

Empirics of the Oslo Stock Exchange. Basic, descriptive, results 1980-2016.

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We give some basic empirical characteristics of the Oslo Stock Exchange in the period after 1980. We give statistics for number of firms, the occurrences of IPO's, dividend payments, trading volume, and concentration. Returns for various market indices and portfolios are calculated and described. We also show the well known calendar anomalies, the link between number of stocks in a portfolio and its variance and industry characteristics of the OSE.

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Chapter 1

Introduction

This document is a source book for people doing empirical asset pricing using data from the Oslo Stock Exchange (OSE). The prime purpose of the paper is pedagogical, it is to be a useful resource for teaching finance in the Norwegian context. The same purpose is reflected in the lack of discussion of the results, the focus is on the numbers themselves, and students are meant to fill in the details. Having said that, the paper may still be useful for researchers since it summarizes in one place various properties of stock returns on the Norwegian stock exchange.

New versions

This paper will be updated with new data and additional analysis. The latest version will always be found at my homepage. I am open for suggestions to additional descriptive statistics you'd like to see, but I make no promises.

Data and data sources

The source data is daily observations of prices and volume of all stocks listed on the OSE, as well as dividends and adjustment factors necessary for calculating returns. In addition to price data accounting data for all stocks listed at the OSE is used. The data comes from two sources. All accounting and equity data are from OBI (Oslo BørsInformasjon), the data provider of the Oslo Stock Exchange. Interest rate data is from Norges Bank. The data starts in 1980. The stock price data ends in 2016.

Can you get the indices?

The data from the OSE used in constructing the various indices is governed by an agreement with the exchange that do not allow distribution of data. The raw data on indices and portfolio returns produced in this research is therefore only available to students and researchers at the Norwegian School of Management BI.

However, after agreement from the OSE, a number of constructed indices *are* made available from my homepage, such as Fama-French factors, portfolio returns for size-sorted indices, and so on.

The various chapters

Chapter 2 characterizes the evolution of the OSE in the period 1980 to 2016, by showing time series plots of market values, number of stocks listed, and trading activity. Chapter 3 looks at IPO's, and details the annual number of IPO's at the OSE. Chapter 4 has some numbers on dividends at the OSE. Chapter 5 has some numbers on repurchases at the OSE. Chapter 6 discusses filtering of the data for returns calculations, in particular for asset pricing purposes Chapter 7 shows return statistics for the whole market. Chapter 8

breaks the stocks listed into sectors, shows distribution of sectors, and sector returns. Chapter 9 looks at the importance of a few large stocks. Chapter 10 replicates the classical analysis of e.g. Wagner and Lau (1971) which looks at the link between the number of assets in a portfolio and the variance of the portfolio, illustrated with simulations on Norwegian data. Chapter 11 looks at the volatility of stocks at the OSE. Chapter 13 shows some calendar effects. Chapter 14 details the interest rate data.

1.1 Additional papers

In addition to this paper that gives basic characteristics of the exchange, there are three additional papers that look more detailed at various aspects of the exchange.

A paper with asset pricing results at the OSE looks at crosssectional portfolios at the OSE, and construct the factor portfolios of Fama and French (1992) and Carhart (1997) in the Norwegian context.

There is a paper that details liquidity at the OSE, providing time series of various liquidity measures.

Finally, there is a paper giving data on ownership at the OSE.

Chapter 2

Characterizing the OSE

In this chapter we look at some aggregate descriptive measures of the Oslo Stock Exchange

2.1 The evolution of market values

Let us start by looking at the aggregate value of all stock on the exchange. Figure 2.1 plots the time series evolution of the total market value of all stocks on the Oslo Stock Exchange.

