Correlation between expected returns

Starting points

Increasing global market integration implies an ...

- increasing comovement of the returns on financial markets
  - Analysis of return correlations
- increasing influence of global factors driving returns
  - Analysis of markets‘ factor exposures
- increasing comovement of expected returns on financial markets
  - Analysis of the correlation of expected returns
- improving fit of global asset pricing models
  - Analysis of pricing consistency
- increasing comovement of global risk premiums across asset classes
  - Analysis of the comovement of global risk premiums

Analysis of pricing consistency

Major steps

- Identification of factors driving returns
- Estimation of global risk premiums and tests of significance
- Analysis of the magnitude of pricing errors

Calculation of pricing errors (PE) across assets

$$\underbrace{\begin{pmatrix} PE_1 \\ \vdots \\ PE_i \\ \vdots \\ PE_n \end{pmatrix}}_{\text{Pricing error}} = \underbrace{\begin{pmatrix} \bar{R}_1 \\ \vdots \\ \bar{R}_i \\ \vdots \\ \bar{R}_n \end{pmatrix}}_{\text{avg returns}} - \underbrace{\left[R_f + \begin{pmatrix} \beta_{11} \\ \vdots \\ \beta_{i1} \\ \vdots \\ \beta_{n1} \end{pmatrix} \cdot \lambda_1 + \begin{pmatrix} \beta_{12} \\ \vdots \\ \beta_{i2} \\ \vdots \\ \beta_{n2} \end{pmatrix} \cdot \lambda_2 + \ldots + \begin{pmatrix} \beta_{1k} \\ \vdots \\ \beta_{ik} \\ \vdots \\ \beta_{nk} \end{pmatrix} \cdot \lambda_k \right]}_{\text{Risk premium based expected return}}$$

unconditional beta pricing model

Analysis of pricing consistency

Mean pricing error for international asset returns

Model alternatives

- **Global CAPM**
  - MSCI world market return
- **Global 3-factor model**
  - MSCI world market return
  - G7 long-term interest rate changes
  - FX rate changes of G7 currencies vs CHF

Setting

- Viewpoint of a Swiss investor
- Simultaneous estimation of factor exposures and risk premiums
- 3 sub-periods

Analysis of pricing consistency

Mean pricing error for international asset returns

period of increased internationalization / diversification

	82.02 - 86.12		87.01 - 89.12		90.01 - 95.02	
Stock markets	**CAPM**	**3-factor**	**CAPM**	**3-factor**	**CAPM**	**3-factor**
Australia	0.464	0.148	0.960	0.146	0.049	0.560
Austria	1.137	0.812	1.038	0.426	0.608	0.216
Belgium	1.249	0.658	0.313	0.006	0.089	0.063
Canada	0.984	0.642	0.214	0.216	0.663	0.116
Denmark	0.282	0.015	1.493	0.343	0.376	0.074
France	0.865	0.048	0.129	0.129	0.336	0.126
Germany	1.128	0.463	0.581	0.349	0.172	0.109
Hong Kong	0.274	0.631	1.727	0.143	1.378	0.532
Italy	0.963	0.169	1.010	0.118	0.787	0.613
Japan	0.726	0.174	0.593	0.282	0.997	0.549
Netherlands	0.673	0.315	0.029	0.053	0.353	0.200
Norway	0.198	0.324	0.042	0.005	0.406	0.490
Spain	0.714	0.488	0.079	0.172	0.508	0.088
Sweden	0.871	0.502	0.245	0.475	0.106	0.654
Switzerland	0.652	0.113	0.771	0.087	0.518	0.203
United Kingdom	0.028	0.204	0.187	0.116	0.001	0.151
United States	0.685	0.146	0.450	0.186	0.130	0.282
Median PE	**0.714**	**0.315**	**0.450**	**0.146**	**0.376**	**0.203**

model fit improved

= better global market fit

Analysis of pricing consistency

Mean pricing error for international asset returns

	82.02 - 86.12		87.01 - 89.12		90.01 - 95.02	
Band markets	**CAPM**	**3-factor**	**CAPM**	**3-factor**	**CAPM**	**3-factor**
Canada	0.129	0.083	0.479	0.404	0.550	0.394
France	0.448	0.245	0.097	0.180	0.010	0.109
Germany	0.538	0.069	0.165	0.141	0.105	0.032
Japan	0.469	0.095	0.104	0.110	0.182	0.205
Netherlands	0.439	0.095	0.208	0.157	0.050	0.076
Switzerland	0.097	0.082	0.002	0.024	0.076	0.119
United Kingdom	0.226	0.278	0.080	0.009	0.174	0.002
United States	0.159	0.055	0.731	0.666	0.374	0.205
~~Average~~ Median PE	0.333	0.089	0.135	0.149	0.140	0.114

Source: Oertmann (1997)

Analysis of the comovement of global risk premiums

IR and currency important factors

Example

Correlations between global risk premiums in stock and bond returns

	Risk premiums		
	Market	**Interest rate**	**FX rate**
1982-1995	0.077	0.468	0.751
Sub-periods			
1982-1986	-0.218	0.465	0.696
1987-1989 (crash period)	-0.030	0.509	0.796
1990-1995	0.511	0.360	0.918

increased integration of global stock & bond markets

Source: Oertmann (1997)

→ Motivation to include alternative assets (e.g. Private equity, hedgefunds, infrastructure, ...)

Integration and asset pricing

- **Segmented markets**
  - Tests using assets from one country
  - CAPM: Sharpe (1964), Lintner (1965), Black (1965)
- **Perfectly integrated markets**
  - Tests on the cross-section of international assets
  - World CAPM with FX risk: Dumas (1994), Dumas/Solnik (1995)
  - World multibeta models: Solnik (1983); Ferson/Harvey (1993, ...)
- **Mild market segmentation**
  - Assuming a certain degree of segmentation
- **Time-varying market integration**
  - Allowing the degree of integration to change through time
  - Bekaert/Harvey (1995)
  - Bekaert/Harvey/Lundblad/Siegel (2011)

Multifactor models – an overview

Model	Input and Output	Applications
Multifactor model $R_{it} = a_i + \sum_{j=1}^{k} \beta_{ij} \cdot \delta_{jt} + \varepsilon_{it}$	**IN** Time series of returns and factor changes **OUT** Factor sensitivities (β's)	• Analyze the risk profile of assets • Explain return variance • Play scenarios
Multifactor asset pricing model $E(R_i) = R_f + \sum_{j=1}^{k} \beta_{ij} \cdot \lambda_j$	**IN** Risk-free rate, assets' β's and risk premiums **OUT** Cross-sectional consistent expected returns	• Generate (a vector of) expected returns as an input for Strategic Asset Allocation (SAA)
Instrumental forecasting model $R_{it} = w_{i1} + \sum_{j=1}^{k} w_{ij} \cdot Z_{j,t-1} + \varepsilon_{it}$	**IN** Time series of returns and lagged instruments **OUT** Instrument sensitivities (w's)	• Forecast asset returns
Conditional asset pricing model $E_t(R_i) = R_{ft} + \sum_{j=1}^{k} \beta_{ij} \cdot \lambda_{jt}(\underline{Z}_{t-1})$	**IN** Risk-free rate, assets' β's and risk premiums at t-1 **OUT** Cross-sectional consistent expected returns at time t-1	• Generate (a vector of) conditionally expected return as an input for Tactical Asset Allocation (TAA)

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International Capital Markets and Investment Practice

Part 6

Asset Allocation

Prof. Dr. Peter Oertmann
TUM School of Management
Technical University of Munich
peter.oertmann@tum.de

Part 6: Asset Allocation

Part 6: Positioning in the lecture

Major fields in asset management

Diversification	Asset allocation
Security selection	Investment strategy implementation
Risk management	Trading and execution

Knowledge base

Stylized facts on global markets Empirical research	Sources of risk and return Models and empirical research
Asset pricing Theories, models and empirical tests	Portfolio construction Models and empirical tests
Financial economics Models and empirical research	Time series analysis Models and empirical procedures

Part 6: Asset Allocation

Asset allocation – introductory remarks

- Structure of an investment portfolio on the level of asset classes
- There is **no industry standard** for the definition and implementation of an asset allocation, in most cases investors combine quantitative methods with judgmental considerations
- Asset classes are individually defined segments of the capital market

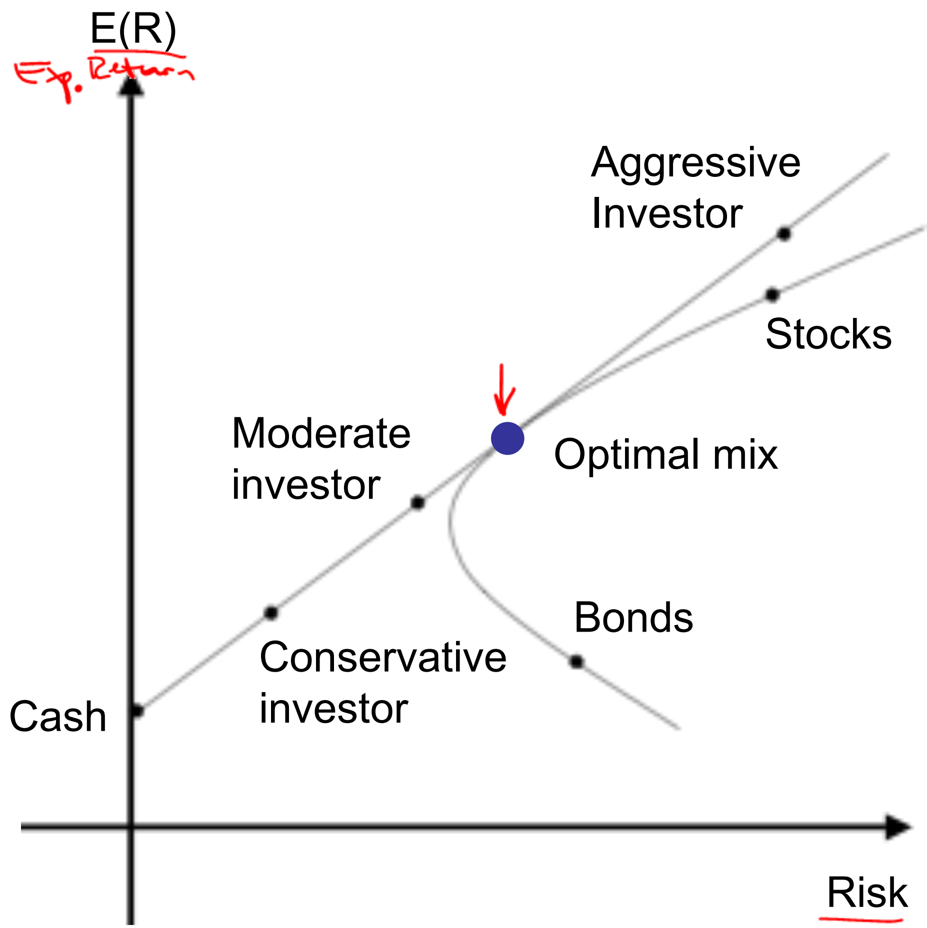
Strategic asset allocation (SAA) is generally considered the most important value driver of an investment portfolio, it should be consistent with long-term return expectations as well as the risk budget and tolerance of the investor

→ long term structure

Many institutional investors also implement a **tactical asset allocation** (TAA) process in order to adjust their portfolio structure to risks and chances along with the changing fundamental market environment

→ dynamic mgmt

Asset allocation following Markowitz (1952)



Tobin's mutual fund theorem

- All investors hold the same combination of risky assets (tangency portfolio)
- Conservative investors combine this portfolio with cash to reduce variance of return
- Aggressive investors borrow money to leverage their investments in this portfolio

In investment practice asset allocations are individual solutions!

→ modern portfolio theory

Advice is individual – the “asset allocation puzzle”

	Percent of portfolio			
Advisor and investor type	Cash	Bonds	Stocks	Bonds/Stocks
Fidelity				
Conservative	50	30	20	1,50
Moderate	20	40	40	1,00
Aggressive	5	30	65	0,46
Merrill Lynch				
Conservative	20	35	45	0,78
Moderate	5	40	55	0,73
Aggressive	5	20	75	0,27
Jane Bryant Quinn				
Conservative	50	30	20	1,50
Moderate	10	40	50	0,80
Aggressive	0	0	100	0,00
The New York Times				
Conservative	20	40	40	1,00
Moderate	10	30	60	0,50
Aggressive	0	20	80	0,25

Source: Canner, Mankiw and Weil (1997)

Asset allocation approaches

Approach		Value creation
Passive	**Indexing**	Replicating the investment weights of a benchmark index (e.g. MSCI World)
Active	**Strategic asset allocation** (long-term, 3-5 years) → long term	Implementing tilts based on long-term views of asset class performance, deviations from market indices
	Tactical asset allocation (short-term, 1-3 months) → short term	Implementing bets based on short-term views on financial markets, deviations from strategic weights
	High-frequency tactical asset allocation	Daily trading and risk management, deviations from tactical weights

Remark: See also Dahlquist and Harvey (2001)

The Brinson-Hood-Beebower (BHB) model for performance analysis

Timing \ Selection	Actual	Passive
Actual	(4) Actual Portfolio return	(2) Policy and timing return
Passive	(3) Policy and security selection return	(1) Policy return (benchmark)

Calculation of returns

Quadrant (1) $\sum(\mathrm{Wpi} \cdot \mathrm{Rpi})$

Quadrant (2) $\sum(\mathrm{Wai} \cdot \mathrm{Rpi})$

Quadrant (3) $\sum(\mathrm{Wpi} \cdot \mathrm{Rai})$

Quadrant (4) $\sum(\mathrm{Wai} \cdot \mathrm{Rai})$

where

Wpi = policy weight

Wai = actual weight

Rpi = passive return

Rai = active return

... for asset class i

Source: Brinson, Hood and Beebower (1986)

BHB model – analysis of portfolio return

Selection

Timing		Actual	Passive
	Actual	(4) **9.01%**	(2) **9.44%**
	Passive	(3) **9.75%**	(1) **10.11%**

Attribution of active returns

Timing	(2) - (1)
Selection	(3) - (1)
Other	(4) - (3) - (2) + (1)
Total	(4) - (1)

Results

Timing	-0.66%
Selection	-0.36%
Other	-0.07% ← Cross effects
Total	-1.10%

Mean annualized returns by activity from 91 US pension plans, 1974-1983

Source: Brinson, Hood and Beebower (1986)

BHB model – analysis of portfolio risk

Selection

Timing		Actual	Passive
	Actual	(4) **100%**	(2) **95.3%**
	Passive	(3) **97.8%**	(1) **93.6%**

Percentage of total return variation explained by activity, average of 91 pensions plans

significant driver

Results

- Investment policy return explains on average 93.6% of the the total return variation (min 75.8% / max 98.6%)
- Timing returns add only 1.7% on average to the explained variation
- Selection returns add only 4.2% on average to the explained variation

Source: Brinson, Hood and Beebower (1986)

Exercise question

The benchmark of a fund features 30% invested in equity markets and 70% invested in fixed income assets (policy weights). The actual weights imposed by the fund management over the last 12 months were 40% equity and 60% fixed income. The passive equity return was 4.5% and the passive fixed income return was 1.5%, while the active returns achieved by the fund management were 5% in equity and 1.0% in fixed income.

Evaluate the active competences of the fund management

	Equity	FI
$W_{policy} = W_p$	30%	70%
$W_{actual} = W_a$	40%	60%
$R_{policy} = R_p$	4.5%	1.5%
$R_{actual} = R_a$	5%	1%

(4) Actual return
$0.4 \cdot 0.05 + 0.6 \cdot 0.01 = 2.6$

(2) Policy and timing return
$0.4 \cdot 0.045 + 0.6 \cdot 0.015 = 2.7\%$

(3) Policy & selection return
$0.3 \cdot 0.05 + 0.7 \cdot 0.01 = 2.2\%$

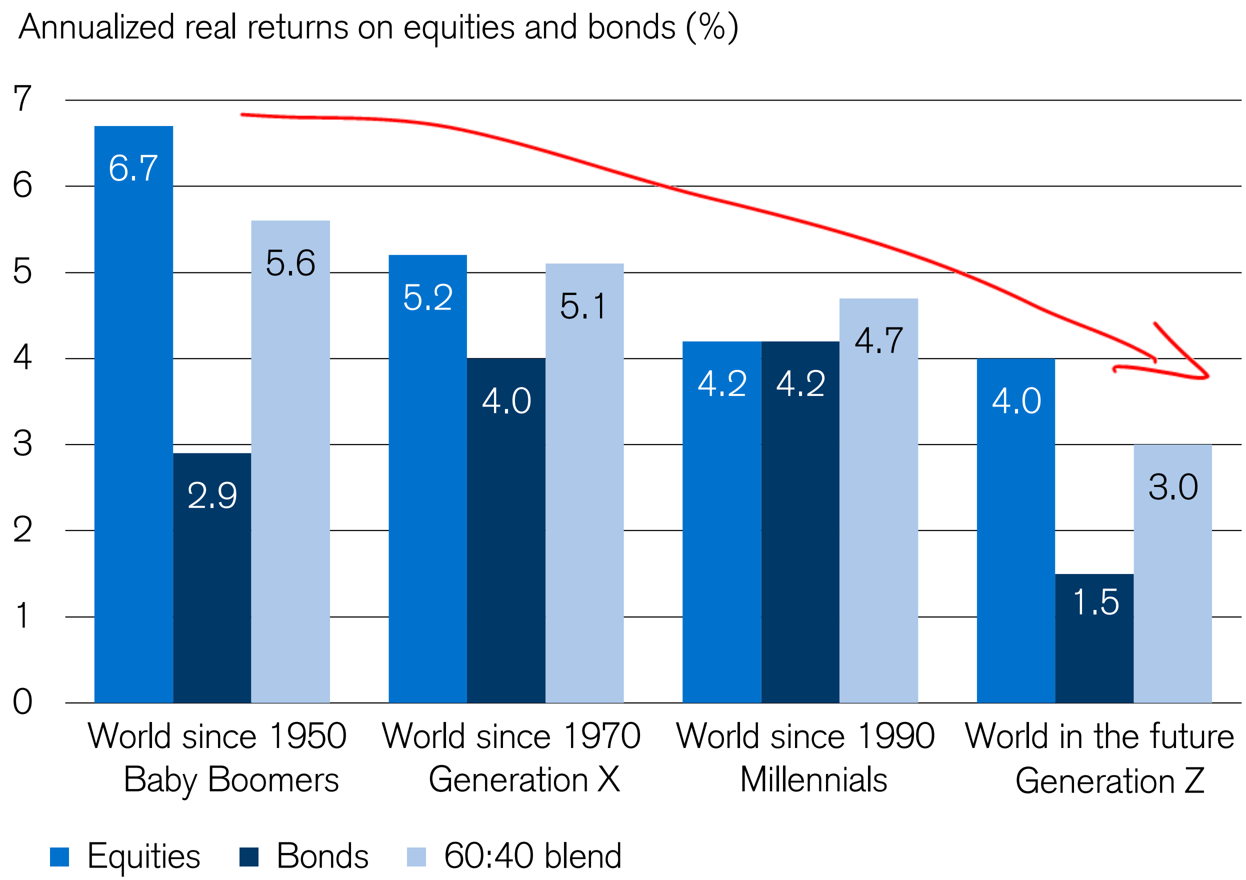
(1) Policy return
$0.3 \cdot 0.045 + 0.7 \cdot 0.015 = 2.4\%$

$\Rightarrow$ Timing contributes $2.7\% - 2.4\% = 0.3\%$
$\Rightarrow$ Selection contributes $2.2\% - 2.4\% = -0.2\%$

Added value by good timing, but destroyed by bad selection

Exercise question (cont.)

Real return experiences across generations



Generation Z (born 1997-2012) invests under new conditions. The “golden age” of bonds is over.

Source: Elroy Dimson, Paul Marsh and Mike Staunton, Credit Suisse Global Investment Returns Yearbook 2023

Part 6: Asset Allocation

a. Introduction

b. Case: Investment policy of the Yale endowment

c. Strategic asset allocation in practice

d. Tactical asset allocation and overlay management

e. Study: Conditional asset allocation over the first decade

f. Alternative approaches for asset allocation

US university endowments – performance overview

University	Inception	Geometric Return (%)	Arithmetic Return (%)	Standard Deviation (%)	Sharpe Ratio
A. Inception–2017					
Ivy League					
Brown	1901	5.0	5.9	14.7	0.38
Columbia	1900	5.2	6.0	12.9	0.45
Cornell	1904	5.0	5.9	14.7	0.39
Dartmouth	1909	6.0	7.1	16.5	0.43
Harvard	1900	5.5	6.4	14.0	0.44
Princeton	1900	6.1	6.9	13.3	0.50
U Penn	1900	5.0	5.9	14.9	0.38
Yale	1900	6.1	7.1	15.4	0.45
Non–Ivy League					
Chicago	1904	6.2	7.1	15.0	0.46
Johns Hopkins	1925	5.6	6.2	11.4	0.53
MIT	1900	5.6	6.4	13.9	0.44
Stanford	1914	5.6	6.3	12.1	0.54
Averages					
Ivy		5.5	6.4	14.6	0.43
Non-Ivy		5.7	6.5	13.1	0.50
All universities		5.6	6.4	14.1	0.45
US financial market returns					
Equities	1900	6.5	9.1	25.4	0.34
Government bonds	1900	2.0	2.5	10.3	0.17
Corporate bonds	1900	2.7	3.2	10.3	0.25

=Risk

Source: Chambers, Dimson and Kaffe (2020)

The Yale endowment – investment policy

- Yale's portfolio is structured using a **combination of academic theory and informed market judgment**.
- The theoretical framework relies on **mean-variance analysis**, an approach developed by Nobel laureates James Tobin and Harry Markowitz, both of whom conducted work on this important portfolio management tool at Yale's Cowles Foundation.
- Using **statistical techniques** to combine expected returns, variances, and covariances of investment assets, Yale employs mean-variance analysis to estimate expected risk and return profiles of various asset allocation alternatives and to test sensitivity of results to changes in input assumptions.

  methods & experience
- Because investment management involves **as much art as science**, qualitative considerations play an extremely important role in portfolio decisions.
- The **definition of an asset class is subjective**, requiring precise distinctions where none exist.

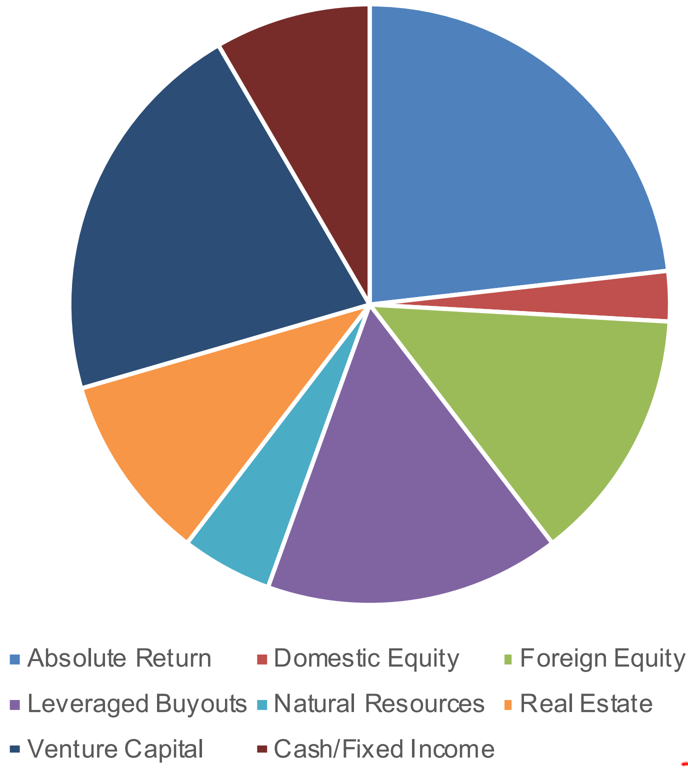
Source: The Yale Endowment 2017

The Yale endowment – investment policy (cont.)

- Returns and correlations are difficult to forecast. **Historical data provide a guide, but must be modified** to recognize structural changes and compensate for anomalous periods.
- Quantitative measures have difficulty incorporating factors such as market liquidity or the influence of significant, low-probability events. In spite of the operational challenges, the rigor required in conducting mean-variance analysis brings an important perspective to the **asset allocation process**.

Source: The Yale Endowment 2017

The Yale endowment – asset allocation 2019



asset classes

- Yale's eight **asset classes are defined by differences in their expected response to economic conditions**, such as economic growth, price inflation, or changes in interest rates, and are weighted in the Endowment portfolio by considering their risk-adjusted returns and correlations.
- The university combines the asset classes in such a way as **to provide the highest expected return for a given level of risk**, subject to fundamental diversification and liquidity constraints.

↳ diversification over market periods

Source: The Yale Endowment 2019

The Yale endowment – economic rationale for the asset classes

Absolute Return	Absolute return investments are expected to generate high long-term real returns by exploiting market inefficiencies. The portfolio is invested in two broad categories: event-driven strategies and value-driven strategies. → market ineff.
Domestic Equity	Equity owners reasonably expect to receive returns superior to those produced by less risky assets such as bonds and cash. Despite recognizing that the U.S. equity market is highly efficient, Yale elects to pursue active management strategies, aspiring to outperform the market index by a few percentage points, net of fees, annually. → expect equity premium
Fixed Income	Fixed income assets generate stable flows of income, providing more certain nominal cash flow than any other Endowment asset class. The bond portfolio exhibits a low covariance with other asset classes and serves as a hedge against financial accidents or periods of unanticipated deflation. → hedge against deflation
Foreign Equity	Foreign equity investments give the Endowment exposure to the global economy, providing diversification and the opportunity to earn outsized returns through active management. Yale's investment approach to foreign equities emphasizes active management designed to uncover attractive opportunities and exploit market inefficiencies. → ex

Source: The Yale Endowment 2017

The Yale endowment – economic rationale for the asset classes (cont.)

Leveraged Buyout	Leveraged buyouts offer extremely attractive long-term risk-adjusted returns, stemming from the University's strong stable of managers that exploit market inefficiencies. Yale's leveraged buyout strategy emphasizes partnerships with firms that pursue a value-added approach to investing.
Natural Resources	Equity investments in natural resources—oil and gas, timberland, and agriculture—share common risk and return characteristics: protection against unanticipated inflation, high and visible current cash flow, and opportunities to exploit inefficiencies. At the portfolio level, natural resource investments provide attractive return prospects and significant diversification.
Real Estate	Investments in real estate provide meaningful diversification to the Endowment. A steady flow of income with equity upside creates a natural hedge against unanticipated inflation without sacrificing expected return. While real estate markets sometimes produce dramatically cyclical returns, pricing inefficiencies in the asset class and opportunities to add value allow superior managers to generate excess returns over long time horizons.
Venture Capital	Venture capital investments provide compelling option-like returns as the university's premier venture managers gain exposure to innovative start-up companies from an early stage. Yale's venture capital program, one of the first of its kind, is regarded as among the best in the institutional investment community and the university is frequently cited as a role model by other investors.

Source: The Yale Endowment 2017

The Yale endowment – asset allocation over time

Asset class	2020	2019	2018	2017	2016	2015	2014	2013
Absolute Return	21,6%	23,2%	26,1%	25,1%	22,1%	20,5%	17,4%	17,8%
Domestic Equity	2,3%	2,7%	3,5%	3,9%	4,0%	3,9%	3,9%	5,9%
Foreign Equity	11,4%	13,7%	15,3%	15,2%	14,9%	14,7%	11,5%	9,8%
Leveraged Buyouts	15,8%	15,9%	14,1%	14,2%	14,7%	16,2%	19,3%	21,9%
Natural Resources	3,9%	4,9%	7,0%	7,8%	7,9%	6,7%	8,2%	7,9%
Real Estate	8,6%	10,1%	10,3%	10,9%	13,0%	14,0%	17,6%	20,2%
Venture Capital	22,6%	21,1%	19,0%	17,1%	16,2%	16,3%	13,7%	10,0%
Cash/Fixed Income	13,7%	8,4%	4,7%	5,8%	7,2%	7,7%	8,4%	6,5%
Return	6,8%	5,7%	12,3%	11,3%	3,4%	11,5%	20,2%	12,5%

Source: The Yale Endowment 2017-2020

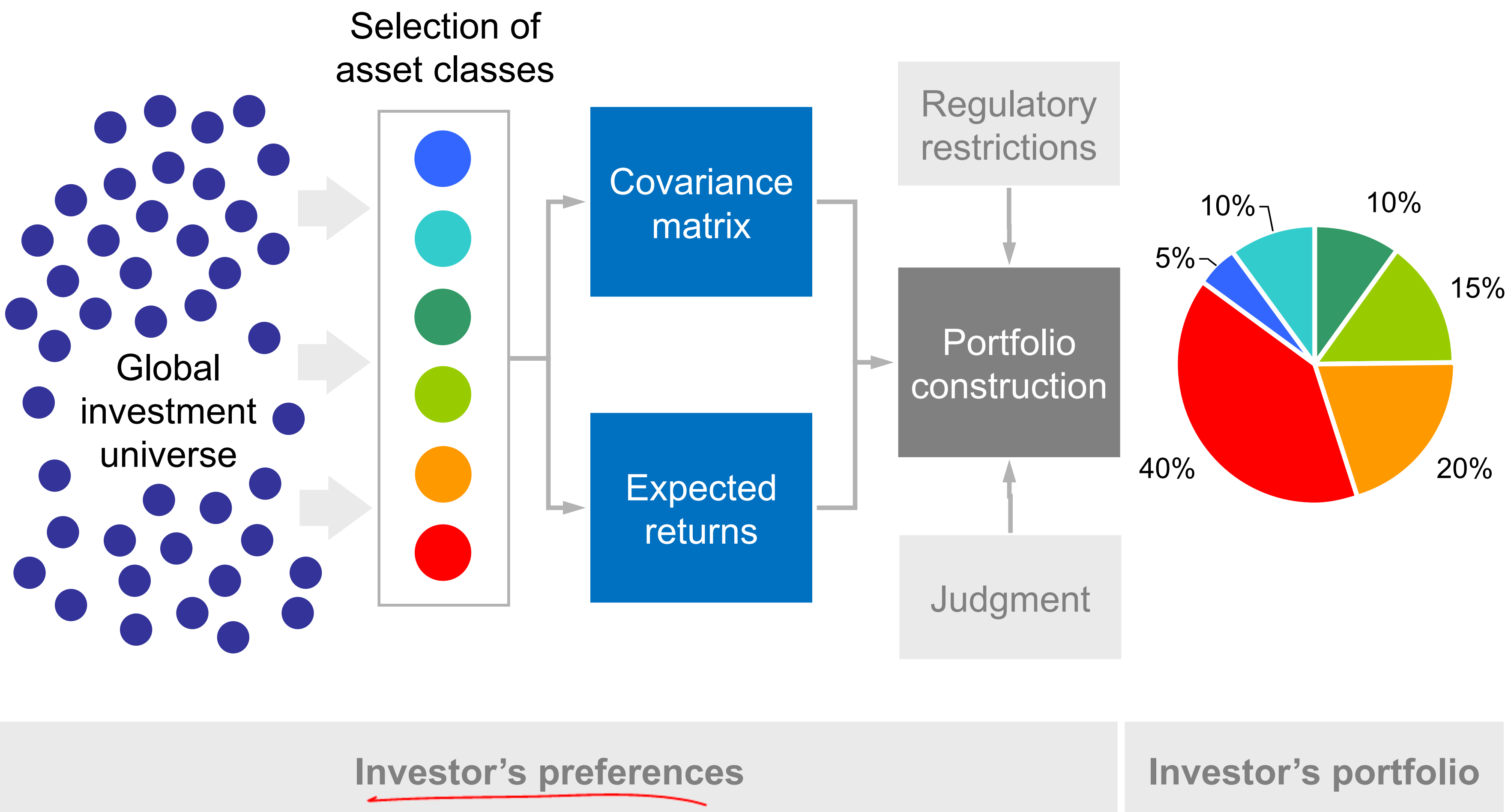
The Yale endowment – What's behind it?

Conscious selection of asset classes according to their "economic function" and contribution to the portfolio

Three "economic functions"	Example asset classes
Harvesting Allocation to asset classes to participate in systematic risk premiums	• US equity • European equity • Fixed income
Hedging Allocation to asset classes for diversification of the portfolio, especially in times of crisis	• Long-duration fixed income • Gold • Commodity strategies
Opportunities Allocation to asset classes or strategies that offer access to exceptional sources of return	• Private equity • Infrastructure • Natural resources

Part 6: Asset Allocation

The asset allocation process



Example: Simple SAA with tactical bands → Min / Max ✗

	Currency	SAA	Minimum weights	Maximum weights
Bonds		**70,0%**	**50,0%**	**90,0%**
EUR	EUR	40,0%	20,0%	60,0%
USD	USD	30,0%	10,0%	50,0%
Stocks		**30,0%**	**10,0%**	**50,0%**
Europe	EUR	10,0%	0,0%	30,0%
USA	USD	10,0%	0,0%	30,0%
Japan	JPY	5,0%	0,0%	10,0%
EM	USD	5,0%	0,0%	5,0%

SAA basics

Steps

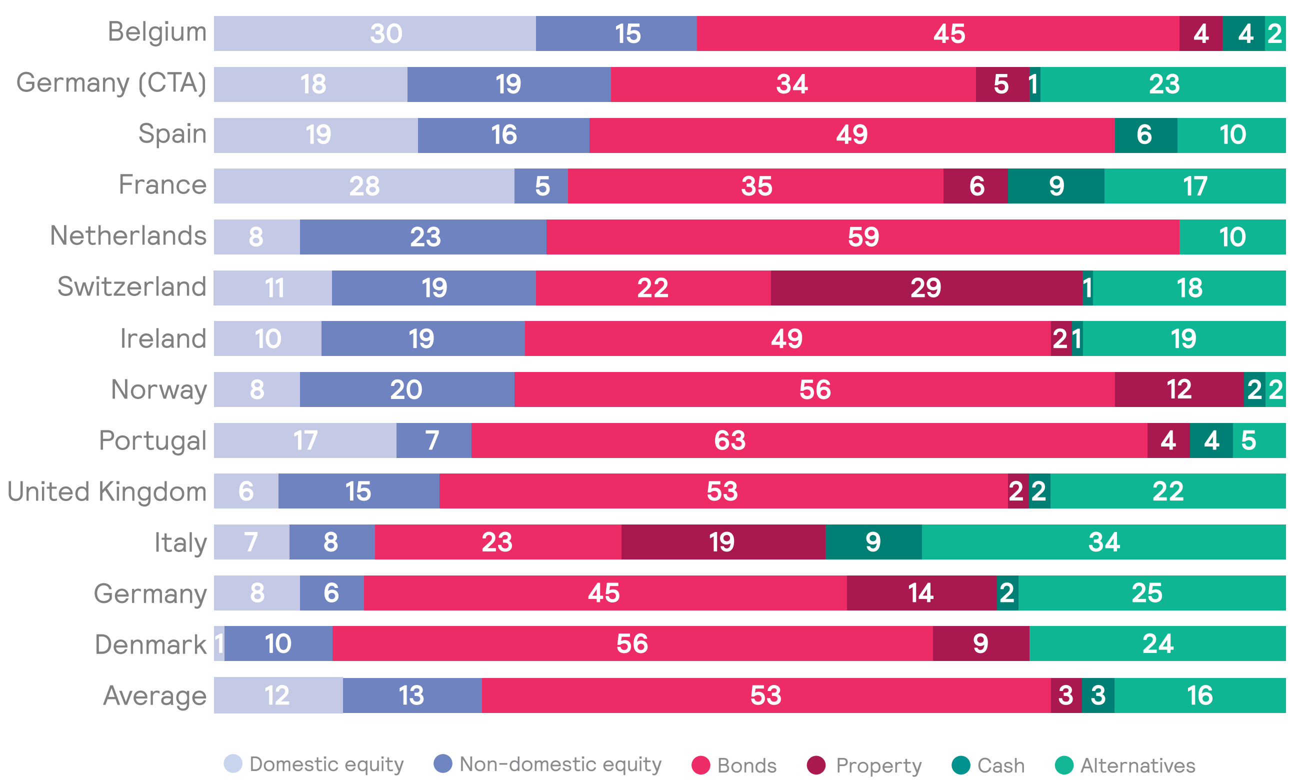
1. Define investment goals (return, risk, time horizon)
2. Select international asset classes
3. Identify the "optimal" portfolio
4. Select investment products and managers
5. Invest the capital
6. Revise the SAA periodically → 3 years

Methods and concepts applied

- Analyze **time series of asset returns** to understand risk-return characteristics
- Determine **covariances** between selected asset classes
- Use an **asset pricing model** to generate cross sectional consistent return expectations as input for portfolio optimization
- Use a **portfolio optimizer** to determine the asset allocation

Asset allocation of European institutional investors

Chart 5. Strategic Asset Allocation by Country (%)



Source: Mercer European Asset Allocation Survey 2019

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Tactical asset allocation

- Overlay management of a portfolio‘s capital market risks
- Variation of the exposure to
  - Investment segments (stocks, bonds, money market)
  - Regions, countries, and sectors within the stock allocation
  - Regions, countries, and maturities within the bond allocation
  - Currencies

  by use of derivative instruments (futures, options, forwards)
- Goals
  - **Increasing the expected portfolio return**
  - **Stabilizing the performance**

  under certain restrictions

Categories of portfolio overlays

Risk-oriented

Path-dependent adjustments of the portfolio structure in accordance with certain criteria

- Rebalancing → stabilize e.g. by hedging
- CPPI, Portfolio insurance

Conditioning the portfolio structure on the risk budget

Market-oriented

Active portfolio management on the level of asset classes in accordance with market fundamentals

- Timing (buy/sell)
- Switching (between asset classes)
- Global Tactical Asset Allocation (GTAA)

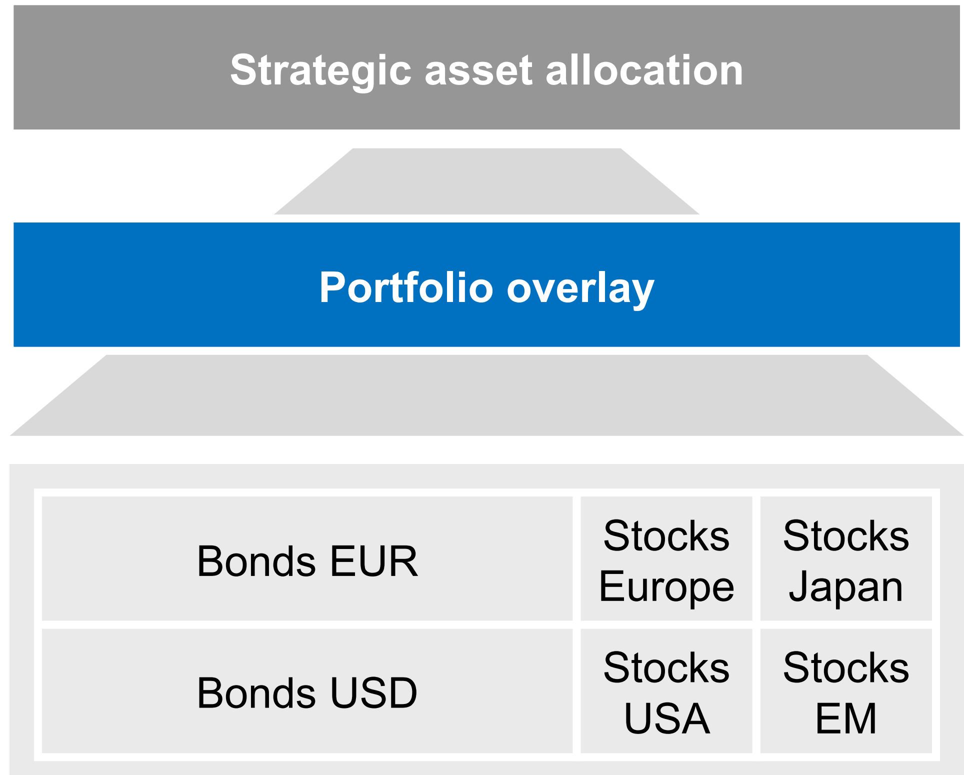
Conditioning the portfolio structure on the market fundamentals

Overlay management in the investment process

Long-term investment goals and risk budget …

Short-term chances and risks in the capital markets …

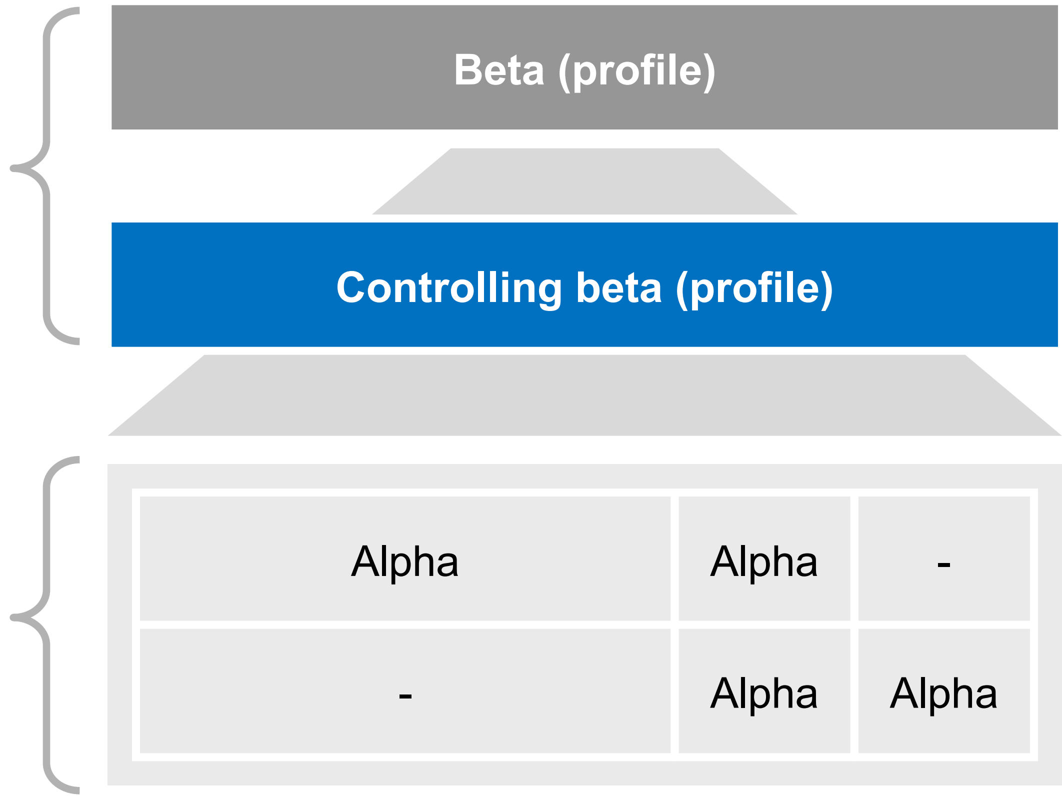
Benchmarks and manager selection …



What return sources are addressed?

Exposure to systematic capital market risks

Exploration and exploitation of market inefficiencies and valuation anomalies



Fields of tactical overlay management

Stock-bond quota
Currency allocation

Stocks	Fixed income
Regions and countries	Regions and countries
Investment styles	Duration
Sectors	Credit risks

Global Tactical Asset Allocation (GTAA)

Case

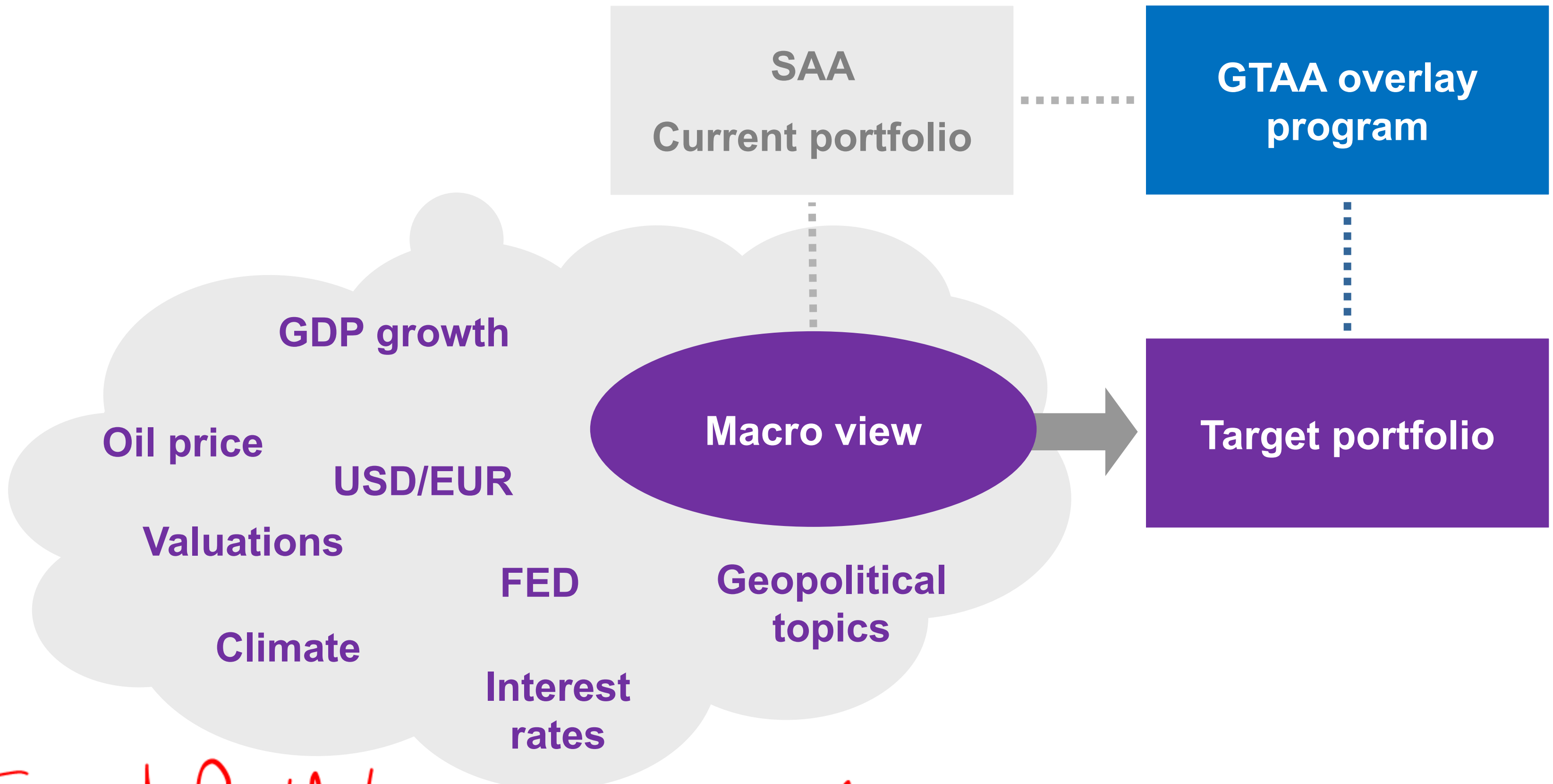
Asset allocation

	Currency	SAA	Minimum weights	Maximum weights
Bonds		**70,0%**	**50,0%**	**90,0%**
EUR	EUR	40,0%	20,0%	60,0%
USD	USD	30,0%	10,0%	50,0%
Stocks		**30,0%**	**10,0%**	**50,0%**
Europe	EUR	10,0%	0,0%	30,0%
USA	USD	10,0%	0,0%	30,0%
Japan	JPY	5,0%	0,0%	10,0%
EM	USD	5,0%	0,0%	5,0%