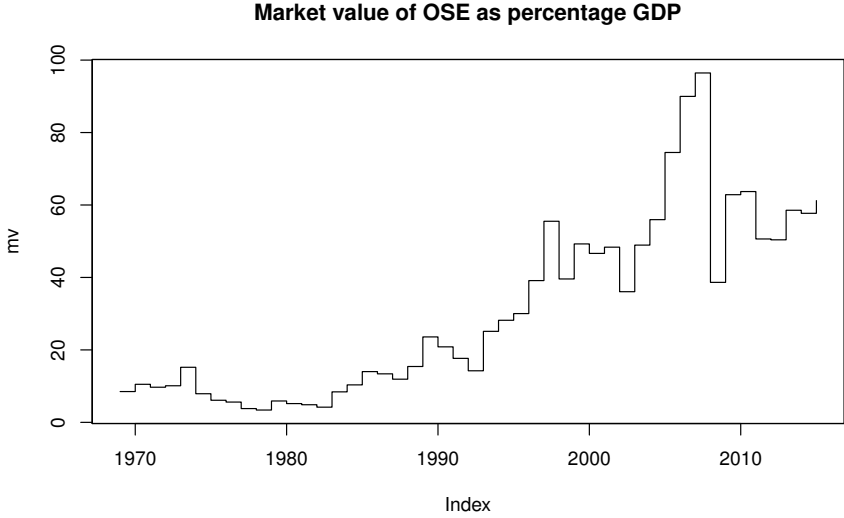
Figure 2.1 Monthly market values



The plot shows monthly observations of aggregated market values the OSE, in billion NOK. The values are in nominal (current) NOK.

To judge the importance of the stock market in the Norwegian economy figure 2.2 shows the total market value of all companies at the OSE as a fraction of the annual GDP (Gross Domestic Product) for Norway.

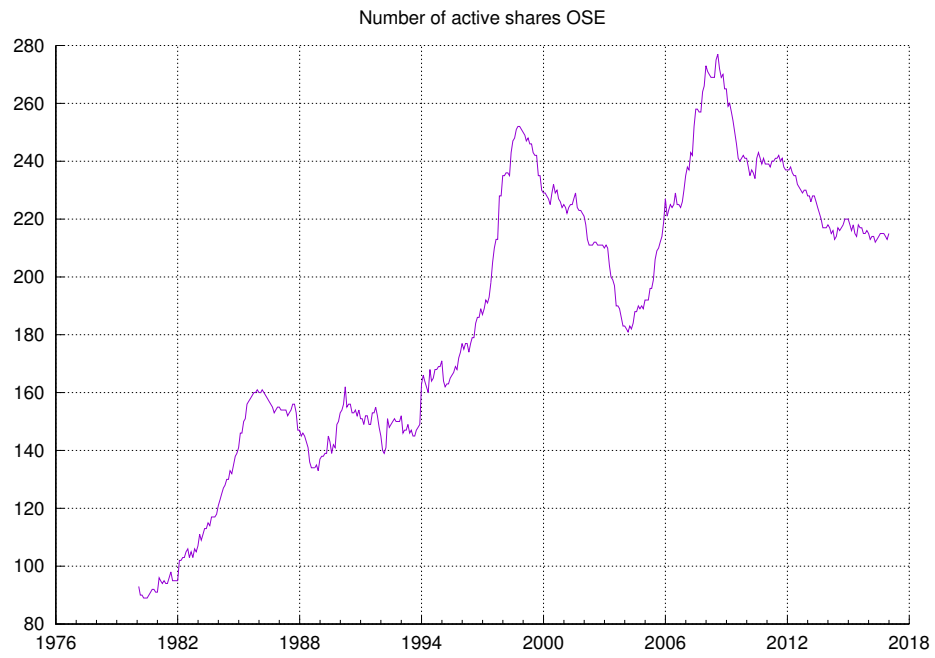
Figure 2.2 Market value OSE relative to annual GDP for Norway



The plot shows annual observations of market values at the OSE, using all stocks on the Exchange, as a percentage fraction of GDP for that year. The data on GDP are from Statistics Norway.

2.2 The number of stocks listed

Figure 2.3 Number of active shares at the OSE each month



2.3 The evolution of trading activity

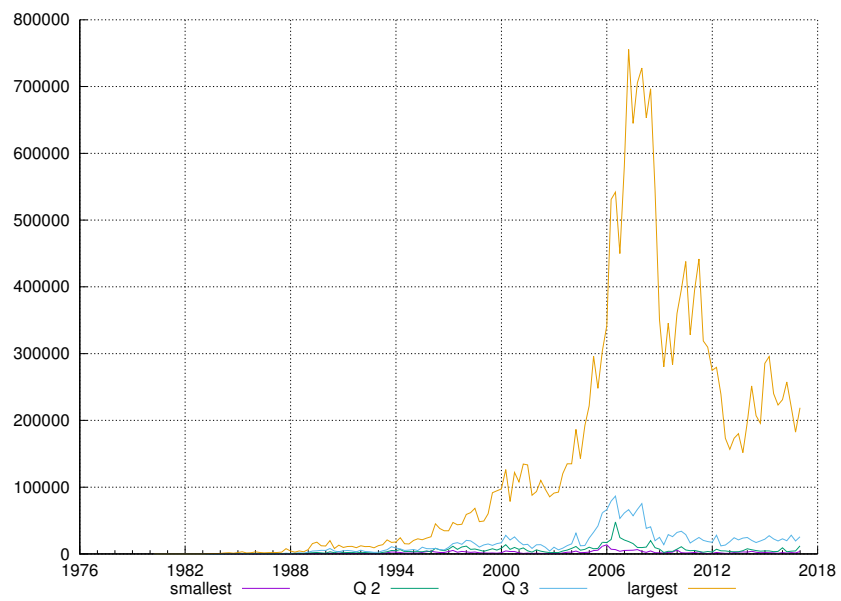
A simple measure of the activity at the OSE is the total trading volume in NOK.

Figure 2.4 Quarterly trading volume



The plot shows quarterly trading volume at the OSE, in bill NOK, using all stocks on the Exchange.

Figure 2.5 Quarterly trading volume split size portfolios



Trading volume at the OSE, in mill NOK. Stocks are sorted into four size based portfolios, and then we calculate the aggregate volume for the period.

Chapter 3

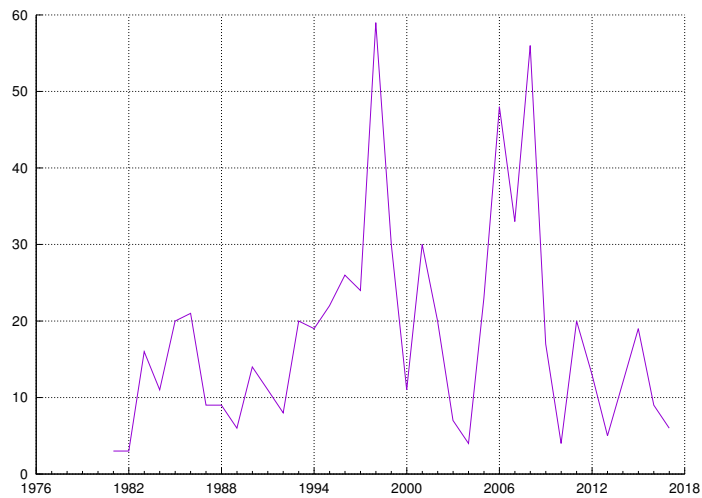
New listings

In this chapter we give some details on new listings at the OSE (Initial Public Offers – IPOs).

3.1 Numbers of new stocks starting to trade at OSE

Figure reffig:newlistings and table 3.1 shows how many firms are introduced at the OSE each year.

Figure 3.1 New listings per year



Each year we count the number of new equities in the OSE stock price data. Data for stocks listed at the Oslo Stock Exchange during the period 1980-2016.