A multifactor model is used to control the portfolio's risk

- Global interest rates
- Commodity prices
- Value of foreign currencies
- World stock market

Basic structure of an overlay decision



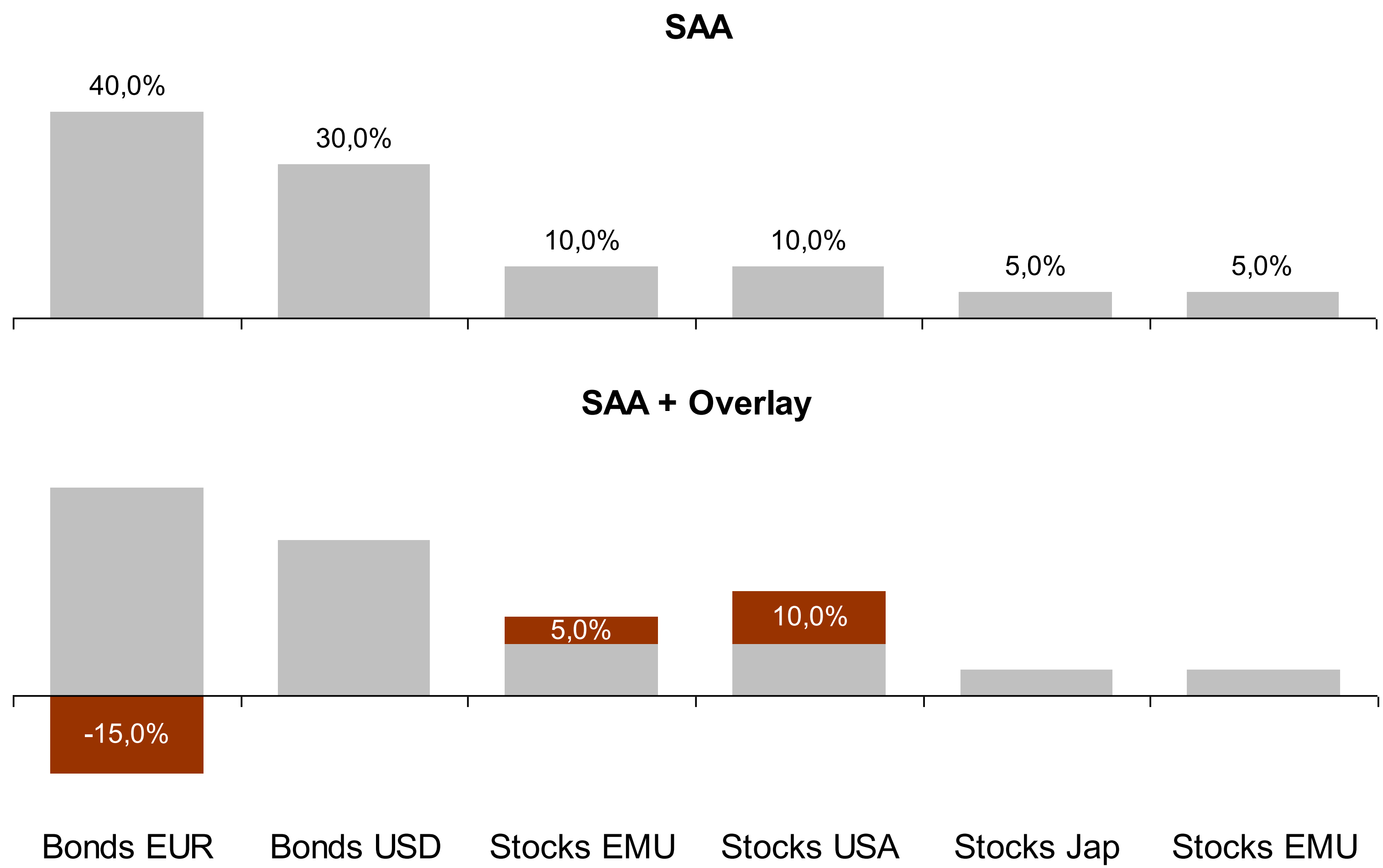
Target Portfolio = Current Portfolio + GTAA

GTAA overlay program

Macro view „Expecting rising interest rates in the Eurozone, while stocks in Europe and USA are valued attractively …“

	Currency	SAA	Minimum weights	Maximum weights	Overlay	Target portfolio
Bonds		**70,0%**	**50,0%**	**90,0%**	**-15,0%**	**65,0%**
EUR	EUR	40,0%	20,0%	60,0%	-15,0%	25,0%
USD	USD	30,0%	10,0%	50,0%	0,0%	30,0%
Stocks		**30,0%**	**10,0%**	**50,0%**	**15,0%**	**45,0%**
Europe	EUR	10,0%	0,0%	30,0%	5,0%	15,0%
USA	USD	10,0%	0,0%	30,0%	10,0%	20,0%
Japan	JPY	5,0%	0,0%	10,0%	0,0%	5,0%
EM	USD	5,0%	0,0%	5,0%	0,0%	5,0%

GTAA overlay program (2)



Strategic portfolio exposure to macro factors

	SAA	Global interest	Commodity prices	Currencies	World stock market
Bonds EUR	40%	-6,319	0,022	0,014	-0,003
Bonds USD	30%	-9,049	-0,003	1,158	-0,023
Stcoks EMU	10%	1,112	-0,046	-0,658	1,160
Stocks USA	10%	0,638	-0,019	0,209	1,016
Stocks Japan	5%	-2,328	0,100	0,832	0,553
Stocks EM	5%	-3,477	0,090	-0,520	1,535
Portfolio	**100%**	**-5,358**	**0,011**	**0,324**	**0,314**

Overlayed portfolio exposure to macro factors

	SAA + Overlay	Global interest	Commodity prices	Currencies	World stock market
Bonds EUR	25%	-6,319	0,022	0,014	-0,003
Bonds USD	30%	-9,049	-0,003	1,158	-0,023
Stcoks EMU	15%	1,112	-0,046	-0,658	1,160
Stocks USA	20%	0,638	-0,019	0,209	1,016
Stocks Japan	5%	-2,328	0,100	0,832	0,553
Stocks EM	5%	-3,477	0,090	-0,520	1,535
Portfolio	**100%**	**-4,290**	**0,003**	**0,310**	**0,474**

Part 6: Asset Allocation

a. Introduction

b. Case: Investment policy of the Yale endowment

c. Strategic asset allocation in practice

d. Tactical asset allocation and overlay management

e. Study: Conditional asset allocation over the first decade

f. Alternative approaches for asset allocation

Motivation of the study *

Starting point

- The 1st decade was a huge challenge for asset allocation
- Investors had to cope with severe market events
  - Dotcom bubble
  - 9/11
  - US subprime crisis
  - Lehman crisis
  - Global financial crisis

Setup of the study

asset pricing in accordance with market conditions

- Use a conditional asset pricing model for dynamic asset allocation (DAA)
- Apply a “30/70” benchmark which is typical for a European institutional investor
- Data: 01.01.2000-31.12.2009

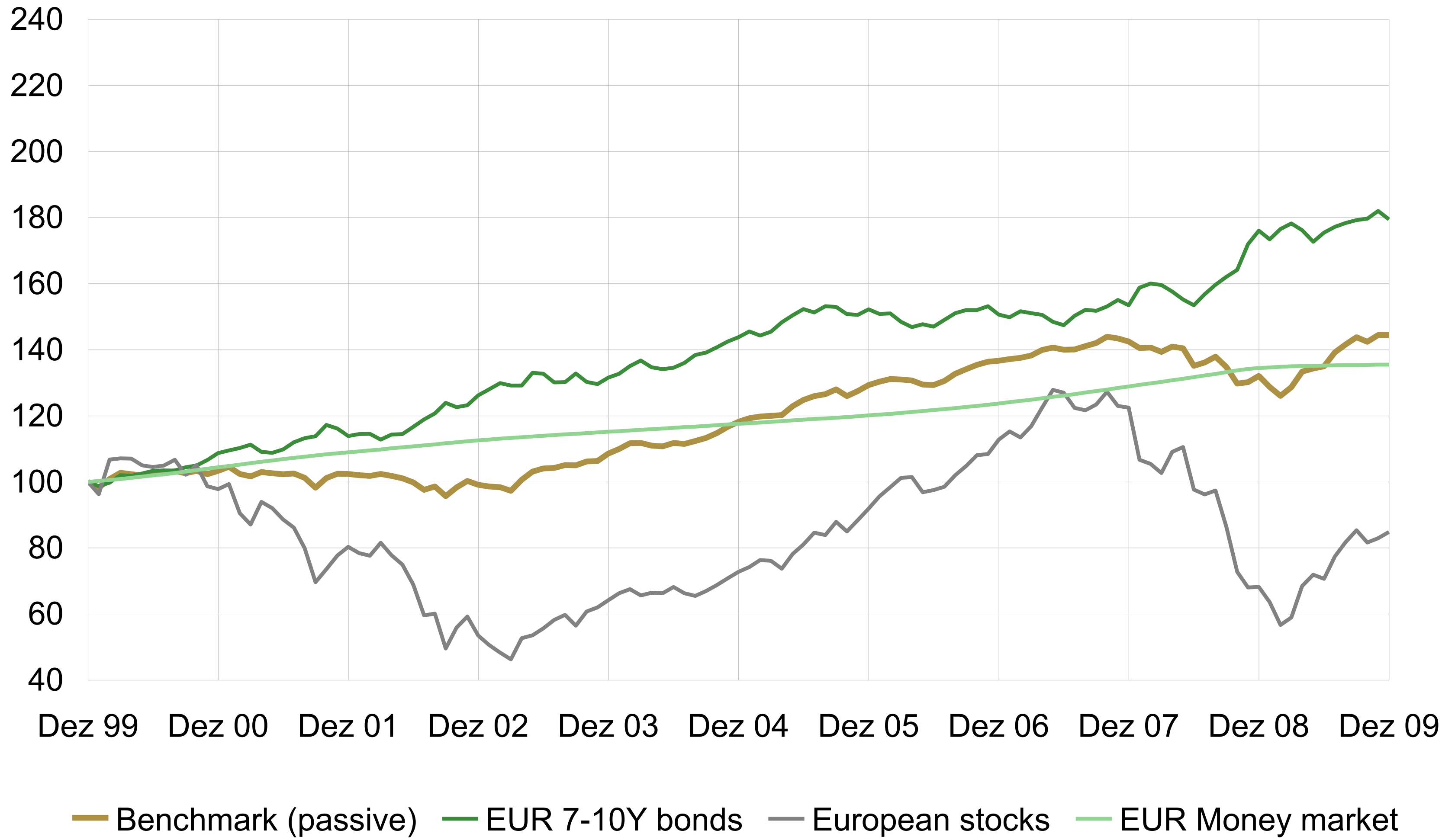
* Source: Oertmann and Seiler (2010)

Return and risk of asset classes 2000-2009

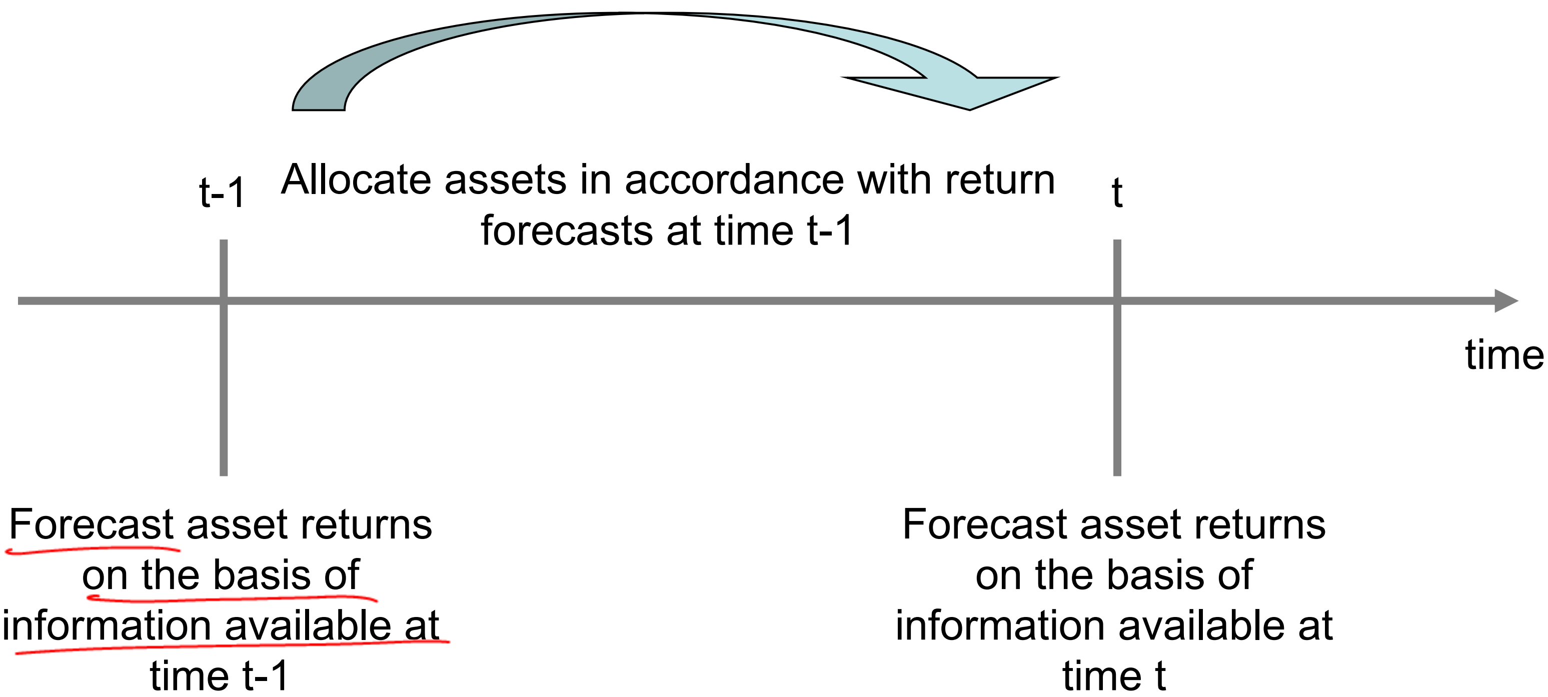
	Average Return p.a.	Volatility	Benchmark Weight
Stock Markets			
USA	-3,1%	16,5%	7%
Europe	-1,6%	20,0%	20%
Japan	-5,8%	18,2%	1%
Australia	6,7%	13,3%	1%
Emerging Markets	10,2%	21,0%	1%
European Government Bonds			
Time to Maturity 1-3 Y	4,1%	1,4%	5%
Time to Maturity 3-5 Y	5,0%	2,7%	20%
Time to maturity 7-10 Y	6,0%	4,5%	40%
Euro Money Market	3,1%	0,3%	5%
Benchmark	3,7%	4,8%	100%

Period: 01.01.2000 bis 31.12.2009. Euro based returns and volatilities, currency hedged.

Performance of asset classes 2000-2009



Approach: Using time t-1 information



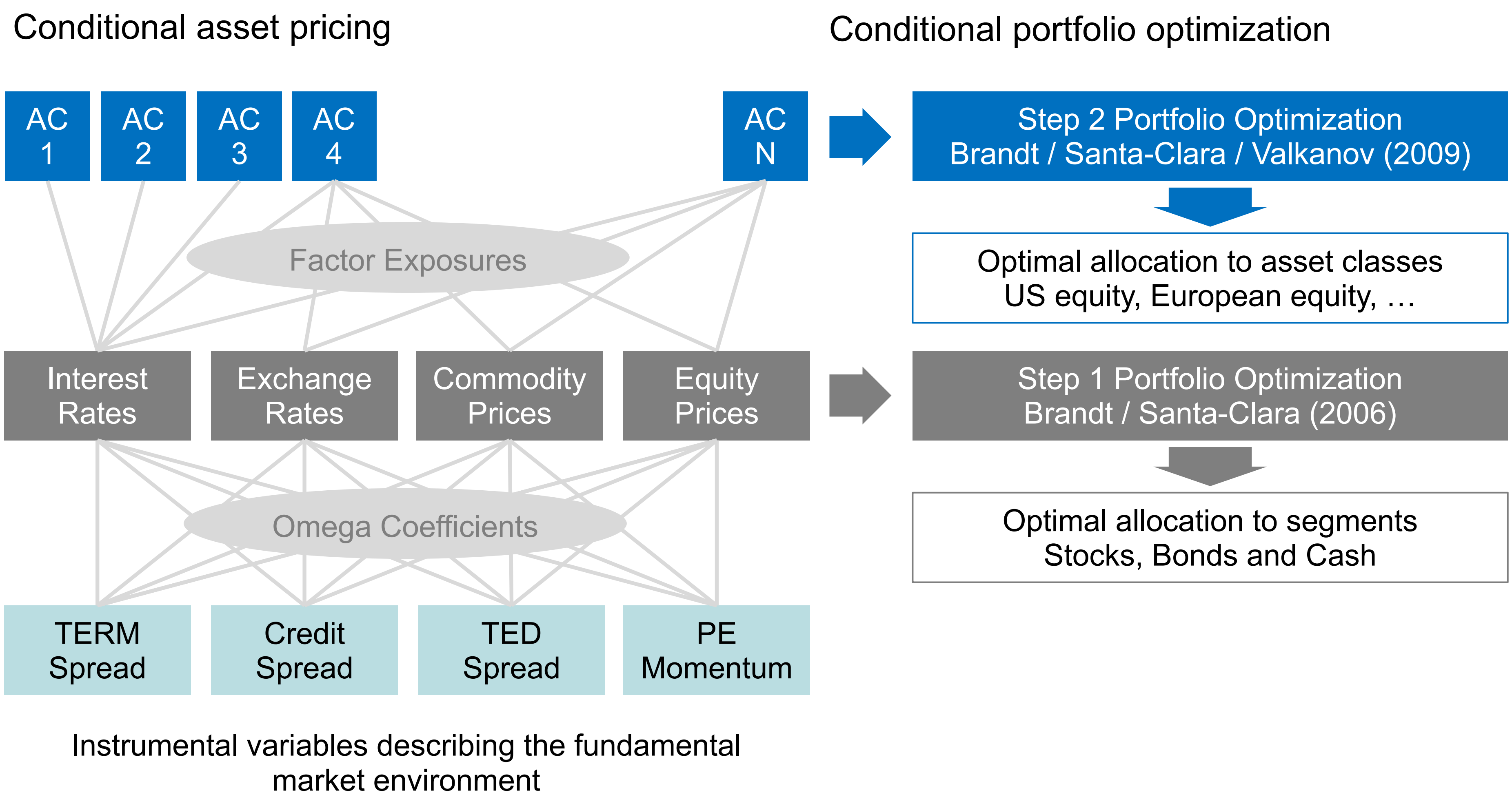
Review past forecast with actual information

Approach: Conditional multifactor model

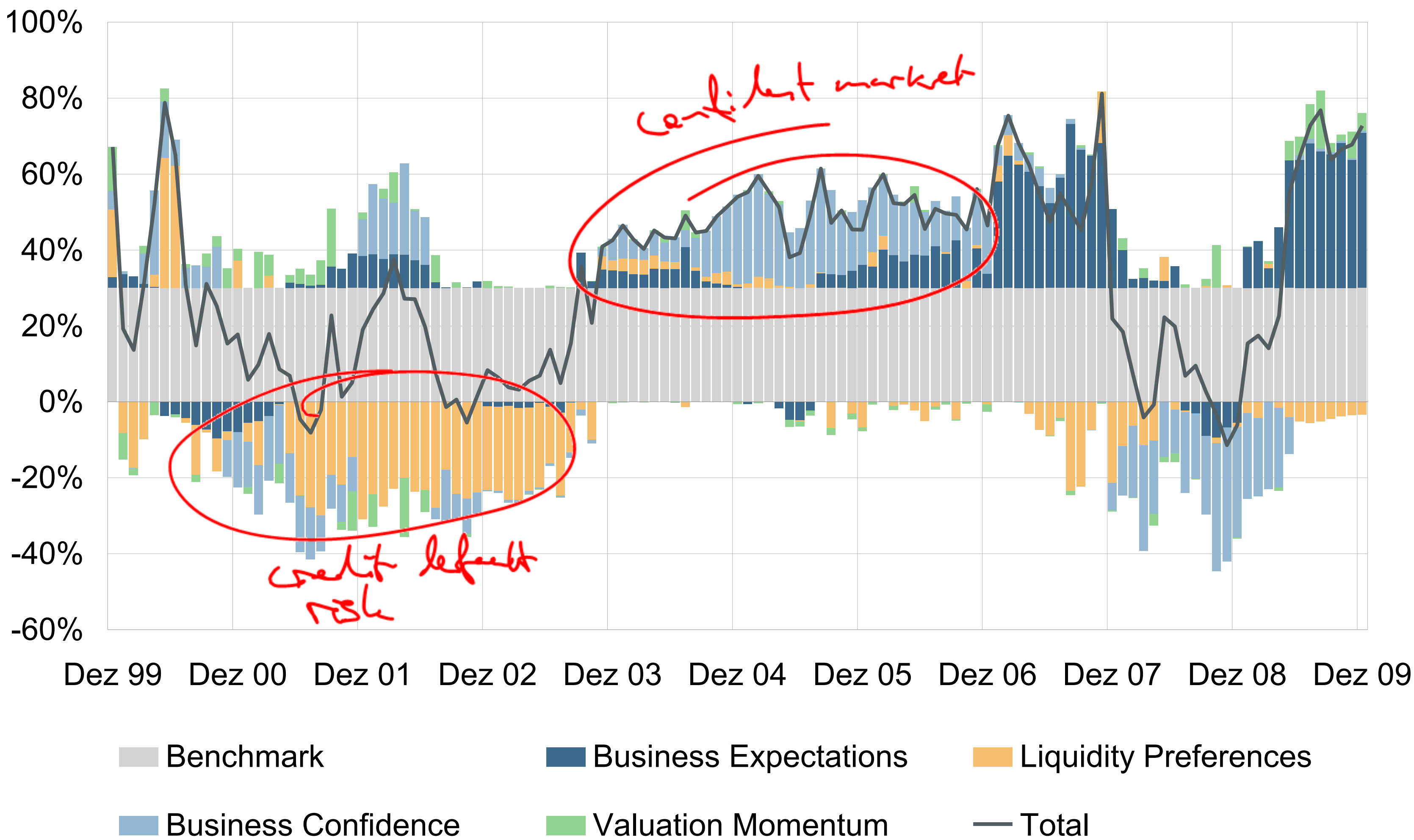
Using the global conditional beta pricing model introduced in Part 5 of the lecture to generate expected returns for the stock and bond markets

$$\begin{pmatrix} r_{1t} \\ \vdots \\ r_{nt} \end{pmatrix} = \underbrace{\underbrace{\begin{pmatrix} \beta_{11} \cdots \beta_{13} \\ \vdots \\ \beta_{n1} \cdots \beta_{n3} \end{pmatrix}}_{\text{factor exposures}} \cdot \underbrace{\begin{pmatrix} \omega_{10} \cdots \omega_{15} \\ \vdots \\ \omega_{30} \cdots \omega_{35} \end{pmatrix} \cdot \begin{pmatrix} Z_{0,t-1} \\ \vdots \\ Z_{5,t-1} \end{pmatrix}}_{\text{time-varying risk premia}}}_{\text{conditionally expected returns}} + \underbrace{\underbrace{\begin{pmatrix} \beta_{11} \cdots \beta_{13} \\ \vdots \\ \beta_{n1} \cdots \beta_{n3} \end{pmatrix}}_{\text{factor exposures}} \cdot \underbrace{\begin{pmatrix} \delta_{1t} \\ \vdots \\ \delta_{3t} \end{pmatrix}}_{\text{factor returns}} + \underbrace{\begin{pmatrix} \varepsilon_{1t} \\ \vdots \\ \varepsilon_{nt} \end{pmatrix}}_{\text{residual returns}}}_{\text{unexpected returns}}$$