Table 3.1 New listings per year

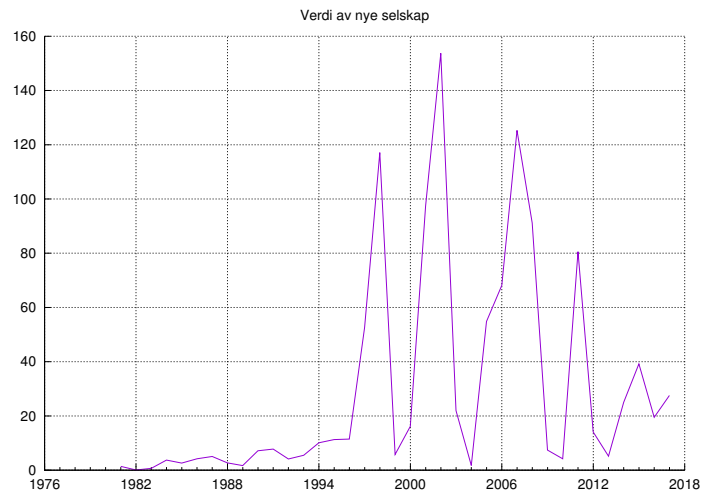
Year	Number of new listings
1980	3
1981	3
1982	16
1983	11
1984	20
1985	21
1986	9
1987	9
1988	6
1989	14
1990	11
1991	8
1992	20
1993	19
1994	22
1995	26
1996	24
1997	59
1998	30
1999	11
2000	30
2001	20
2002	7
2003	4
2004	23
2005	48
2006	33
2007	56
2008	17
2009	4
2010	20
2011	13
2012	5
2013	12
2014	19
2015	9
2016	6

Each year we count the number of new equities in the OSE stock price data. Data for stocks listed at the Oslo Stock Exchange during the period 1980-2016.

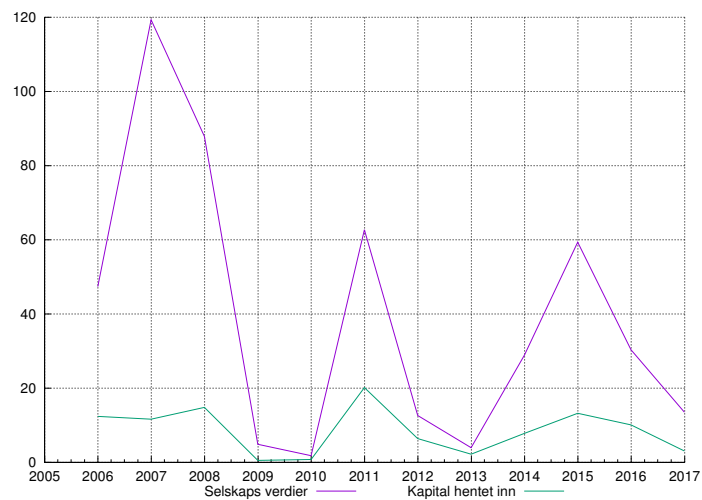
3.2 Aggregate values

Figure 3.2 IPO's aggregate values

Panel A: Total value of all new companies at yearend.



Panel B: Comparing total firm values and amounts raised at IPO date.