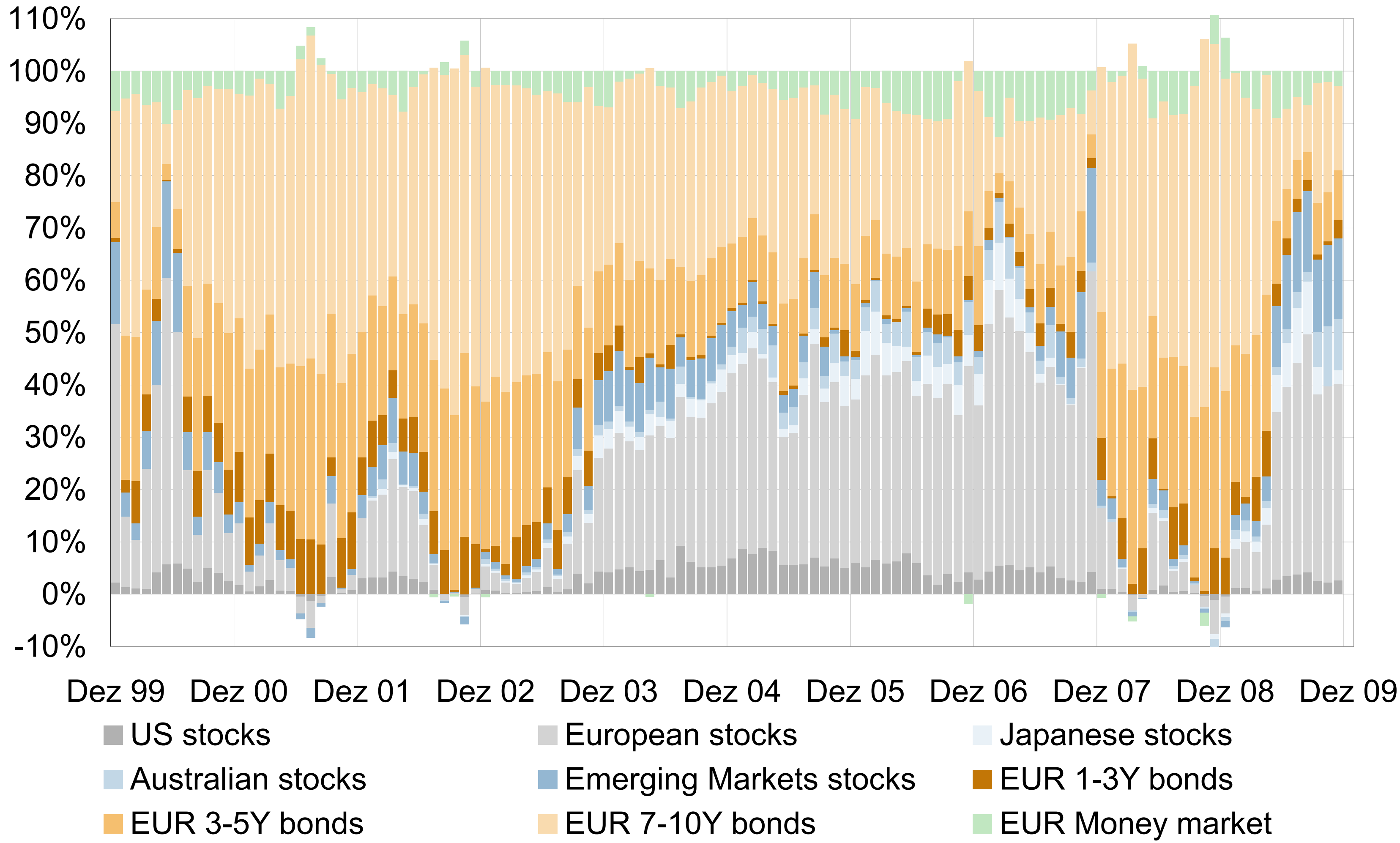
Approach: Integrated portfolio optimization



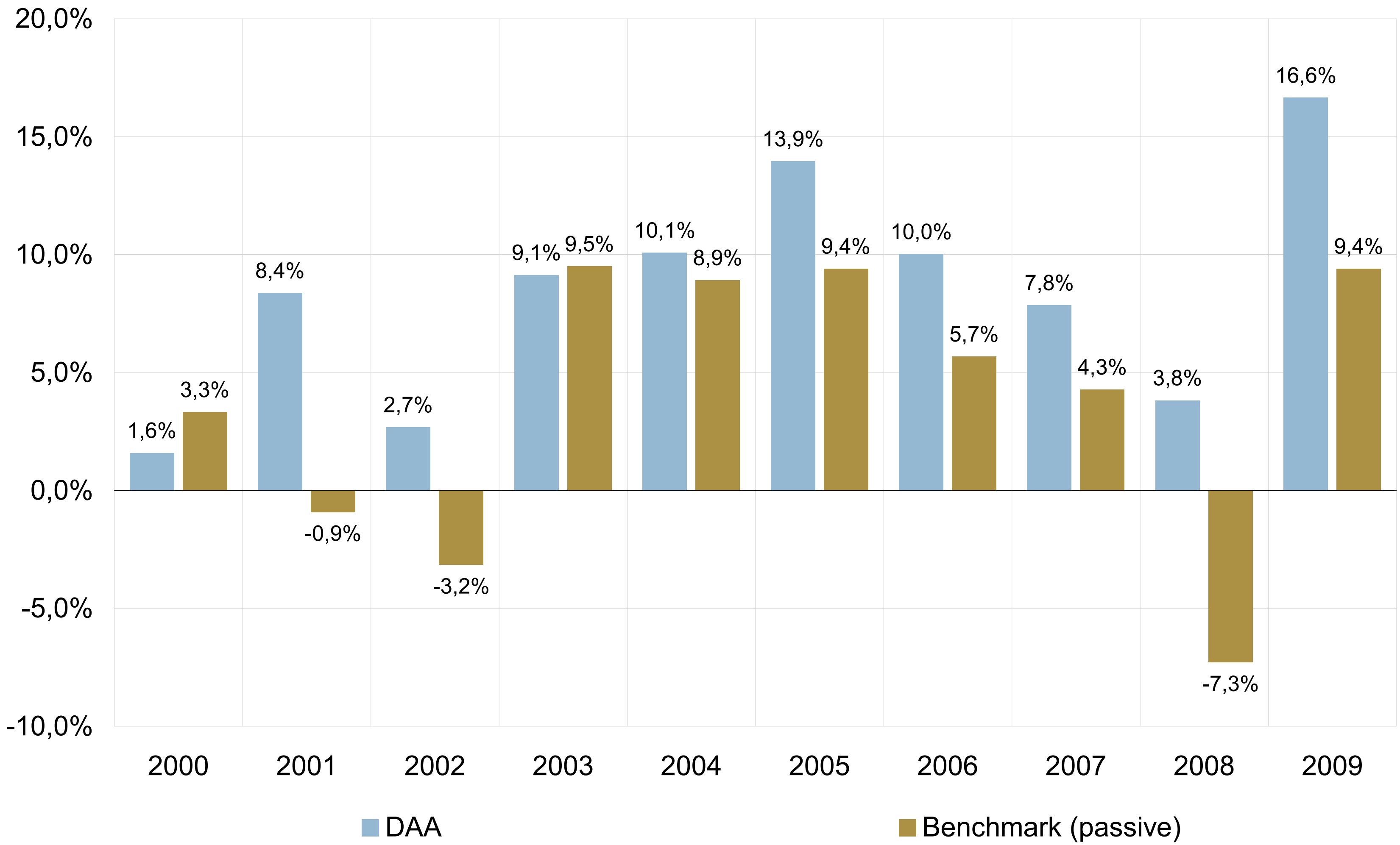
Conditional equity quota and fundamental attribution



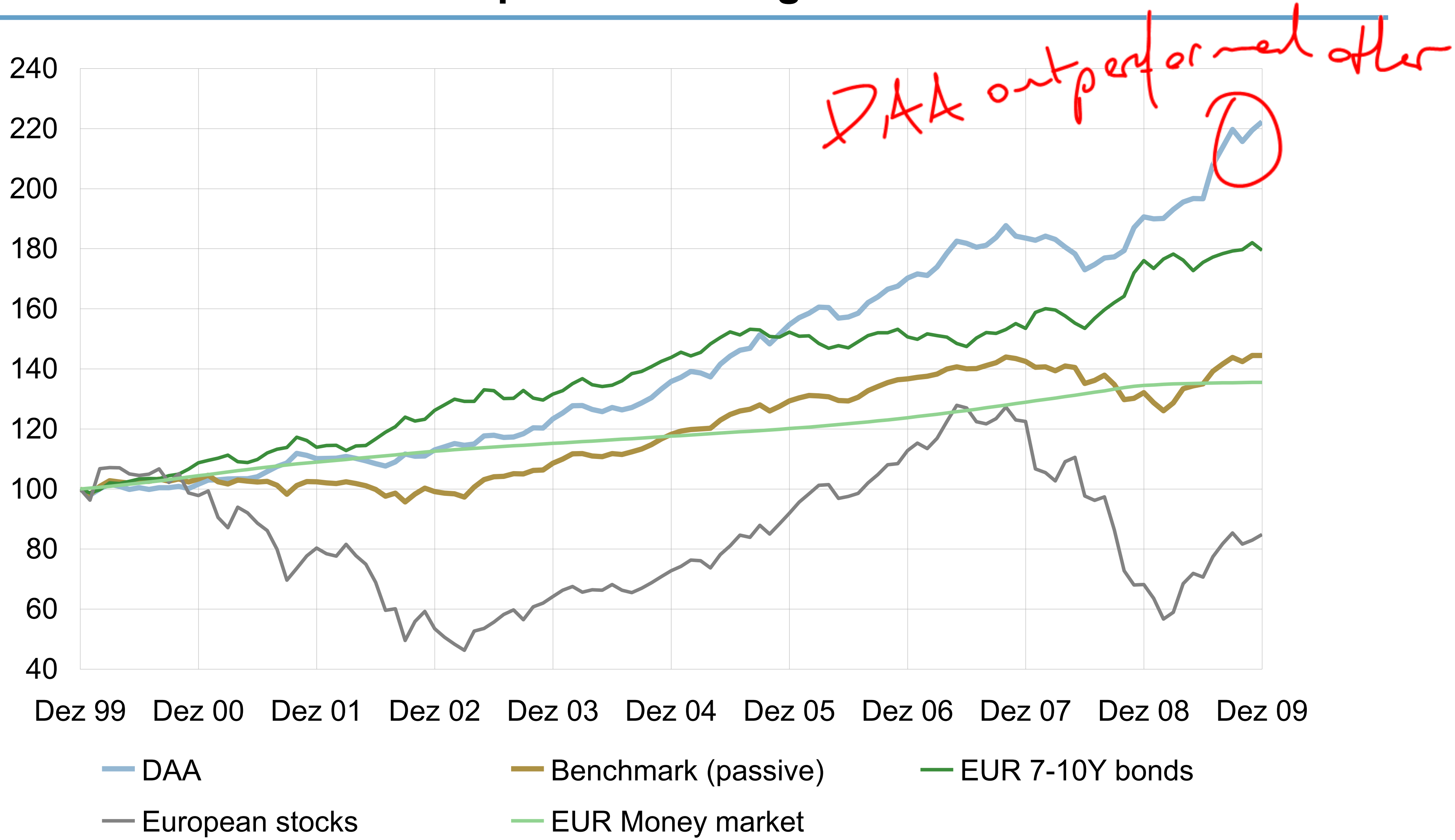
Dynamic asset allocation (DAA)



Yearly returns of the DAA vs. benchmark



Performance of the DAA vs. passive strategies



Overview of alternative strategies 2000-2009

	DAA	Benchmark (passive)	EUR 7-10Y bonds	European stocks	EUR Money market
Return					
Total 2000-2009	122,3%	44,5%	79,5%	-15,2%	35,5%
Average p.a.	8,3%	3,7%	6,0%	-1,6%	3,1%
Volatility	4,7%	4,8%	4,5%	20,0%	0,3%
Sharpe Ratio	1,07	0,13	0,63	negative	0,00
Performance Measures					
Beta	0,54				
Jensens Alpha p.a.	4,7%				
Information Ratio	0,33				

Period: 01.01.2000 bis 31.12.2009. Euro based returns and volatilities, currency hedged.

Part 6: Asset Allocation

Sources of return – perspective of capital market theory

Beta (β)

Taking systematic risk in capital markets by holding diversified portfolios of securities

Alpha (α)

Taking unsystematic risks

- Giving up diversification
- Betting on specific prices changes in market segments

Risk free interest rate

Giving up immediate consumption for investing capital

Sources of return – a different perspective

The choice of

- **Asset classes**
- **Management styles**
- **Strategies**

determines the return:

1. **Asset class risk premium**: Compensation investors expect to earn in excess of the risk-free rate on a passive investment in a traditional broad source of risk, such as equities or bonds
2. **Style risk premium**: Captures the expected return on assets with similar fundamental or technical characteristics – i.e. management styles – in excess of the broad asset class premiums
3. **Strategy risk premium**: Compensation generated by the execution of a (rule-based) investment strategy

Note: Classification in accordance with Bender, J. et al. (2010)

The investor's playing field

Asset class	Market segment	Management style Activity focus	Strategies
Equity	• Global regions • Developed / Emerging markets • Countries • Industry sectors • Private equity	• Value / Growth stocks • Small / Large stocks • Sustainable	• Momentum / Contrarian • Merger arbitrage • Short volatility strategies • …
Fixed income	• Currencies • Developed / Emerging markets • Countries, Regions • Government / Corporate bonds • Mortgage backed securities	• Term structure (duration) • Credit spreads	• Momentum • Convertible arbitrage • Carry trades • …
Commodities	• Grains • Livestock • Exotics • Industrial / Precious metals • Energy	• Holding physical commodities • Strategies in commodity futures • (Commodity stocks)	• Harvesting liquidity premiums • Fundamental spreads • …
Real assets	• Real estate • Farmland • Timberland • Infrastructure • …	• Holding physical real assets • Funds (open, closed-end)	

Study of Bender et al. – „Portfolio of Risk Premia“ → Diversification over risk premiums

Ways of Capturing Different Risk Premia: An Illustration

Risk Premium	Long Position	Short Position
Value	MSCI World Value	MSCI World Growth
Size	MSCI AC World Small Cap	MSCI AC World Large Cap
Momentum	Simulated World Momentum	MSCI World
Credit Spread	Citigroup USBIG Corp (AAA/AA)	Citigroup USBIG Treas./Gov.
High-Yield Spread	Citigroup High-Yield Market	Citigroup USBIG Corp (AAA/AA)
Term Spread	Citigroup USBIG Treas. 10+ Y	Citigroup USBIG Treas. 1–3 Y
Merger Arbitrage	Targets	Acquirer
Convertible Arbitrage	Convertible Bond	Underlying Stock
Carry Trade	3 Highest Interest Rate G10 Currencies	3 Lowest Interest Rate G10 Currencies
Currency Value	3 Most-Undervalued G10 Currencies	3 Most-Overvalued G10 Currencies
Currency Momentum	3 Best-Performing G10 Currencies	3 Worst-Performing G10 Currencies

Source: Bender, J. et al. (2010)

Study of Bender et al. – „Portfolio of Risk Premia“

Risk-and-Return Profiles of Selected Risk Premia, May 1995–September 2009

Risk Premia Type	Risk Premium	Annual Premium	Annual Volatility	Sharpe Ratio	Max Drawdown
Asset Class (Equity)	MSCI EAFE	2.4%	17.0%	0.14	–58.2%
	MSCI Japan	–3.4%	19.7%	–0.17	–69.0%
	MSCI USA	4.0%	16.1%	0.25	–58.8%
	MSCI EM	6.4%	25.4%	0.25	–63.1%
Asset Class (Bonds)	Citigroup USBIG	2.4%	3.8%	0.63	–7.5%
Style	Value	1.7%	8.4%	0.20	–30.0%
	Size	1.8%	7.8%	0.22	–38.4%
	Momentum	2.3%	8.4%	0.28	–24.4%
	Credit Spread	0.1%	3.0%	0.02	–14.8%
	High-Yield Spread	0.8%	10.1%	0.08	–36.3%
	Term Spread	3.1%	8.4%	0.36	–13.0%
Strategy	Merger Arb*	3.2%	4.3%	0.75	–9.7%
	Convertible Arb**	4.4%	7.4%	0.59	–35.4%
	Carry Trade	8.0%	8.5%	0.93	–28.4%
	Currency Value	5.3%	7.5%	0.71	–9.2%
	Currency Momentum	1.5%	9.9%	0.16	–22.0%

*Note: *CSFB/Tremont Merger Arb Index; **CSFB/Tremont Convertible Arb Index.*

Source: Bender, J. et al. (2010)

Study of Bender et al. – „Portfolio of Risk Premia“

Correlations of Styles and Strategies, May 1995–September 2009

	Value	Size	Momentum	Credit Spread	High-Yield Spread	Term Spread	Merger Arb	Conv. Arb	Carry Trade	Curr. Value	Curr. Mom
Value	1.00										
Size	**0.12**	1.00									
Momentum	**–0.54**	**–0.01**	1.00								
Credit Spread	**0.01**	**0.19**	**–0.08**	1.00							
High-Yield Spread	**0.03**	0.30	**–0.11**	0.38	1.00						
Term Spread	**0.01**	**–0.04**	**0.08**	**–0.04**	**–0.06**	1.00					
Merger Arb	**0.09**	0.34	**0.08**	0.37	0.42	**–0.04**	1.00				
Conv. Arb	**0.01**	0.28	**0.02**	0.61	0.52	**–0.08**	0.48	1.00			
Carry Trade	**0.02**	**0.10**	**–0.04**	0.33	0.37	**0.08**	0.30	0.49	1.00		
Currency Value	**0.07**	**0.01**	**–0.07**	**0.00**	0.28	**0.00**	**0.01**	**0.05**	0.52	1.00	
Currency Momentum	**–0.12**	**–0.18**	**0.16**	**0.06**	**–0.31**	**0.05**	**–0.09**	**–0.10**	**–0.04**	**–0.26**	1.00

Note: Bold denotes less than 0.20.

Source: Bender, J. et al. (2010)

Study of Bender et al. – „Portfolio of Risk Premia“

Correlations with Traditional Asset Classes

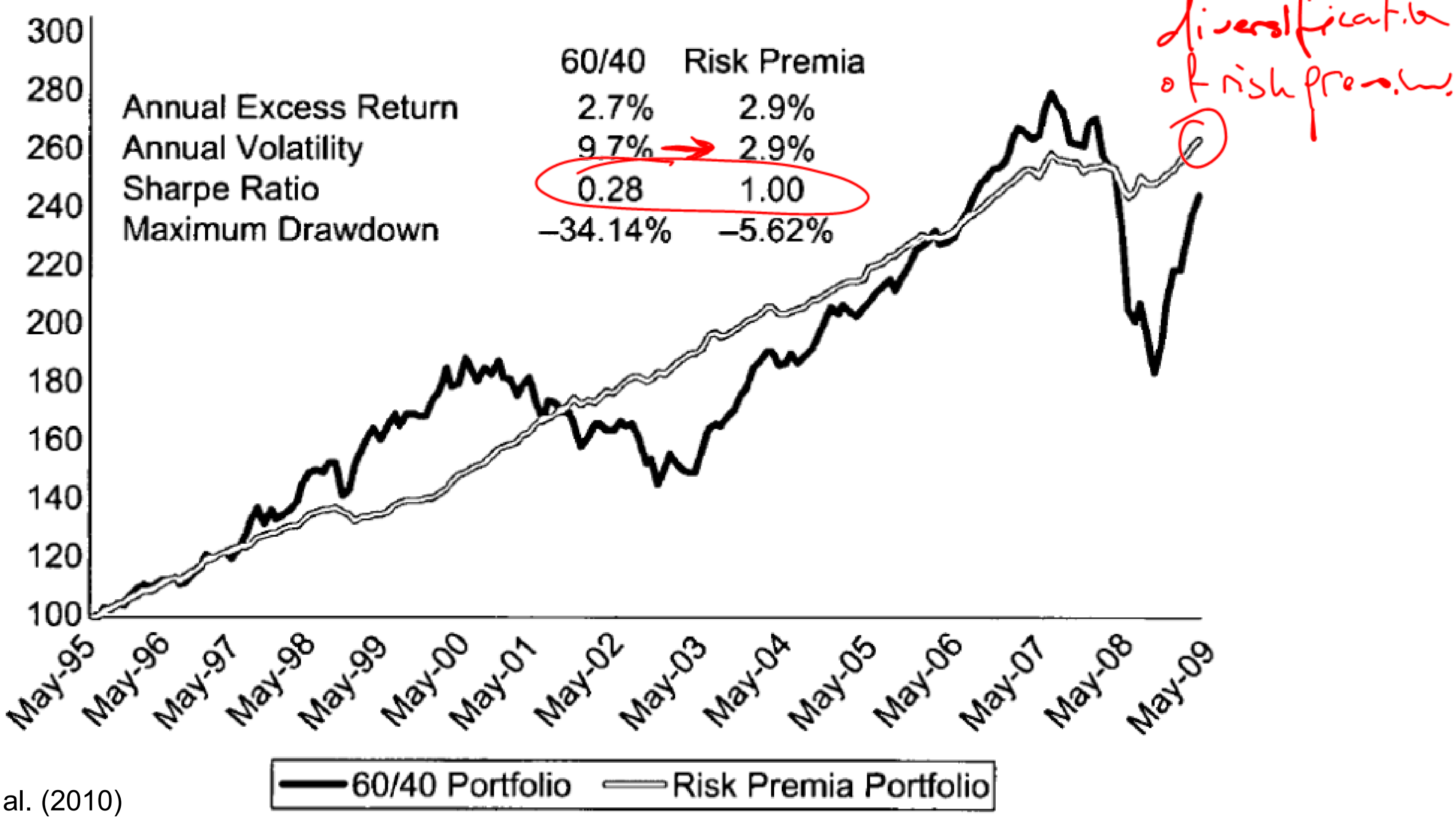
	MSCI EAFE	MSCI Japan	MSCI U.S.	MSCI EM	Citigroup USBIG
Value	**–0.03**	**–0.07**	**–0.08**	**–0.06**	**0.00**
Size	**0.11**	**0.16**	**–0.11**	0.24	**–0.01**
Momentum	**–0.01**	**–0.02**	**–0.02**	**0.02**	**0.01**
Credit Spread	0.51	0.37	0.43	0.46	**0.15**
High-Yield Spread	0.56	0.33	0.56	0.59	**–0.29**
Term Spread	**–0.06**	**–0.01**	**–0.06**	**–0.13**	0.88
Merger Arb	0.57	0.37	0.48	0.61	**0.02**
Conv. Arb	0.42	0.25	0.36	0.42	**0.10**
Carry Trade	0.37	**0.12**	0.39	0.44	**0.09**
Currency Value	**0.12**	**0.01**	0.27	0.26	**–0.03**
Currency Momentum	**–0.21**	**–0.20**	**–0.16**	**–0.18**	**0.00**

Note: Bold denotes less than 0.20.

Source: Bender, J. et al. (2010)

Study of Bender et al. – „Portfolio of Risk Premia“

Cumulative Return of Traditional Asset Allocation and Risk Premia–Based Asset Allocation



Source: Bender, J. et al. (2010)

1/N for asset allocation

Motivation

- Common approaches for asset allocation are often criticized, e.g.
  - Dept volume weighted bond benchmarks are under scrutiny
  - Cap-weighted stock benchmarks may not sufficiently capture future economic growth potentials
- For many alternative asset classes price histories are too short to calculate reliable parameters for quantitative portfolio optimization
- Valuation of some alternative asset classes is impossible due to illiquidity

Classical asset weighting schemes and portfolio optimization methods depending on risk and return parameters derived from historical time series (under the assumption of normally distributed returns) may not be able to capture the today’s needs of institutional investors.

Hierarchical 1/N portfolio construction – an example

Level 1 Investment segment

1/N	Stocks 1/4	Bonds 1/4	Real assets 1/4	Absolute return strategies 1/4

Level 2 Investment region

1/N	Americas 1/3	Europe, Middle East and Africa 1/3	Asia-Pacific 1/3

Level 3 Maturity of the market

1/N	Developed	Emerging	Frontier

Level 4 Currency region

1/N	USD	EUR	CHF	GBP

Level 5 Country

1/N	Germany	France	Netherlands	Italy

Performance of cap-weighted portfolios vs. 1/N portfolios

Strategy	Currency risks unhedged			Currency risks hedged		
	Mean [p.a.]	Volatility [p.a.]	Sharpe Ratio [p.a.]	Mean [p.a.]	Volatility [p.a.]	Sharpe Ratio [p.a.]
2000 - 2011						
Balanced portfolio (50% stocks and 50% bonds)						
1/N (stocks DM, EM)	3,63	10,28	0,35	3,80	8,71	0,44
Cap-weighted (stocks DM, EM)	-0,31	8,34	-0,04	2,97	8,24	0,36
1/N (stocks DM)	1,76	8,86	0,20	2,57	7,06	0,36
Cap-weighted (stocks DM)	-0,91	8,20	-0,11	2,32	7,91	0,29
Stocks						
1/N (stocks DM, EM)	4,57	19,91	0,23	4,30	18,47	0,23
Cap-weighted (stocks DM, EM)	0,00	0,00	0,00	2,79	17,17	0,16
1/N (stocks DM)	0,84	16,60	0,05	1,84	15,30	0,12
Cap-weighted (stocks DM)	-2,89	15,49	-0,19	1,50	16,47	0,09
Bonds						
1/N	2,68	6,18	0,43	3,30	4,34	0,76
Cap-weighted	1,07	6,94	0,15	3,15	3,73	0,84

Source: Oertmann, Kirner and Seiler (2011)

$\Rightarrow$ 1/n outperformed in most cases as 1/n avoids $\nearrow$ estimation risk $\searrow$ model risk

Why does 1/N dominate MV-optimized portfolios?

Hypothesis: ***Robustness with respect to estimation and model risks***

A – Simulation of estimation risk

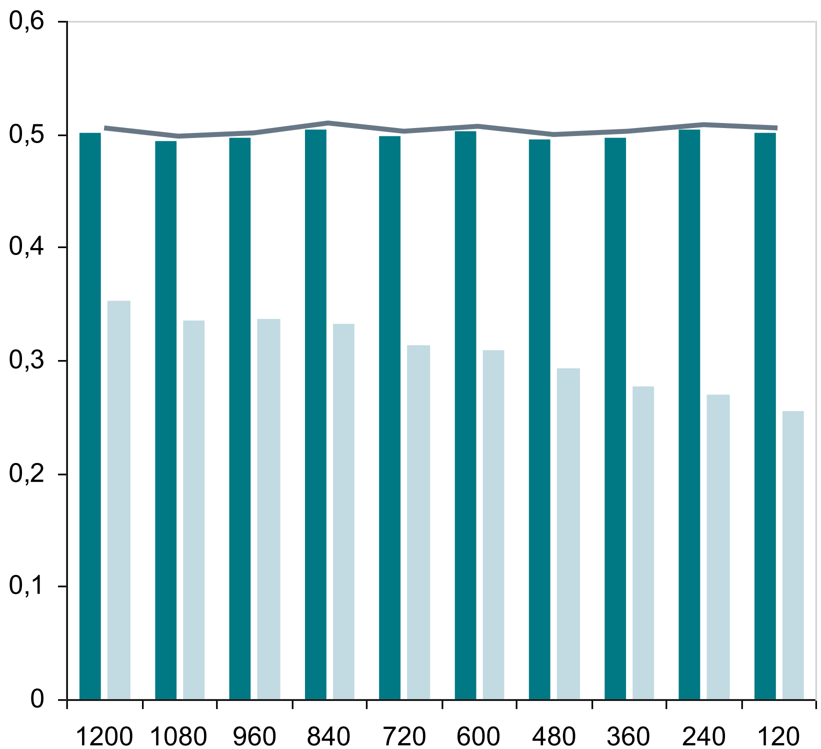
Estimation period	Testing period
Return distribution A	*Return distribution A*
Generating optimal MV-portfolios for estimation windows including 120 to 1200 months	Analysis of the Sharpe ratios of the optimal MV-portfolios in comparison to the “real” MV-portfolio and the 1/N-portfolio

B – Simulation of model risk

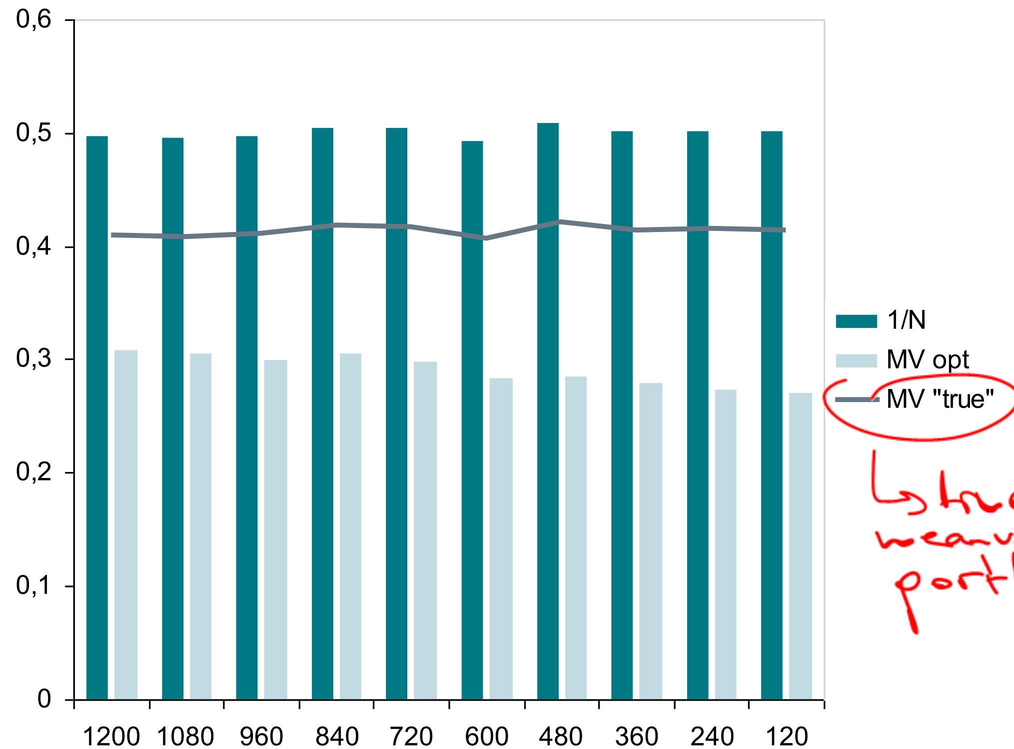
Estimation period	Testing period
Return distribution A	*Return distribution B*
Generating optimal MV-portfolios for estimation windows including 120 to 1200 months	Analysis of the Sharpe ratios of the optimal MV-portfolios in comparison to the “real” MV-portfolio and the 1/N-portfolio

Why does 1/N dominate MV-optimized portfolios? (cont.)

Simulation results – Sharpe ratios



A – Influence of estimation risk



↳ true meanvariance portfolio

B – Influence of model risk

Part 6: Selected references

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International Capital Markets and Investment Practice

Part 7

Equity investments

Prof. Dr. Peter Oertmann
TUM School of Management
Technical University of Munich
peter.oertmann@tum.de

Part 7: Equity investments

Part 7: Positioning in the lecture

Major fields in asset management

- Diversification
- Asset allocation
- Security selection
- Investment strategy implementation
- Risk management
- Trading and execution

Knowledge base

- **Stylized facts on global markets** – Empirical research
- **Sources of risk and return** – Models and empirical research
- **Asset pricing** – Theories, models and empirical tests
- **Portfolio construction** – Models and empirical tests
- **Financial economics** – Models and empirical research
- **Time series analysis** – Models and empirical procedures

Part 7: Equity investments

What are equity investments?

- Money invested in a company through the purchase of its shares
- Equity investment usually begins with a purchase of shares on the stock exchange or the purchase of an equity mutual fund
- Equity investors purchase shares in the expectation that they
  - will rise in value in the form of capital gains
  - generate capital dividends from the company
- Should an equity investment rise in value, the investor receives the monetary difference only through the sale of the held shares or if the company's assets are liquidated and all its obligations are met

Motivation: Increase in share price + dividends

Equity investment philosophies

High-conviction

- Active taking of unsystematic risks → stock picking
- Investment in a portfolio with few securities
- Stock picking based on fundamental analysis and individual equity stories

Style Investing
Smart beta

- Relaxation of diversification
- Implementation of specific factor tilts (e.g., value)
- Systematic stock selection based on fundamental ratios or price history

Indexed
Passive Investing

- Perfect diversification
- Replicating market indices (e.g., MSCI world)
- No analysis of individual stocks

Part 7: Equity investments

The concept of intrinsic value

Dividend discount model

The current intrinsic value of a stock is the expected discounted value of the dividend and value next period: = PV of Future Dividends

$$V_t = E_t\left(\frac{D_{t+1} + V_{t+1}}{1 + k_t}\right)$$

(V: value; D: dividend; k: discount factor)

Assuming a constant discount rate, the valuation formal can be written as follows:

$$V_t = \sum_{j=1}^{\infty} \frac{E_t\left(D_{t+j}\right)}{(1+k)^j}$$

The concept of intrinsic value (cont.)

Gordon growth model

If in addition to a constant discount factor, constant expected dividend growth is assumed, the intrinsic value of a stock reduces to:

$$V_t = \frac{(1+g) \cdot D_t}{k-g} = \frac{D_{t+1}}{k-g}$$

(V: value; D: dividend; k: discount factor; g: dividend growth rate)

Remarks:

- Only appropriate for firms with constant dividend growth rate
- Growth rate (g) must be less that the discount factor (k)
- Multi-stage DDM's allow to analyze firms going through periods with changing dividend growth

A question of philosophy…

Efficient markets

If an investor believes in efficient markets:

$$V_t = \frac{(1+g)\cdot D_t}{k-g} = P_t$$

The intrinsic value and market price of a stock are always the same!

Efficiently inefficient markets

From the viewpoint of a value investor:

$$V_t = \frac{(1+g)\cdot D_t}{k-g} < or > P_t$$

The intrinsic value can deviate from the market price of a stock. Value investors buy stocks where the market price is cheap relative to the intrinsic value ("margin of safety").

Exercise

For a stock, a next dividend of EUR 4.50 and a long-term constant dividend growth of 5% is expected.

What is the intrinsic value of the stock if a discount factor of 8% is applied?

$$V = \frac{4.5}{0.08 - 0.05} = 150\,€$$

Exercise (cont.)

The market price of the share is EUR 130. How do you rate this current market price?

$V = 150 \quad P = 130$ ⇒ Stock is undervalued / cheap

⇒ Margin = 20 €

How does the intrinsic value of the stock change if the expected dividend growth weakens to 4%?

$V = 112.50$

Value-oriented equity selection

What do we know?

- Value stocks tend to outperform growth stocks and the market
- But there are also longer time periods in which value stocks significantly underperformed
- Value indicators: High…
  - book/price
  - dividend/price (dividend yield)
  - earnings/price
  - cash flow/price
  - sales/price
- Sector neutral value strategies (no industry bets) work better
- Be aware of the value trap: A stock that does look cheap can deserve to be cheap because its fundamentals are collapsing!

Most prominent value investor: Warren Buffett

Berkshire Hathaway buys stocks that are…

- "safe" with low beta and low volatility
- "cheap" in terms of well-known valuation criteria
- "high-quality" in terms of profitability, growth, and payout ratios

Study "Buffett's Alpha" by Frazzini/Kabiller/Pedersen (2013)

- Period: Nov 1976 to Dec 2011
- Excess return: 19.0% (market: 6.1%)
- Volatility: 24.9% (market: 15.8%)
- Sharpe ratio: 0.76 (market: 0.39)
- Market beta: 0.7
- Information ratio: 0.66 $= \frac{\alpha}{\text{deviation from market}}$

Higher return for higher volatility

Whether we're talking about stocks or socks, I like buying quality merchandise when it is marked down.

Warren Buffett, Berkshire Hathaway, Annual Report 2008

Berkshire Hathaway's portfolio as of 31 March 2024

Company		Weight	Company		Weight	Company		Weight
Apple Inc	AAPL	43,6%	Amazon.com Inc	AMZN	0,5%	Liberty Latin America Series C	LILAK	0,0%
Bank of America Corp	BAC	10,4%	Mastercard Inc	MA	0,5%	Liberty Live Series A	LLYVA	0,0%
American Express Company	AXP	8,9%	Capital One Financial Corp.	COF	0,4%	NVR Inc	NVR	0,0%
Coca-Cola Co	KO	6,6%	Liberty SiriusXM Series C	LSXMK	0,4%	Paramount Global Class B	PARA	0,0%
Chevron Corp	CVX	5,0%	Nu Holdings Ltd	NU	0,4%	Sirius XM Holdings Inc	SIRI	0,0%
Occidental Petroleum Corp	OXY	4,1%	Financial Inc	ALLY	0,3%	SPDR S&P 500 ETF Trust	SPY	0,0%
Kraft Heinz Co	KHC	2,7%	Aon PLC	AON	0,3%	Vanguard S&P 500 ETF	VOO	0,0%
Moody's Corp	MCO	2,7%	Charter Communications Inc	CHTR	0,3%			
Chubb Ltd	CB	1,8%	Liberty SiriusXM Series A	LSXMA	0,2%			
Mitsubishi Corp	8058:TYO	1,8%	Snowflake Inc	SNOW	0,2%			
Itochu Corporation	8001:TYO	1,5%	T-Mobile Us Inc	TMUS	0,2%			
Davita Inc	DVA	1,3%	Floor & Decor Holdings Inc	FND	0,1%			
Citigroup Inc	C	0,9%	Liberty Formula One Series C	FWONK	0,1%			
Marubeni Corp	8002:TYO	0,7%	Liberty Live Series C	LLYVK	0,1%			
Mitsui & Co	8031:TYO	0,7%	Louisiana-Pacific Corp	LPX	0,1%			
BYD Co. Ltd	BYDDF	0,6%	Atlanta Braves Holdings Inc Series C	BATRK	0,0%			
Kroger Co	KR	0,6%	Diageo plc	DEO	0,0%			
Sumitomo Corp	8053:TYO	0,6%	Jefferies Financial Group Inc	JEF	0,0%			
VeriSign, Inc	VRSN	0,6%	Lennar Corp Class B	LEN.B	0,0%			
Visa Inc	V	0,6%	Liberty Latin America Series A	LILA	0,0%			

Mix of value and growth stocks

USD 386.208.316.588

Source: https://cnbc.com

Part 7: Equity investments

a. Introduction
b. Fundamental equity selection
c. Exploring factors in stock returns
d. Factor-based equity strategies in the business cycle
e. ETF-based equity investing

The birth of asset pricing theory

CAPM by Sharpe (1964) and Lintner (1965)

$$E(R_i) = R_f + \beta_i \cdot \left(E(R_M) - R_f\right) \quad where\ \beta_i = \frac{Cov(R_i, R_m)}{Var(R_M)}$$

The expected return on any asset is the risk-free interest rate plus a risk premium, which is the asset's market beta times the premium per unit of beta risk.

Empirical version

systematic excess return

unsystematic

$$R_{it} - R_f = \alpha_i + \beta_{iM} \cdot \left(R_{Mt} - R_f\right) + \varepsilon_{it}$$

Time-series regression test proposed by Jensen (1968): Since the expected excess return on any asset is completely explained by the expected market risk premium, the intercept term in the time-series regression – Jensen's alpha – is zero.

Some comments on the empirical content of the CAPM

- **Joint hypotheses problem**: The model knows only one systematic risk factor, which is also not perfectly observable → use index such as MSCI as proxy for r_m
- **Empirical tests do not produce convincing results**:
  – Many methodological challenges (e.g. the "errors-in-variables problem")
  – Cross-section regression tests: Market beta is not able to explain the cross-sectional variation of returns. Studies document a positive relation between beta and average return, but it is too flat. In addition, studies find that the intercept is greater than the average risk-free rate, and the coefficient on beta is less than the average excess market return.
  – Time-series regression test: The evidence that the relation between beta and average return is too flat is confirmed. Studies document that the intercepts in time-series regressions of excess asset returns on the excess market return are positive for assets with low betas and negative for assets with high betas
- Equity returns appear to be systematically influenced by multiple factors

Empirical security market line

Average Annualized Monthly Return versus Beta for Value Weight Portfolios Formed on Prior Beta, 1928–2003

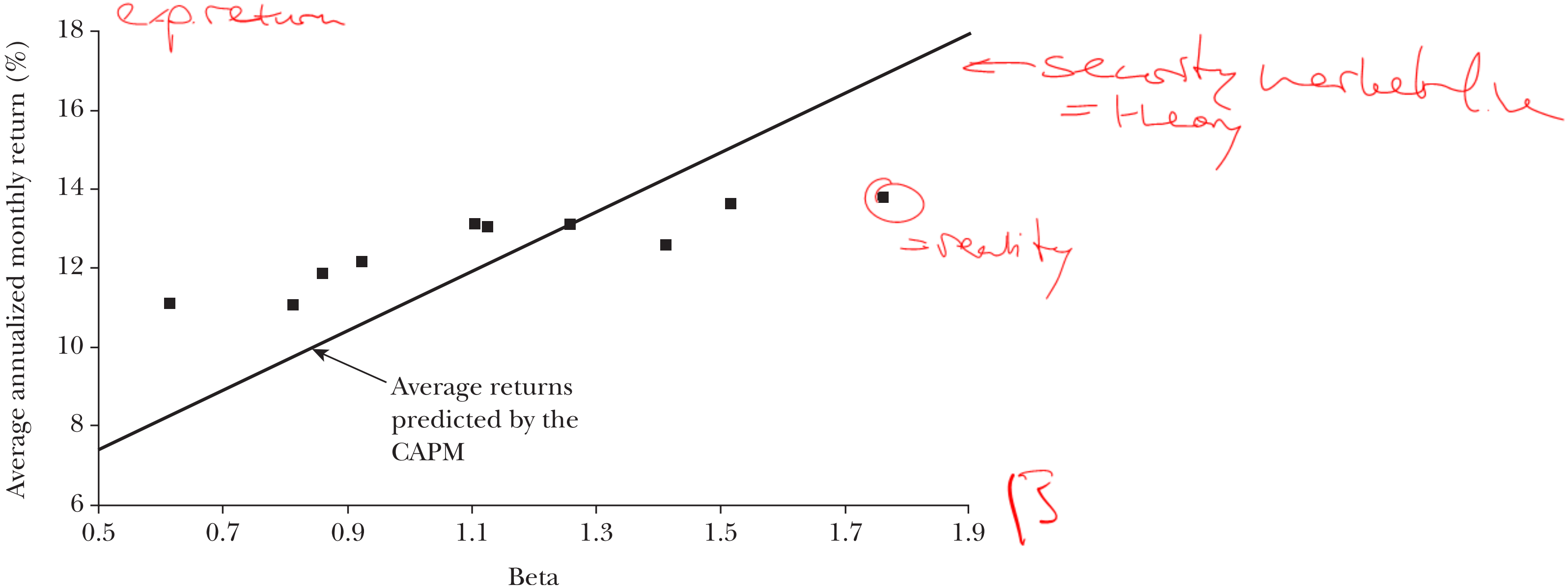
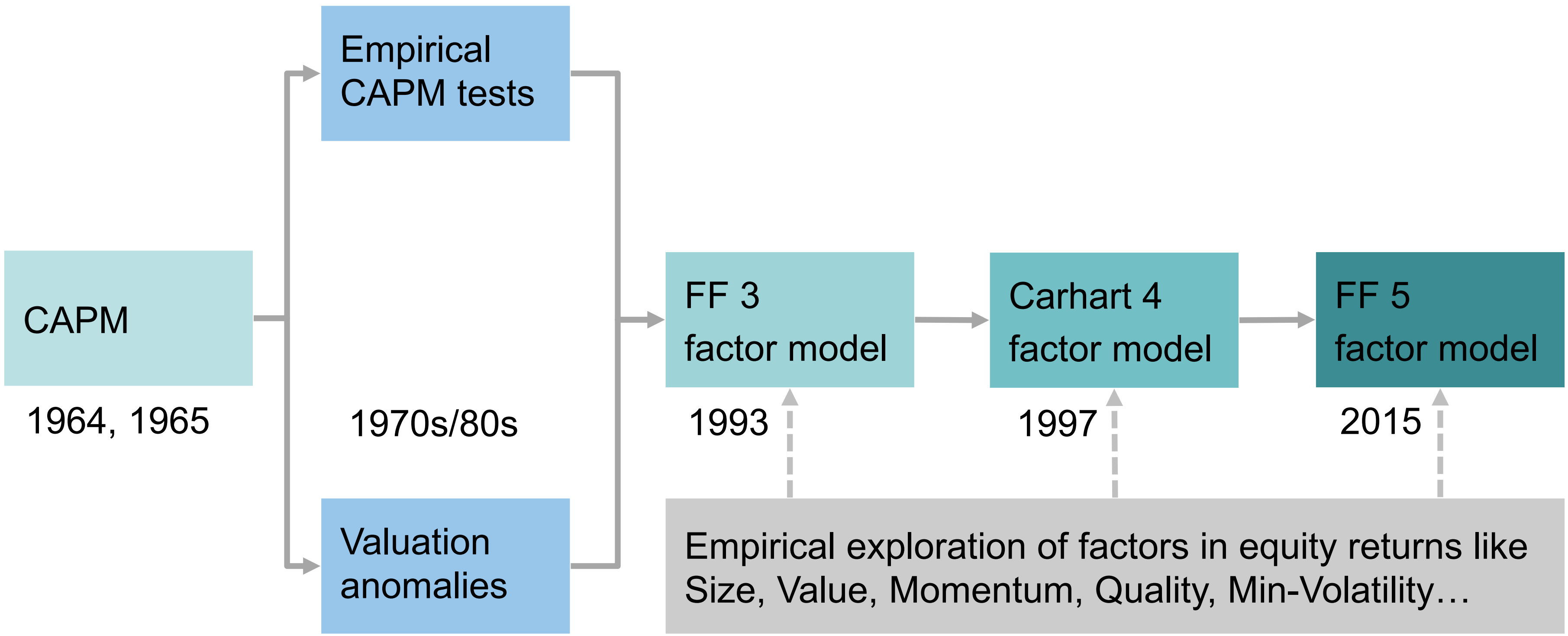


Figure 2 from Fama/French (2004): “In December of each year, we estimate a pre-ranking beta for every NYSE (1928–2003), AMEX (1963– 2003) and NASDAQ (1972–2003) stock in the CRSP (Center for Research in Security Prices of the University of Chicago) database, using two to five years (as available) of prior monthly returns. We then form ten value-weight portfolios based on these pre-ranking betas and compute their returns for the next twelve months. We repeat this process for each year from 1928 to 2003. The result is 912 monthly returns on ten beta-sorted portfolios. Figure 2 plots each portfolio’s average return against its post-ranking beta, estimated by regressing its monthly returns for 1928–2003 on the return on the CRSP value-weight portfolio of U.S. common stocks.”