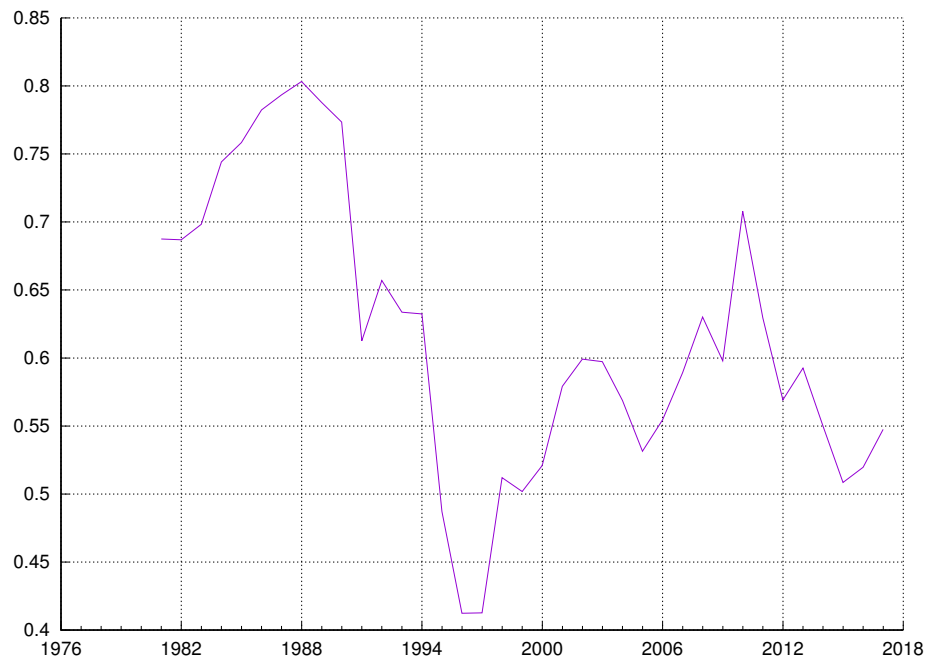
In the figure in panel A we sum the firm values at yearend for all stocks newly listed on OSE during the year. In the figure in panel B we show the same aggregate values, calculated at the IPO date, together with the aggregate amounts raised during the IPO (lower line). Data for stocks listed at the Oslo Stock Exchange during the period 1980-2016.

Chapter 4

Dividends

In this chapter we describe various aspects of dividend payments at OSE. First we look at the actual dividend amounts per security. Table 4.1 stratifies dividends amounts into four groups: no dividend payment, dividend up to NOK 5, dividend between NOK 5 and NOK 10, and dividend above NOK 10. The most striking feature of the table is the number of stocks which is not paying dividend at all, particularly in the early period. To further illustrate this particular point figure 4.1 shows the fraction of companies on the OSE which is not paying dividends. The figure clearly shows a regime change in dividend payments, where in 1985 close to 75% of the companies on the OSE did not pay dividends, which had fallen to less than 30% in 1995. This particular change is most likely a result of a tax change. In 1992 a new tax code was introduced. Under the new code dividends are much less tax disadvantaged. The huge increase in firms starting to pay dividends is most likely a result of this tax code change.

Figure 4.1 What fraction of securities do not pay dividends?



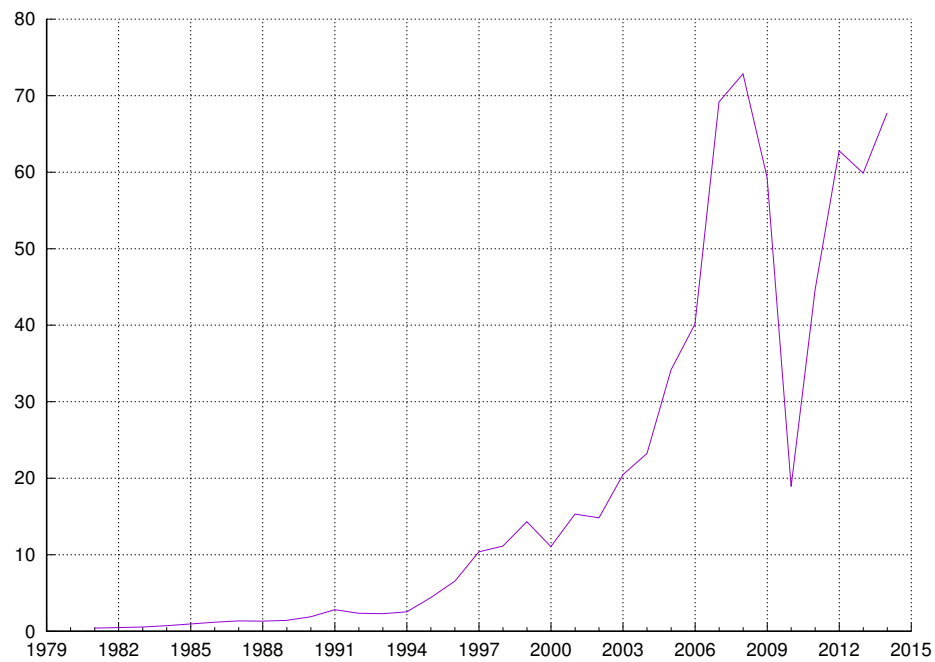
The plot shows what fraction of companies on the OSE does not pay dividend. For each year we count the number of firms listed on the exchange during the year, and the number of those paying dividends. We report what fraction the dividend payers are of the total. Data for stocks listed at the Oslo Stock Exchange during the period 1980-2016.