Evolution of our understanding of equity risk



Theoretical anchor points of multifactor models

Intertemporal Capital Asset Pricing Model (ICAPM) of Merton (1973)

- The intertemporal capital asset pricing model (ICAPM) assumes that investors are concerned not only with their end-of-period payoff (as in the CAPM), but also with the opportunities they will have to consume or invest the payoff
- When choosing a portfolio at time t-1, investors consider how their wealth at time t might vary with future state variables (e.g. labor income, prices of consumption goods)
- Optimal portfolios have the largest possible expected return given their return variances and covariances with the relevant state variables

Arbitrage Pricing Theory (APT) of Ross (1976)

- Framework for analyzing the relationship between asset returns and returns on abstract state variables (factors)
- Assuming that asset returns are generated by multiple factors, the APT ends up with a linear multifactor asset pricing equation

The Fama-French 3-factor model, 1993 = extension of CAPM

Empirical version

$$R_{it} - R_f = \alpha_i + \beta_{iM} \cdot (R_{Mt} - R_f) + \beta_{iS} \cdot \underline{SMB}_t + \beta_{iV} \cdot \underline{HML}_t + \varepsilon_{it}$$

The excess return on any asset is explained by 3 factors:

1. Market (CAPM factor)
2. SMB ("small minus big"): Difference between the returns on diversified portfolios of small and big stocks (size factor)
3. HML ("high minus low"): Difference between the returns on diversified portfolios of high and low book-to-market stocks (value factor)

Motivation for the additional factors: The discovery of the…

- Value (E/P, B/M) effect by Basu (1977), Stattman (1980), and many others
- Size effect by Banz (1981), and many others

The Fama-French 3-factor model, 1993

Design idea

- Indirect approach in the spirit of Ross's (1976) APT since size and book-to-market equity are not themselves considered state variables
- Argue that the higher average returns on small stocks and high book-to-market stocks reflect unidentified state variables that produce undiversifiable risks (covariances) in stock returns that are not captured by the market return and are priced separately from market betas

1927-2003	annual mean	annual standard deviation
Market	8.3%	21.0%
SMB	3.6%	14.6%
HML	5.0%	14.2%

Source: Fama/French (2004)

Starting point of the Fama-French 3-factor model

Size and book-to-market equity effects in equity portfolio returns

	Book-to-Market Portfolios										
	All	Low	2	3	4	5	6	7	8	9	High
All	1.23	0.64	0.98	1.06	1.17	1.24	1.26	1.39	1.40	1.50	1.63
Small-ME	1.47	0.70	1.14	1.20	1.43	1.56	1.51	1.70	1.71	1.82	1.92
ME-2	1.22	0.43	1.05	0.96	1.19	1.33	1.19	1.58	1.28	1.43	1.79
ME-3	1.22	0.56	0.88	1.23	0.95	1.36	1.30	1.30	1.40	1.54	1.60
ME-4	1.19	0.39	0.72	1.06	1.36	1.13	1.21	1.34	1.59	1.51	1.47
ME-5	1.24	0.88	0.65	1.08	1.47	1.13	1.43	1.44	1.26	1.52	1.49
ME-6	1.15	0.70	0.98	1.14	1.23	0.94	1.27	1.19	1.19	1.24	1.50
ME-7	1.07	0.95	1.00	0.99	0.83	0.99	1.13	0.99	1.16	1.10	1.47
ME-8	1.08	0.66	1.13	0.91	0.95	0.99	1.01	1.15	1.05	1.29	1.55
ME-9	0.95	0.44	0.89	0.92	1.00	1.05	0.93	0.82	1.11	1.04	1.22
Large-ME	0.89	0.93	0.88	0.84	0.71	0.79	0.83	0.81	0.96	0.97	1.18

Table V from Fama/French (1992): "The average return matrix in Table V gives a simple picture of the two-dimensional variation in average returns that results when the 10 size deciles are each subdivided into 10 portfolios based on ranked values of BE/ME for individual stocks. Within a size decile (across a row of the average return matrix), returns typically increase strongly with BE/ME: on average, the returns on the lowest and highest BE/ME portfolios in a size decile differ by 0.99% (1.63%-0.64%) per month. Similarly, looking down the columns of the average return matrix shows that there is a negative relation between average return and size: on average, the spread of returns across the size portfolios in a BE/ME group is 0.58% per month."

→ Smaller companies are more profitable (based on avg. return)
→ The higher B/M ratio, the higher the return

Carhart 4-factor model, 1997

Empirical version

$$R_{it} - R_f = \alpha_i + \beta_{iM} \cdot \left(R_{Mt} - R_f\right) + \beta_{is} \cdot SMB_t + \beta_{iV} \cdot HML_t + \beta_{i1YM} \cdot \underline{PR1YR_t} + \varepsilon_{it}$$

= 1 year momentum

The excess return on any asset is explained by 4 factors:

1. Market (CAPM factor)
2. SMB ("small minus big"): Factor-mimicking portfolio for size
3. HML ("high minus low"): Factor-mimicking portfolio for book-to-market equity
4. PR1YR: Factor-mimicking portfolio for one-year return momentum

Motivation for the additional factor: The discovery of…

- Persistence in mutual fund performance over short-term horizons by Hendriks/Patel/Zeckhauser (1993), and others
- One-year momentum in stock returns by Jegadeesh/Titman (1993)

Fama-French 5-factor model, 2015

Empirical version

$$R_{it} - R_f = \alpha_i + \beta_{iM} \cdot \left(R_{Mt} - R_f\right) + \beta_{iS} \cdot SMB_t + \beta_{iV} \cdot HML_t + \beta_{iP} \cdot RMW_t$$

$$+ \beta_{iI} \cdot CMA_t + \varepsilon_{it}$$

The excess return on any asset is explained by 5 factors:

1. Market
2. SMB ("small minus big"): Factor-mimicking portfolio for size
3. HML ("high minus low"): Factor-mimicking portfolio for book-to-market equity
4. RMW ("robust minus weak"): Factor-mimicking portfolio for profitability
5. CMA ("conservative minus aggressive"): Factor-mimicking portfolio for investment

Fama-French 5-factor model, 2015

The Motivation to extend the Fama-French 3-factor model (1993)

- Critique that the model is incomplete
- Empirical finding that the variation in average stock returns is related to profitability and investment by Novy-Marx (2013) and Titman/Wei/Xi (2004)

Most important concerns with the model

- Low-risk anomaly is not captured
- Ignores the momentum effect
- Robustness and economic rationale of the two new factors

… see also the work by Blitz/Hanauer/Vidojevic/van Vliet (2018)

Taming the factor zoo

- It all started with the market factor
- Financial market research over four decades has produced hundreds of factors to explain stock returns
- Now a new zeitgeist is entering the debate
- One wants to bring more discipline into the selection of factors
- The statistical methods are called into question
  - Suspicion that data mining was frequently carried out
  - Statistical hurdles for a significant factor were sometimes set too low
- One of the pioneering articles: Harvey/Liu/Zhu (2015): "…and the cross-section of expected returns", RFS

> "In particular, a question that remains open is: How to judge whether a new factor adds explanatory power for asset pricing, relative to the hundreds of factors the literature has so far produced?" Feng/Giglio/Xiu (2020), JoF

Part 7: Equity investments

Taking exposure to economic or behavioral risks

- Modern equity strategies are often based on empirical findings on valuation-relevant factors such as size, value, momentum, etc.
- In the background of such strategies, there is always an exposure to economic or behavioral risks in capital markets:
  - **Economic**: Fundamental equity characteristics like size (market capitalization), value (book-to-price ratio), profitability (ratio between profits and total assets or book value and equity), and investment (e.g. the annual change in total assets) decide how susceptible a company is to the business cycle, economic shocks and financial distortion and whether it is able to take growth opportunities in the long term
  - **Behavioral**: Characteristics such as momentum or the volatility of price changes reflect the sensitivity of a stock to certain patterns in the behavior of market participants
- Factor-based equity strategies assume that risk premiums resulting from these economic and behavioral causes have a systematic component

Motivation and setup of the study

- Factor-based risk premiums are not stable over time
- We examine the properties of factor-based strategies on international equity markets over the business cycle
- The analysis covers the period from January 1975 to May 2018
- The performance of the MSCI World Index is compared to global MSCI indices for five popular investment styles:
  - Value
  - Small cap
  - Quality
  - Momentum
  - Minimum volatility
- Our analysis aims to develop a basic understanding of how the most significant risk of an investment in equities – the global economic risk – can be diversified using factor-based strategies

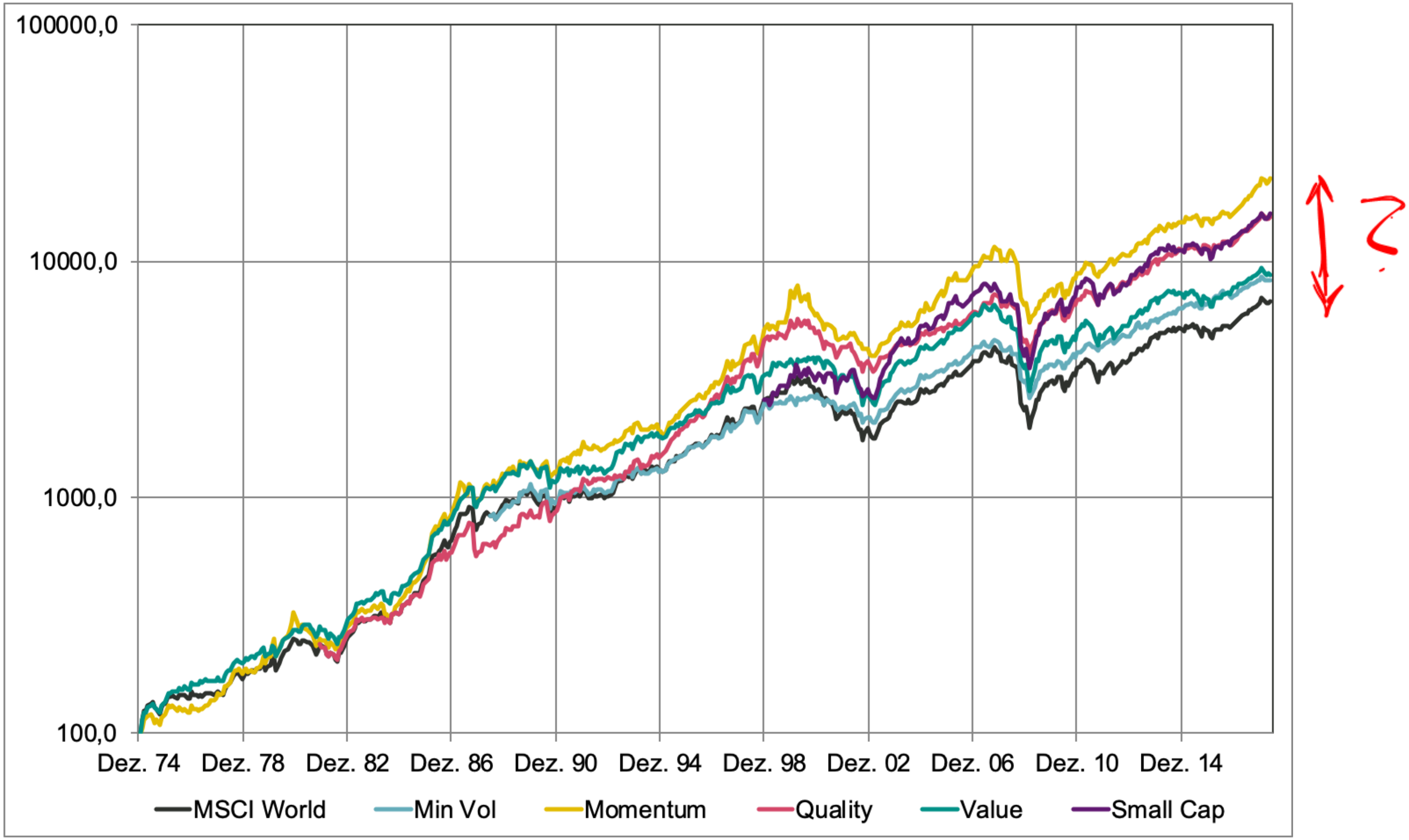
Motivation and setup of the study (cont.)

- The equity risk premium and the factor risk premia are analyzed in various phases of the business cycle
- The business cycle of the United States of America is used as a proxy for the global business cycle, using data from the **Business Cycle Dating Committee of the National Bureau of Economic Research (NBER)**. This committee maintains a chronology of the cycle phases of the U.S. economy, determining the months in which the economy transitions from expansion to contraction (peak) and from contraction back to expansion (trough)
- The study begins at the tail end of the first oil crisis in the mid-1970s and takes in the second energy crisis at the start of the 1980s, the severe U.S. economic crisis in 1981 and 1982, the recession in the Western world of the early 1990s, the dot-com crash after the turn of the millennium, and the global financial and economic crisis of 2008 and 2009

Data

MSCI World Index	Represents the global equity market, large and mid-cap companies from 23 developed industrial countries; as of June 29, 2018, it contained 1,643 stocks, covering approximately 85% of the market capitalization in each country
MSCI World Value Index	Equities selected in each of the 23 industrial countries based on the book-to-price and earnings-to-price ratios and the dividend yield; as of June 29, 2018, it contained 865 stocks
MSCI Small Cap Index	Equities selected in each of the 23 industrial countries based on market capitalization; as of June 29, 2018, it contained 4,390 stocks
MSCI Quality Index	Equities selected in each of the 23 industrial countries based on return on equity (ROE), year-on-year profit growth and leverage; as of June 29, 2018, it contained 301 stocks
MSCI Momentum Index	Equities selected in each of the 23 industrial countries based on price momentum with simultaneously high liquidity and investment capacity while ensuring moderate index turnover; as of June 29, 2018, it contained 348 stocks
MSCI Minimum Volatility Index	Equities selected in each of the 23 industrial countries based on a global optimization (minimization) of absolute risk under a given set of constraints from the MSCI World universe; as of June 29, 2018, it contained 341 stocks

Performance of factor indices since 1975



U.S. business cycles looked at in the study

Regime	Start	End	# Months	Background	Ø US GDP growth
Recession	Nov 73	Mar 75	3	Oil crisis, US stagflation	-3,2%
Expansion	Apr 75	Jan 80	58		4,3%
Recession	Feb 80	Jul 80	6	Energy crisis, increasing rates	-2,2%
Expansion	Aug 80	Jul 81	12		4,4%
Recession	Aug 81	Nov 82	16	US economic crisis	-2,7%
Expansion	Dec 82	Jul 90	92		4,3%
Recession	Aug 90	Mar 91	8	Oilprice shock, US jobless recovery	-1,4%
Expansion	Apr 91	Mar 01	120		3,6%
Recession	Apr 01	Nov 01	8	Dotcom crisis	-0,3%
Expansion	Dec 01	Dec 07	73		2,8%
Recession	Jan 08	Jun 09	18	Global fiscal and economic crisis	-5,1%
Expansion	Jul 09		107		2,2%

Data: http://www.nber.org/cycles

→ 6 recessions & 6 expansions

Performance of strategies across economic cycles

			Cumulated excess return (USD)					
Regime	Start	End	World market	Min Vol	Momentum	Quality	Value	Small Cap
Recession	Nov 73	Mar 75	23,6%		14,9%		21,0%	
Expansion	Apr 75	Jan 80	13,8%		38,9%		30,5%	
Recession	Feb 80	Jul 80	0,4%		0,3%		1,2%	
Expansion	Aug 80	Jul 81	-9,5%		-12,1%		-5,8%	
Recession	Aug 81	Nov 82	-15,2%		-12,3%		-15,5%	
Expansion	Dec 82	Jul 90	116,7%		167,0%	93,9%	142,8%	
Recession	Aug 90	Mar 91	-7,4%	-9,4%	-4,8%	-0,3%	-8,8%	
Expansion	Apr 91	Mar 01	46,1%	41,3%	115,7%	153,0%	63,6%	
Recession	Apr 01	Nov 01	-7,5%	-4,2%	-11,4%	-0,9%	-9,7%	0,8%
Expansion	Dec 01	Dec 07	46,8%	54,6%	97,9%	36,0%	55,6%	92,1%
Recession	Jan 08	Jun 09	-39,0%	-31,5%	-45,8%	-30,5%	-40,2%	-35,5%
Expansion	Jul 09		150,9%	150,9%	242,7%	194,7%	122,8%	212,8%

Data: MSCI Indices (USD), NBER, Bloomberg; own calculations

Long-term risk premiums and performance

		Factor-based strategies				
	World market	Min Vol	Momentum	Quality	Value	Small Cap
Start of time series	Jan. 75	Jun. 88	Jan. 75	Dez. 81	Jan. 75	Jan. 99
Excess return (monthly) = return − r_m	0,36%	0,35%	0,59%	0,58%	0,41%	0,60%
Sharpe Ratio (annualised)	0,30	0,37	0,46	0,50	0,34	0,41
CAPM based performance analysis						
World market beta		0,68	0,92	0,87	0,97	1,04
Alpha (monthly)		0,15%	0,26%	0,24%	0,06%	0,36%
Significance of alpha (t Stat)		2,07	2,59	3,32	1,55	2,55
R-Squared		0,82	0,74	0,86	0,95	0,82
Degrees of freedom		358	519	436	519	231

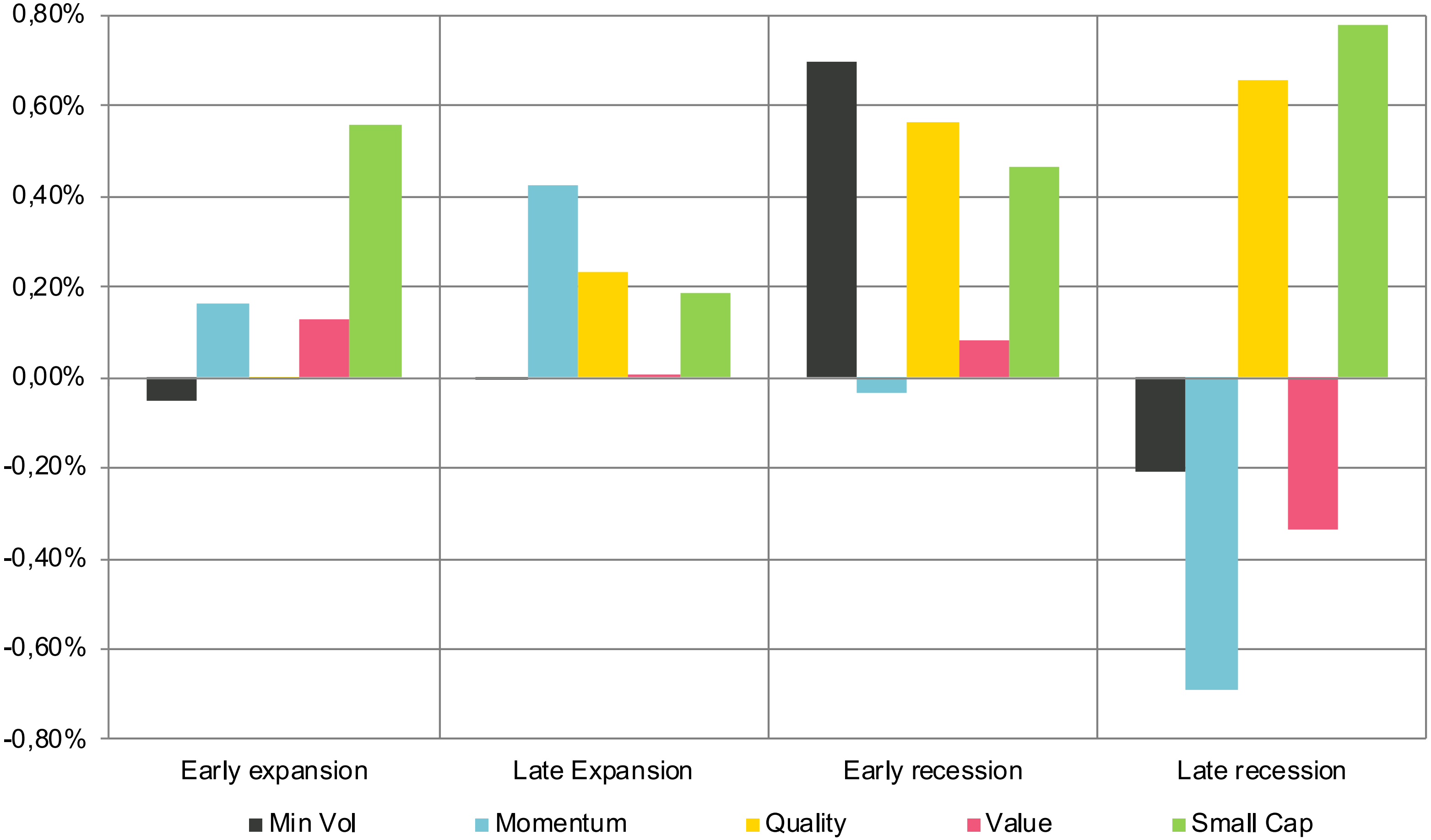
Data: MSCI Indices (USD), Libor-Cash-Index, Bloomberg; own calculations

Performance in economic expansions and recessions

	Factor-based strategies				
	Min Vol	Momentum	Quality	Value	Small Cap
Return in excess of World Market					
Total period	0,001%	0,217%	0,169%	0,045%	0,377%
Recession	0,244%	-0,378%	0,614%	-0,137%	0,620%
Expansion	-0,024%	0,293%	0,116%	0,069%	0,347%
CAPM based performance analysis					
World market beta					
Recession	0,75	0,82	0,85	0,98	1,17
Expansion	0,65	0,95	0,88	0,96	0,99
Alpha (monthly)					
Rezession	-0,10%	-0,48%	<u>0,44%</u>	-0,15%	<u>0,92%</u>
Expansion	<u>0,20%</u>	<u>0,33%</u>	<u>0,21%</u>	<u>0,10%</u>	<u>0,35%</u>

Data: MSCI Indices (USD), NBER, Bloomberg; own calculations; world market betas are estimated on a 95% level of significance; alpha estimates on a 95% level of significance are underlined

Performance in economic expansions and recessions



Findings and summary

- The performance of factor strategies relative to the global equity market very much depends on the current state of the economy
- The factor risk premiums seem to be “transformations” of the equity risk premium
- Factor-based stock selection can be used to shape the economic risk profile of an equity portfolio
- In the conception of forecast models for tactical allocation in factor strategies, it stands to reason to use instrumental variables that reflect the individual phases of the business cycle
- Practical implication: There is promising return potential for active asset management in the field of factor-based equity strategies (such approaches are followed in the study by Hodges, Hogan, Peterson, and Ang (2017) and tested with MSCI USA factor indices)

Part 7: Equity investments

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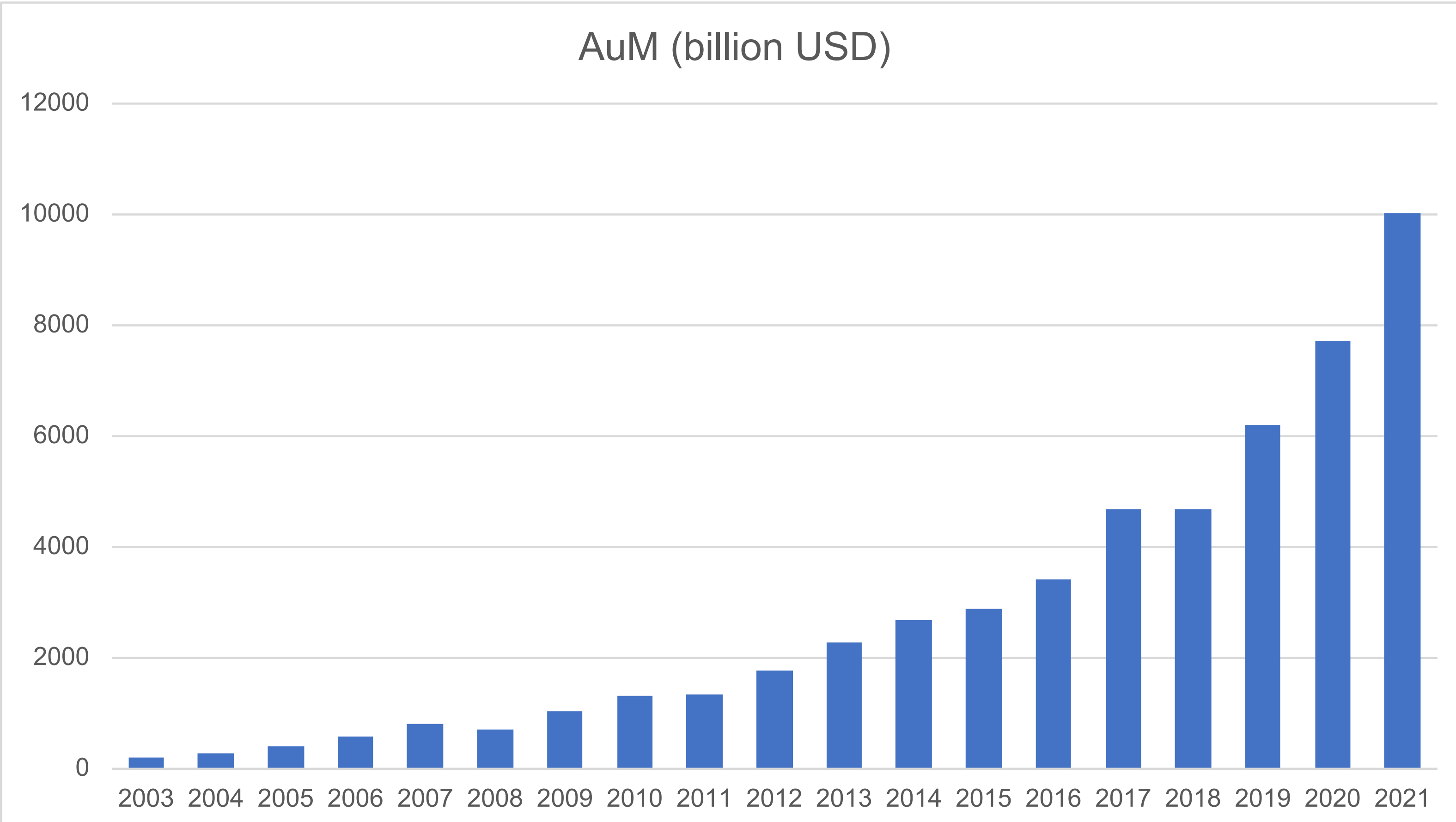
Exchange Traded Funds (ETFs)

- Investment fund traded on stock exchanges
- ETFs invest in stocks, bonds, and commodities
- Most ETFs track a stock or bond index
- The design of ETFs is based on the idea of passive investing of John C. Bogle, founder of the Vanguard Group (1974) and inventor of the first index mutual fund available to the general public (1976)
- The first ETF-like instruments were launched in the late 1980s
  - 1989: “Index Participation Shares” to track the S&P 500
  - 1990: “Toronto 35 Index Participation Units” to track the TSE-35
- Since those early days, ETFs became very popular since they provide a range of important benefits to investors, such as: low costs, liquidity, diversification, tax efficiency, flexibility, accessibility, and transparency

A growing market



Source: Statista

How ETFs replicate an index

- **Physical replication** → Directly investing
  - Full replication: The ETF accurately replicates the reference index via the basket of securities held in custody by the ETF provider. This method is suitable for equity and bond ETFs that consist of a small number of liquid securities, such as the DAX30.
  - Sampling: Only a selection (a sample) of the securities included in the Benchmark Index will be included in the portfolio of the ETF provider. This procedure is useful when securities are less liquid and in particular when the number of securities included in the Benchmark Index is high.
- **Synthetical replication**: Based on swap transactions. The relevant index is replicated via derivatives. The basket of securities is not physically deposited with the ETF provider. This method is chosen, for example, if investment restrictions such as trading restrictions or taxes make market access difficult. However, it is also used for relatively liquid indices for cost reasons. → Counterparty risk

Growth drivers of ETFs

Product features	Use	Structural trends
▪ Intraday trading ▪ Diversification ▪ Transparent pricing ▪ Secondary market trading and additional market liquidity ▪ Cost efficiency	▪ Asset allocation (e.g. in asset classes or regions) ▪ Simplification of investment processes (e.g. in terms of index weighting and market access)	▪ ETFs as core investment ▪ Search for returns in a low interest rate environment brings investment costs into focus ▪ Regulatory innovations ▪ Change in sales

Source: Deutsche Bundesbank (2018)

ETF investors behave more competently :)

Study by D’Hondt, Elmaya and Petitjean (2020)

- Analyze the determinants of retail investing in passive ETFs (P-ETFs)
- Looking at 26.140 retail investors‘ trading accounts
- Data from January 2003 to March 2012

Major findings

- Characteristics of retail investors who are more likely to invest in P-ETFs
  - better educated
  - self-report both higher financial knowledge and longer investment horizon
  - exhibit longer trading experience
  - hold a more diversified stock portfolio
  - trade these stocks more intensively
- On the contrary, retail investors who aim at a higher target return, suffer from either overconfidence or the local bias, are less likely to invest in P-ETFs

Easy ways to invest in the MSCI World

ETF	Replication method	TER (annual)	Performance 2015-19
iShares Core	physical replication	0,20%	10,65%
ISIN: IE00B4L5Y983			
Xtrackers Swap	synthetic replication	0,45%	10,60%
ISIN: LU0274208692			
Xtrackers	physical replication	0,19%	10,59%
ISIN: IE00BJ0KDQ92			
Source	synthetic replication	0,19%	10,58%
ISIN: IE00B60SX394			
Amundi	synthetic replication	0,38%	10,50%
ISIN: LU1681043599			
UBS	physical replication	0,30%	10,48%
ISIN: IE00BD4TXV59			
MSCI World Index			10,53%

Source: finanztip.de

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International Capital Markets and Investment Practice

Part 1

Introduction

Prof. Dr. Peter Oertmann
TUM School of Management
Technical University of Munich
peter.oertmann@tum.de

Part 1: Introduction

a. Asset management – some basics

b. Reflections on the quality of financial market prices

c. Investment strategies in today's financial markets

d. Focus of the lecture

Part 1: Introduction

a. Asset management – some basics

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What is an asset manager?

- An asset manager is a financial professional or firm responsible for managing investments and assets on behalf of clients. These assets can include stocks, bonds, real estate, commodities, and other financial instruments. The primary goal of an asset manager is to maximize the returns on the assets under management while minimizing risk according to the client's investment objectives and risk tolerance.
- Asset managers typically provide a range of services, including portfolio management, investment research, financial analysis, asset allocation, and risk management. They may work with individual investors, institutional clients such as pension funds or insurance companies, or other entities like mutual funds or hedge funds.
- Asset managers often charge a fee for their services, which can be based on a percentage of assets under management, a fixed fee, or a performance-based fee structure. They are expected to act in the best interests of their clients and adhere to legal and regulatory requirements governing the financial industry.

Source: ChatGPT 3.5, personal communication, 17 April 2024

The two major business areas of an asset manager

Management of assets for institutional investors (Managed accounts, mandates)

… such as

- Pension funds
- Insurance companies
- Endowment funds
- State funds
- Banks
- Corporate treasuries
- Family offices
- …

Creation, management and provision of mutual investment funds

… such as

- Equity funds
- Fixed income funds
- Balanced / Multi-asset funds
- Real estate funds
- Liquid alternative funds
- Private equity funds
- Hedge funds
- …

Business model of an asset manager

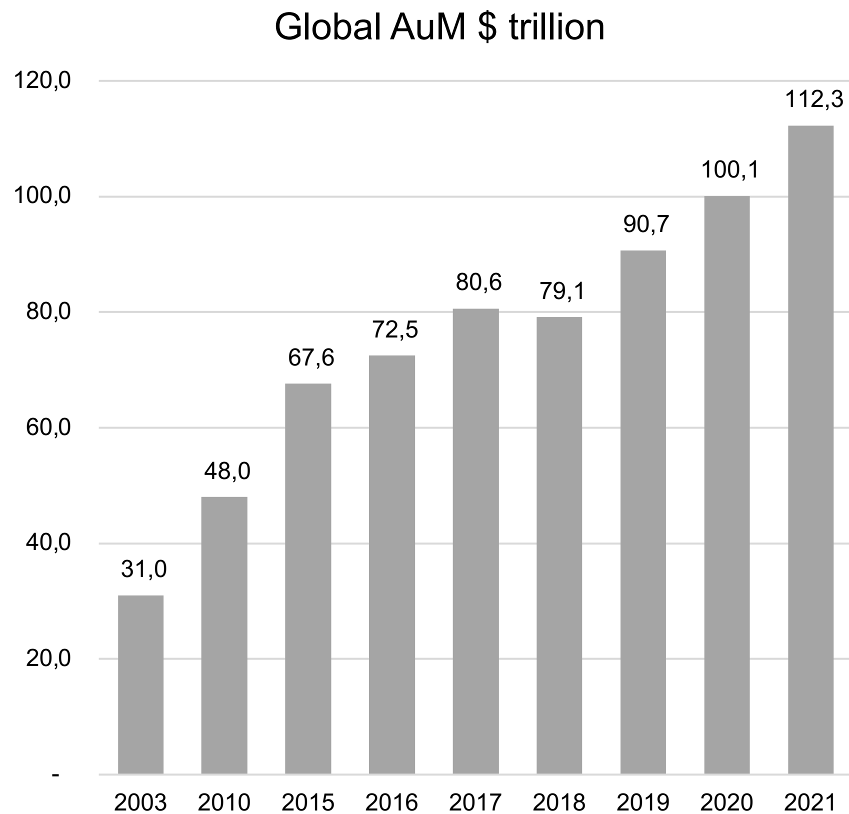
- Earning a fee on Assets-under-Management (AuM)
- Operating in highly regulated markets with partly highly regulated clients and highly regulated products
- In 2021, averaged over the industry, a mandate of EUR 100 million generated net revenues (after distribution costs) of EUR 238.000, incurred costs of EUR 147,000 and resulted in an operating profit of EUR 91,000

	Net Revenues	Costs	Operating profit
	Basispoints (bp)		
2010	31,1	20,3	34,7%
2015	29,2	18,3	37,3%
2020	24,2	15,6	35,5%
2021	23,8	14,7	38,2%

Basis: 101 leading asset managers (62% of global AuM)

Data source: BCG, From Tailwinds to Turbulence, 2022

Size and breakdown of the global asset management market



Region	2001	2010	2020	2021
North America	55,9%	51,6%	48,9%	49,5%
Europe	31,3%	29,9%	25,2%	24,3%
Japan & Australia	9,2%	8,4%	7,6%	7,5%
Latin America	0,4%	1,1%	1,6%	1,6%
Middle East & Africa	1,5%	2,2%	1,3%	1,4%
Asia	1,8%	6,9%	15,3%	15,8%

Source: BCG, own calculations

Note (by BCG): Market sizing includes assets professionally managed in exchange for management fees; AuM includes captive AuM of insurance groups or pension funds where AuM is delegated to asset management entities with fees paid; 44 markets are covered globally, including offshore AuM. For all countries where the currency is not the US dollar, we applied the end-of-year 2021 exchange rate to all years in order to synchronize current and historic data.

Date source: BCG, From Tailwinds to Turbulence, 2022

Over the past 20 years, the industry has grown extraordinarily

"The past few decades presented an outstanding market environment for the asset management industry. Overall, the period from 2001 to 2021 was a time of prolonged growth. Though the global economy experienced severe downturns due to the 2008 financial crisis and the COVID-19 pandemic, each decline was followed by a recovery that brought the market soaring to new highs. The aggregate result has been one of the strongest market runs in history."

Source: BCG, From Tailwinds to Turbulence, 2022

2001 to 2020 global AuM grew by more than 7% p.a. (Source: BCG, 2022)

Main drivers

- Strongly expansive fiscal and monetary policies
- Low inflation around the world
- Declining interest rates reaching historical lows

Two trends the industry is adapting to

Increasing demand for passive investment products

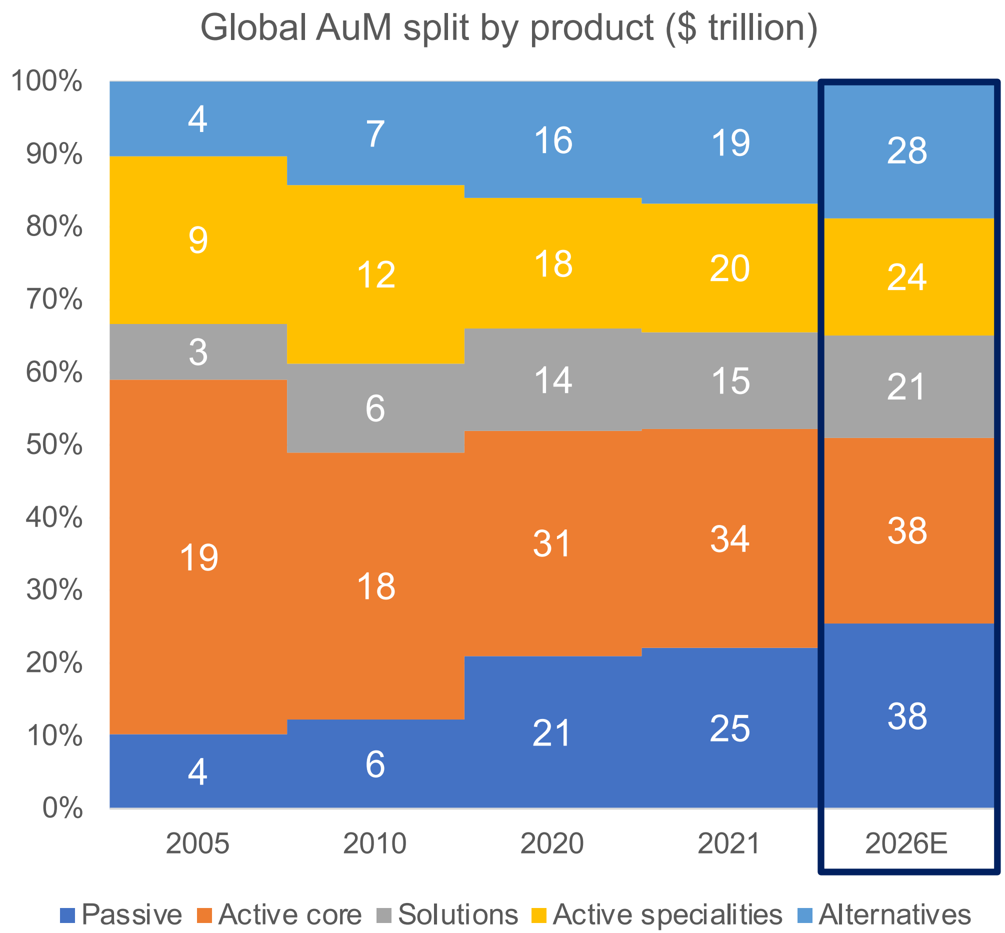
- Investors recognize that with passive funds they can capture market returns without paying the higher fees of active funds
- Passive asset growth began to surge after the GFC
- By 2021, AuM in in passively managed products such as ETFs had grown at more than four times the rate of actively managed funds since 2003

Increasing allocation to alternative assets

- To achieve returns above those of the publicly traded markets, investors began shifting at least part of their portfolios into alternative assets, which offer large illiquidity premiums in return for long lock-in periods and complex deals
- Private equity, hedge funds, and real estate assets have begun to experience a boom which will continue

Source: BCG, From Tailwinds to Turbulence, 2022

Development of the product landscape and forecast (AuM)



Hedge funds, private equity, real estate, infrastructure, commodities, private debt, and liquid alternative mutual funds (such as absolute return, long and short, market-neutral, and trading-oriented)

Equity specialties (foreign, global, emerging markets, small and mid-cap, and themes) and fixed-income specialties (emerging markets, high-yield, flexible, inflation-linked, and structured finance asset-backed securities)

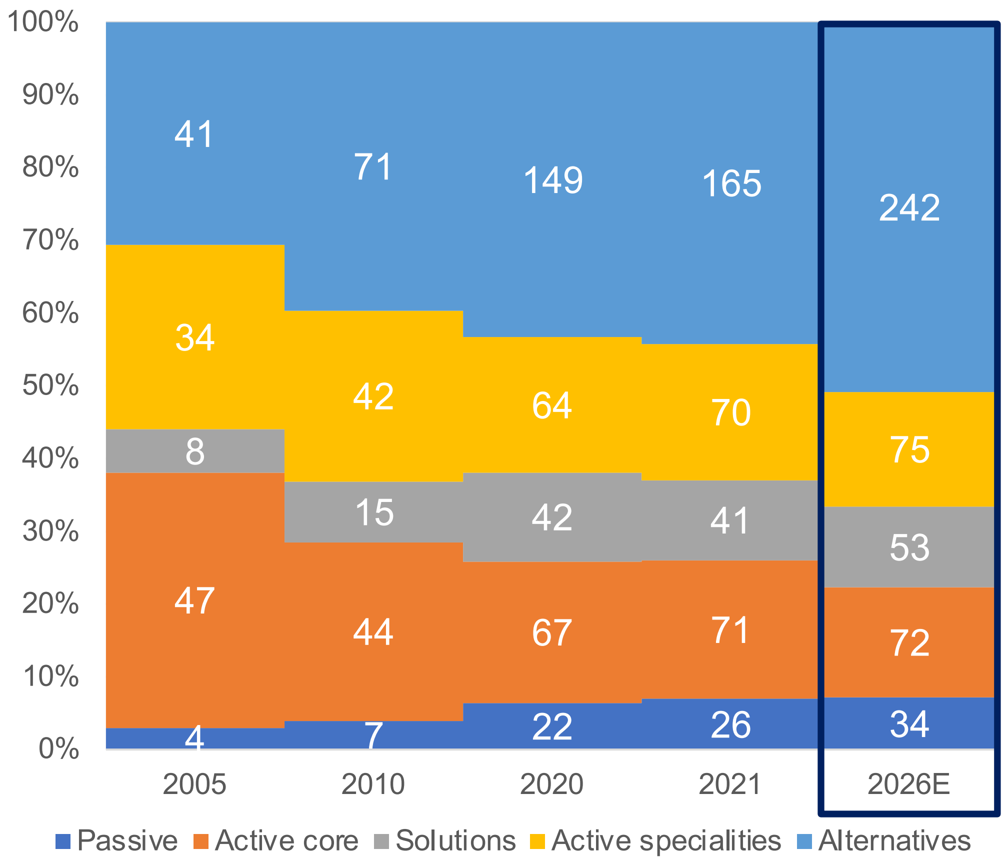
Target-date, target maturity, liability-driven, OCIO, multi-asset balanced, and multi-asset allocation

Actively managed domestic large-cap equity, domestic government and corporate debt, money market, and structured products

Data source: BCG, From Tailwinds to Turbulence, 2022

Development of the product landscape and forecast (revenues)

Global revenue split by product ($ billions)



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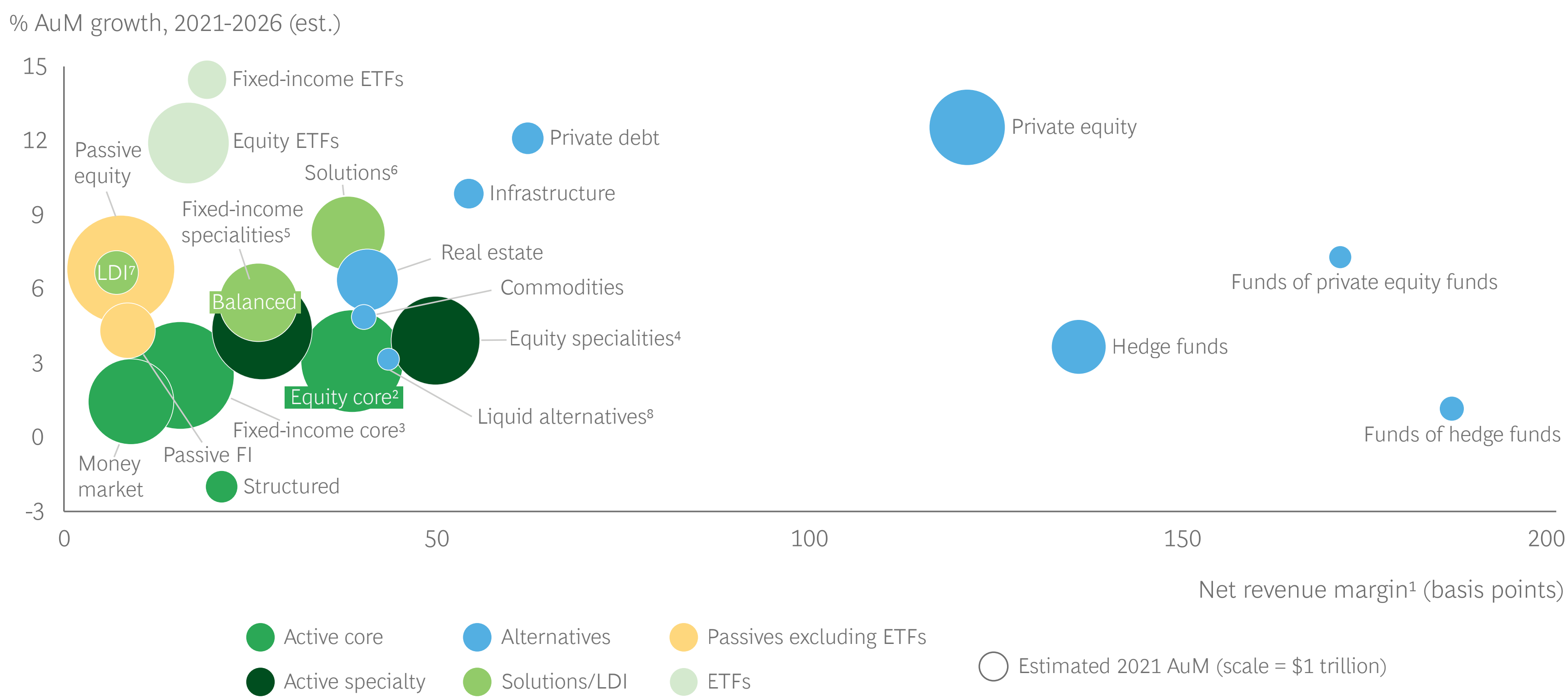
AuM growth forecasts for product categories



Source: BCG, From Tailwinds to Turbulence, 2022

Top 10 asset managers 2020

Rank	Company	Country	billion USD
1	BlackRock	United States	9.464
2	Vanguard Group	United States	8.400
3	UBS	Switzerland	4.432
4	Fidelity Investments	United States	4.230
5	State Street Global Advisors	United States	3.860
6	Morgan Stanley	United States	3.274
7	JPMorgan Chase	United States	2.996
8	Allianz	Germany	2.953
9	Capital Group	United States	2.600
10	Goldman Sachs	United States	2.372

For comparison: GDP Germany 2021 approx. 4.200 billion USD

Source: Wikipedia

The services of asset managers are geared to the needs of investors

Typical case: A life insurance company

- allocates 25 billion euros to international capital markets
- with 30% of the portfolio invested in equity markets, 50% in fixed income and 20% in alternative assets and strategies [→ **Strategic asset allocation**],
- has a preference for passive management in most developed equity markets and for active management in emerging equity markets [→ **Security selection**],
- has mandated specialized asset managers to pursue momentum and value strategies in the US equity market [→ **Investment strategy implementation**],
- complements the portfolio by investments in private equity and commodity strategies as alternative asset classes [→ **Diversification**],
- systematically adjusts the asset allocation in accordance with the changing market environment [→ **Tactical asset allocation**],
- prefers sustainable investments on principle [→ **Investment philosophy**].

It's all about collecting information and making investment decisions

- Strategic asset allocation → Aufteilung
- Security selection → Emerging vs developed
- Investment strategy implementation → value & momentum
- Diversification
- Tactical asset allocation → depending on market
- Investment philosophy → e.g. sustainable

Managing systematic and unsystematic risks in capital markets

Key questions

- Is it possible to beat the market at all?
- What are the most promising fields for collecting information?
- Which strategies work and which not?

Part 1: Introduction

Early models of financial market prices

Gerolamo Cardano (1565)

- Italian mathematician who wrote a textbook on gambling
- Notion of a fair game („martingale“)
- Idea: In a fair game, winnings or losses can’t be forecast by looking at past performance.