Table 4.1 How much are companies paying in dividends?

year	$d = 0$	$d \in (0, 5]$	$d \in (5, 10]$	$d > 10$
1980	66	2	7	21
1981	68	3	2	26
1982	81	3	0	32
1983	96	5	4	24
1984	113	16	2	18
1985	133	20	5	12
1986	146	23	8	7
1987	147	28	1	7
1988	130	25	3	7
1989	140	33	6	2
1990	117	59	10	5
1991	113	53	3	3
1992	109	57	4	2
1993	117	59	3	6
1994	95	76	19	5
1995	80	87	19	8
1996	85	88	17	16
1997	128	77	24	21
1998	135	89	19	26
1999	137	81	28	17
2000	150	66	13	30
2001	148	55	18	26
2002	135	51	20	20
2003	124	50	24	20
2004	110	54	20	23
2005	132	59	21	26
2006	152	61	21	24
2007	184	62	19	27
2008	171	69	23	23
2009	189	63	10	5
2010	163	70	19	7
2011	144	78	24	7
2012	144	77	16	6
2013	132	79	18	11
2014	120	81	22	13
2015	119	84	15	11
2016	121	68	23	9

The table illustrates the amount paid in dividends by companies on the OSE. For each stock we find the annual amount of dividend payment per stock. Each year we then calculate the number of stocks with dividends of zero, dividends between zero and five, dividends between five and ten, and dividends above 10. Data for stocks listed at the Oslo Stock Exchange during the period 1980-2016.

Figure 4.2 What are the aggregate dividend payments at the OSE?



The plot shows the total dividend payments (in billions NOK) for all firms at the OSE. For each year we find all firms listed on the exchange during the year, and add the aggregate dividend payment for each firm. Data for stocks listed at the Oslo Stock Exchange during the period 1980-2016.

Chapter 5

Repurchases

In this chapter we describe various aspects of repurchase activity at the OSE. Repurchases were legalized for Norwegian firms in 1999. The interesting period is therefore the time after 1999.

Let us first look at the aggregate repurchase activity in the period. The data from the OSE is a list of dates with number of shares bought by the firm from the stock market. The firm can also sell back the shares to the market, which is termed a *reverse repurchase*. In table 5.1 we aggregate this for all the OSE firms year by year, and calculate total amounts (first three columns) and number of firms (last five columns).

Table 5.1 Repurchase activity for Norwegian Listed Firms

Year	Aggregate Amounts (mill)			Number of firms				
	Reverse Repur.	Net Repur.	Repurch	Reverse Repur.	Total	Both	First Time	
1999	4472	-177	4296	51	15	51	15	51
2000	5319	-1902	3416	63	28	67	24	32
2001	6052	-2037	4014	74	41	83	32	28
2002	1638	-1175	464	62	39	75	26	11
2003	2210	-738	1472	51	46	67	30	5
2004	5496	-3199	2297	38	49	61	26	6
2005	5813	-2352	3461	61	57	81	37	20
2006	12000	-4439	7561	74	63	91	46	19
2007	8586	-2742	5844	78	62	94	46	18
2008	7210	-1642	5568	83	66	101	48	18
2009	1636	-1682	-46	44	50	69	25	6
2010	4223	-2121	2102	52	51	69	34	6
2011	6716	-2585	4130	61	50	72	39	9
2012	6131	-1813	4318	45	38	60	23	7
2013	4380	-2864	1516	49	39	59	29	5
2014	4229	-2051	2177	56	52	71	37	16
2015	4470	-2826	1644	53	48	69	32	12
2016	3333	-1585	1748	49	47	67	29	4