Louis Bachelier (1900)

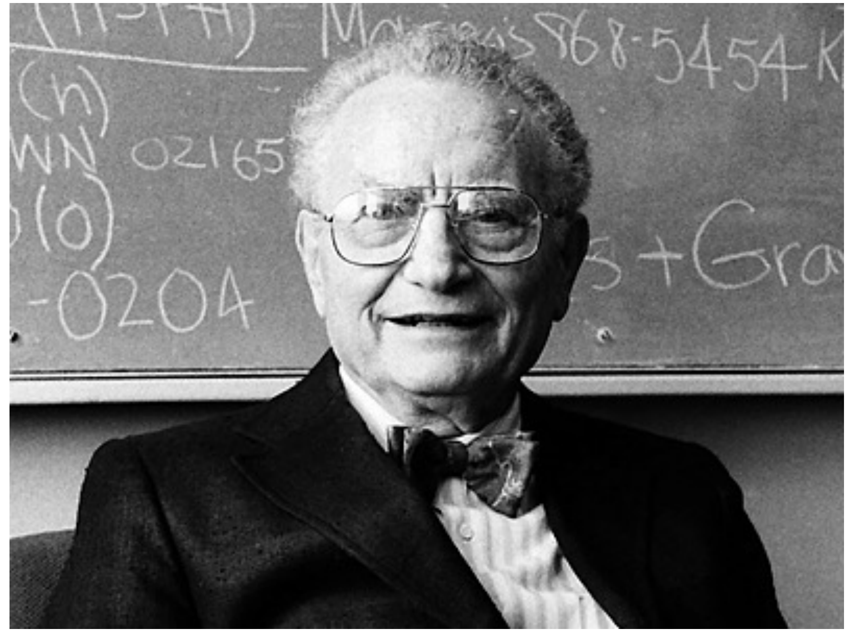
- French mathematics PhD student
- Doctoral thesis: Théorie de la Spéculation
- Idea: The random price movements in the market are martingales and therefore beating the market is mathematically impossible (”random walk model”).

Paul Samuelson (1965)

- American economist and Nobel Prize winner (1970)
- Idea: All the information of an asset’s past price changes are bundled in the asset’s present price. As a result, past price changes carry no information in predicting the asset’s next price.

Note: Comprehensive discussion in Lo (2017), Chapter 1

Cardano, Bachelier, and Samuelson



Strong-form = fully reflect public & priv. inf.
semi-strong-form
weak-form = fully reflect past information

Efficient Market Hypothesis (EMH)

↳ passive invest. vs. inefficient (aka active invest.)

> **"A market in which prices always fully reflect available information is called efficient"**
>
> Eugene F. Fama (1970)

Implications

- It is impossible to systematically outperform the market by deviating from the market portfolio
- Passive investing at minimal cost is the rational approach (e.g. investing in exchange traded funds)
- Active strategies are expected to underperform the market by trading costs and management fees

But!

Only through the countless efforts of active investors around the world trying to beat the markets by squeezing all imaginable sources of information, security prices become efficient in the first place.

Grossman/Stiglitz (1980)

Markets must entail an "equilibrium level of disequilibrium"

Levels of market efficiency

Strong-form efficiency

Security prices fully reflect all publicly available as well as inside information

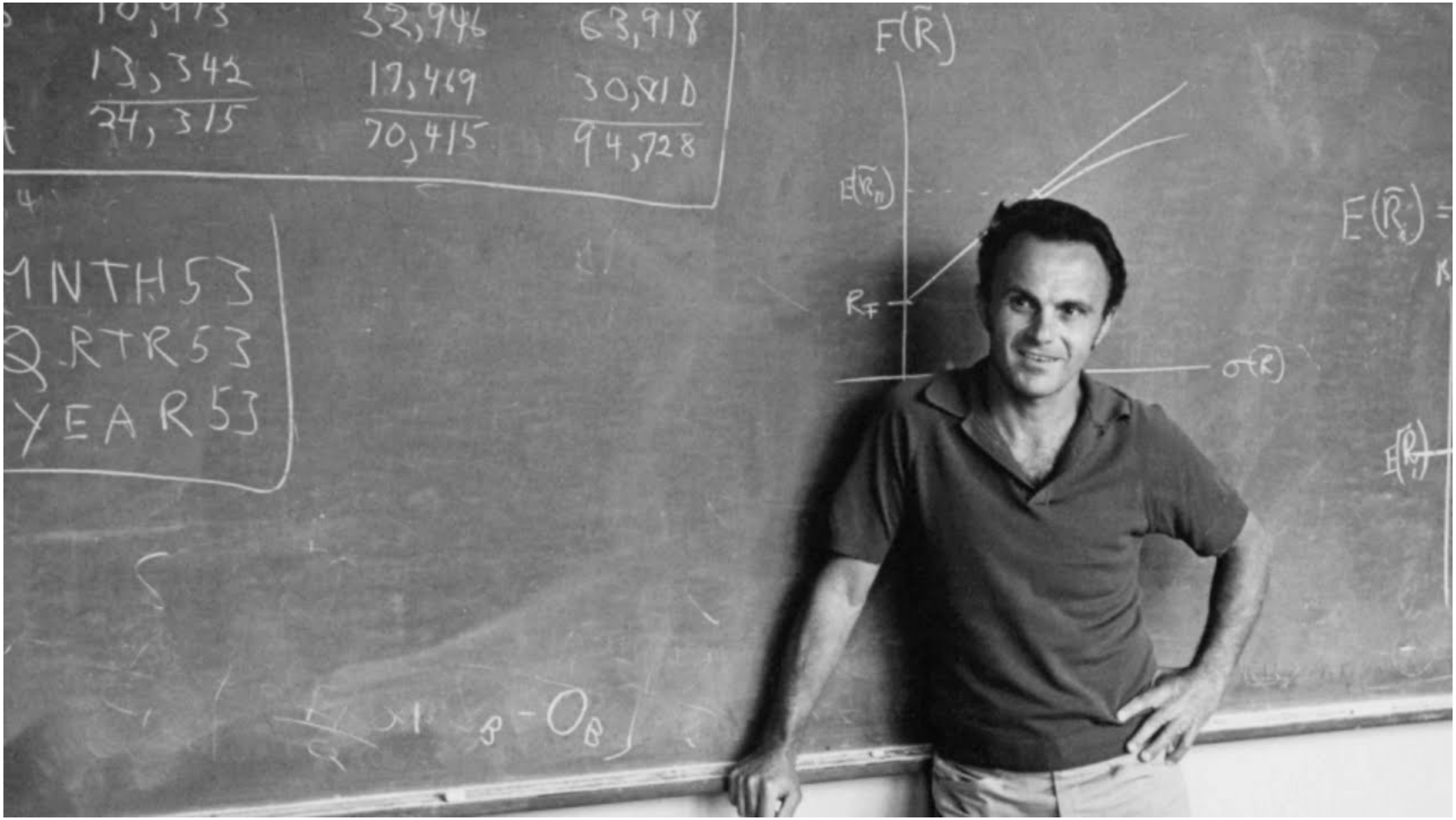
Semistrong-form efficiency

Security prices fully reflect all publicly available information

Weak-form efficiency

Security prices fully reflect all information in past prices

Eugene Fama



Testing market efficiency – two strands of research

Studies of asset prices

- Search for trading rules that generate positive risk-adjusted returns
  - Seasonal patterns in returns (day-of-the-week effect, January effect, …)
  - Forecasting returns by using past returns (correlation tests)
  - Firm characteristics and return (size effect, book-to-market effect, …)
  - Returns after announcements (event studies)
- Note: All tests of of market efficiency are joint tests of market efficiency and the model used for risk adjustment!

Studies of manager performance

- Exploring the ability of active asset managers to generate persistent positive risk-adjusted returns
  - Comparing active and random investment strategies
  - Comparing active and passive (index) investment strategies
- Note: The agency relationship between managers and clients plays a role!

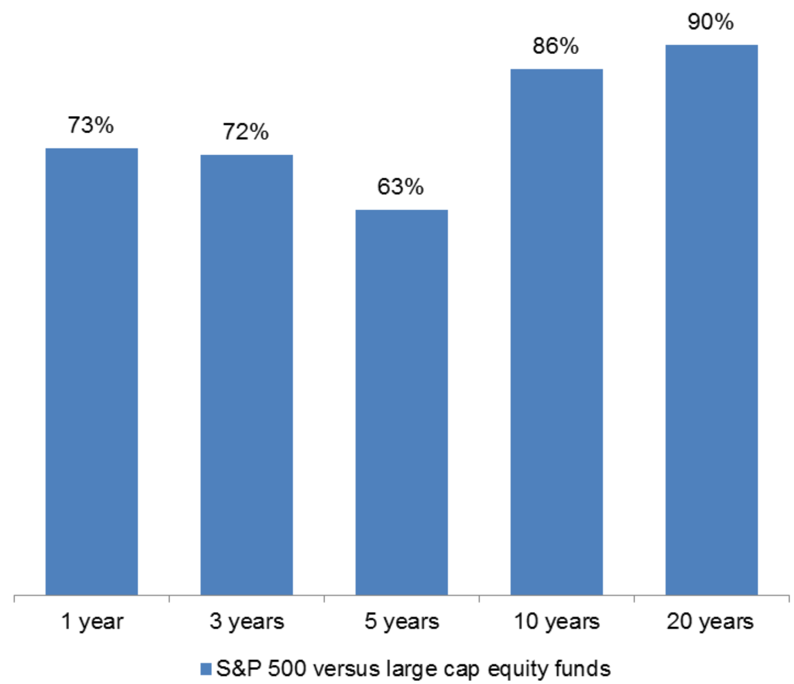
Studies of manager performance – an example

Return of the average equity fund vs. the S&P 500

	10 years to 12/31/03	20 years to 12/31/03
S&P 500 index	10,99%	12,78%
Average equity fund	8,47%	10,54%

Note: Data for all Lipper categories of equity mutual funds. The average (median) fund is compared with the Vanguard (S&P) 500 Index Fund.

Percent of large capitalization equity funds outperformed by index ending December 31, 2003



Source: Malkiel (2005)

Other views on market efficiency

Inefficient markets

Shiller (1981)

- Security prices significantly deviate from fundamentals
- Investors are irrational, make mistakes and are subject to behavioral biases that do not cancel out in aggregate
- Lots of potential for beating the market

Efficiently inefficient markets

Pedersen (2015)

- Markets are inefficient to an efficient extent
- Competition among professional investors makes markets almost efficient, but the markets remain so inefficient that they are compensated for their costs and risks
- It is possible to beat the market by implementing economically motivated investment styles

Robert Shiller

Nobel Prize in Economic Sciences in 2013, together with Lars Peter Hansen and Eugene Fama

Adaptive markets

1. We are **neither always rational nor irrational**, but we are biological entities whose features and behaviors are shaped by the forces of evolution.
2. We display **behavioral biases** and make apparently suboptimal decisions, but we can learn from past experience and revise our heuristics in response to negative feedback.
3. We have the capacity for abstract thinking, specifically forward-looking what-if analysis; predictions about the future based on past experience; and preparation for changes in our environment. This is **evolution at the speed of thought**, which is different from but related to biological evolution.
4. Financial market dynamics are driven by our interactions as we behave, learn, and adapt to each other, and to the social, cultural, political, economic, and natural environments in which we live.
5. **Survival** is the ultimate force driving competition, innovation, and adaptation.

Source: Lo (2017)

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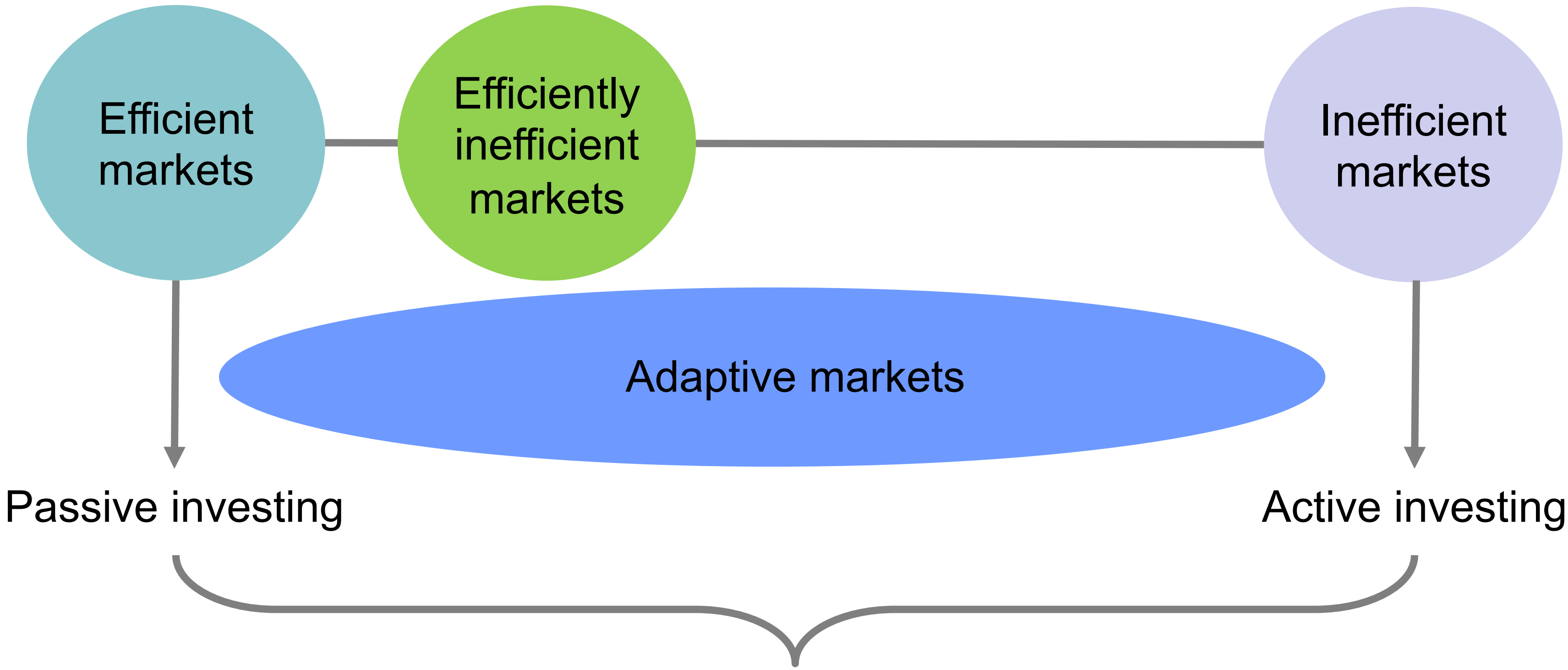
Market efficiency and investment strategies



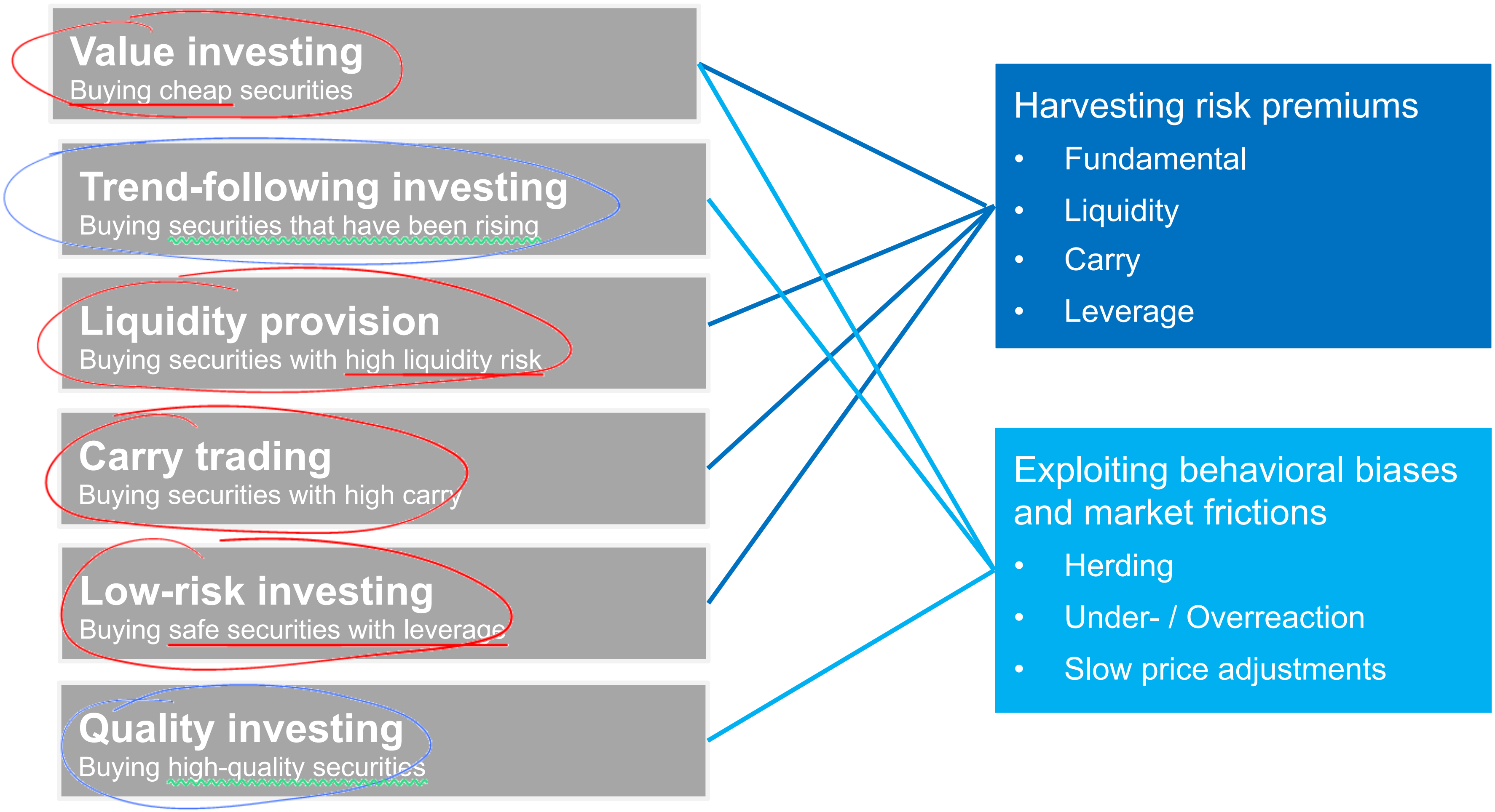
Active strategies in risk premiums and economically motivated investment styles

Fields for harvesting risk premiums

Asset class premiums	Style premiums	Strategy premiums
Equity	Value	Merger Arbitrage
Fixed income	Size	Convertible Arbitrage
Currencies	Momentum	Carry Trades
	Credit Spreads	Momentum
	High-Yield Spreads	Value
	TERM Spreads	

Source: Following Bender et al. (2010)

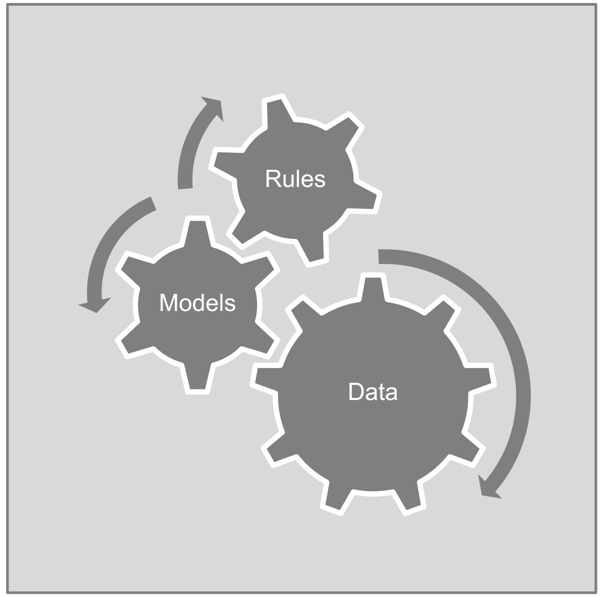
Economically motivated investment styles and their return drivers



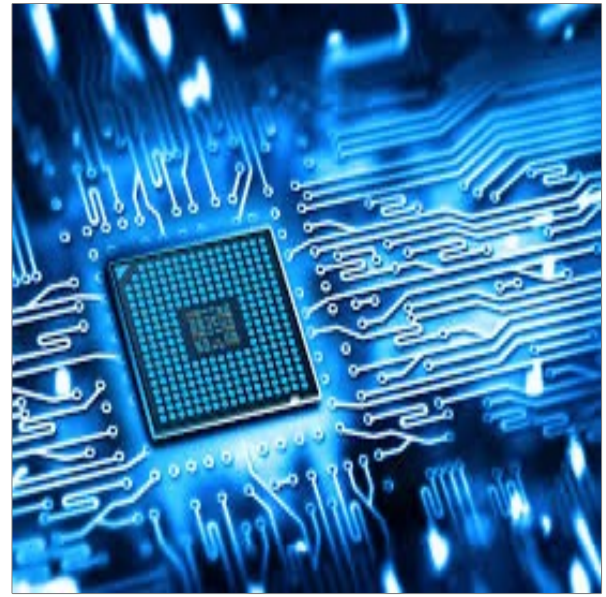
Source: Following Pedersen (2015)

Success factors for extraordinary returns on capital markets

Relevant experience as an investor combined with an outstanding expertise in the pricing of investments



Sound processes for investment decisions and disciplined implementation



Technology for extracting information from data and modelling complex dynamic interdependencies

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Playground of the lecture

Major fields in asset management

- Diversification
- Asset allocation
- Security selection
- Investment strategy implementation
- Risk management
- Trading and execution

Knowledge base

- **Stylized facts on global markets** — Empirical research
- **Sources of risk and return** — Models and empirical research
- **Asset pricing** — Theories, models and empirical tests
- **Portfolio construction** — Models and empirical tests
- **Financial economics** — Models and empirical research
- **Time series analysis** — Models and empirical procedures

Part 2: Risk and return on capital markets

You will learn

- How to calculate returns correctly
- How return variances and volatilities are calculated
- What returns could be achieved at what risks in international capital markets over very long periods of time
- How volatilities on and correlations between stock markets fluctuate and interact across different regimes
- How to calculate returns and risk measures from index time series

Part 3: International asset pricing theories

You will learn

- What challenges capital asset pricing involves in the context of international capital markets (in comparison to the domestic setting)
- How exchange rates, interest rates in different currencies and inflation rates in different countries are interrelated
- How international asset pricing models are designed and what conclusions can be drawn from them regarding risk premiums and portfolio choice
- What additional sources of risk play a role in international investment valuation

Part 4: Rational asset pricing and multifactor models

You will learn

- How economic variables and capital markets interact
- How arbitrage pricing works
- Under what conditions the classical arbitrage pricing theory can be used for international asset pricing
- How to design a multifactor model for international equity and bond markets
- What factors drive equity and bond markets
- How emerging markets differ from developed markets in terms of risk and return
- How to estimate factor sensitivities of equity markets

Part 5: Forecasting returns and conditional asset pricing

You will learn

- How economic expectations and stock returns are related
- How simple forecasting models with lagged variables are specified
- How to model risk premia time-varying in the context of asset pricing models
- How equity and bond pricing is economically related
- What market integration means

Part 6: Asset allocation

You will learn

- At which levels and in which dimensions asset allocation takes place
- How to measure the success of asset allocation decisions
- How US endowment funds invest
- How a strategic allocation process is structured
- How tactical allocation decisions affect the risk profile of a portfolio
- How asset allocation can be implemented “beyond Markowitz”

Part 7: Equity investments

You will learn

- What approaches there are to invest in equity
- How stocks are valued fundamentally
- How the CAPM has been successively extended by additional factors
- That the popular factor investing (or smart beta) strategies have cycles
- Which products are suitable for the private investor

Part 8: AI in asset management

You will learn

- Why machine learning (ML) is particularly challenging in capital markets
- How ML models differ from classical quant asset management approaches
- Where the scientific capital market research stands regarding AI
- How to develop an ML approach for stock selection
- How investment processes will possibly be transformed by AI

Part 9: Epilogue and excerises

You will find there

- A short summary of the fundamental approach of the lecture
- Exercises for exam preparation

Part 1: Selected references

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