The table describes repurchase activity at the OSE. The first three columns shows total amounts bought back, the last five columns number of firms involved in repurchase activities.

Chapter 6

Filtering of data

The basic data for the empirical investigations in this paper are daily observations of all equities traded at the Oslo Stock exchange. The data contains end of day bid and offer prices, as well as the last trade price of the day, if there was any trading. The data also include the total trading volume at a given date.

Not all stocks traded at the Oslo Stock Exchange should necessarily be used in calculating representative returns for the exchange, for example for empirical asset pricing investigations. In particular stocks which are seldom traded are problematic. In the following, in most calculations we therefore require the stocks to have a minimum number (20) of trading days before they enter the sample. Low valued stocks (“penny stocks”) are also problematic since they will have very exaggerated returns. We therefore limit a stocks to have a price above NOK 10 before considering it in the sample. A similar requirement considers total value outstanding, which has a lower limit of NOK 1 million.¹ Table 6.1 provides some descriptive statistics for this filtering of the sample.

¹It should be noted that filtering such as this is very common for asset pricing investigations of this sort. See for example Fama and French (1992).

Table 6.1 Describing securities sample

year	number of securities listed	average number of trading days	Number of securities with		
			– more than 20 trading days	– and price above 10	– and company value above 1 mill
1980	96	48	33	33	33
1981	99	60	48	47	47
1982	116	60	60	58	58
1983	129	106	93	90	90
1984	149	127	122	121	121
1985	170	145	152	149	149
1986	184	135	157	146	146
1987	183	133	149	133	133
1988	165	118	128	113	113
1989	181	131	151	138	138
1990	191	127	163	149	149
1991	172	132	151	123	123
1992	172	111	131	101	101
1993	185	139	147	114	114
1994	195	139	164	143	143
1995	194	149	166	148	148
1996	206	161	189	170	169
1997	250	158	229	200	199
1998	269	146	248	190	190
1999	263	152	241	185	185
2000	259	157	239	183	183
2001	247	150	224	143	143
2002	226	147	210	119	119
2003	218	150	196	109	109
2004	207	180	200	132	132
2005	238	182	226	164	164
2006	258	181	249	193	193
2007	292	179	280	223	223
2008	286	178	275	144	144
2009	267	173	253	113	113
2010	259	188	251	138	138
2011	253	191	245	125	125
2012	243	187	239	119	119
2013	240	189	234	131	131
2014	236	195	231	138	138
2015	229	204	226	131	131
2016	221	217	220	130	130
average	209	149	187	135	135

The table provides some descriptive statistics for the sample of equities traded on the Oslo Stock Exchange in the period 1980 to 2016. The first column lists the year. The second column lists the number of stocks listed during the year. The third column the average number of trading days for all listed stocks. The fourth column lists the number of stocks which traded for more than 20 days. The fifth column adds the requirement that the stock did not have a price below NOK 10. The final column additionally requires an equity market value above 1 mill NOK.

Chapter 7

Market portfolios

The first issue we consider is the evolution of the whole market at the Oslo Stock Exchange.

7.1 Constructing market portfolios

A typical question is what what one would earn if one invested in stocks at the Oslo Stock Exchange. However, there are (at least two) different ways to answer that question. If one picks a random stock, one wants to find the expected return for the typical stock, in which case an equally weighted average is the relevant measure. Alternatively, one can invest in the *whole market*, in which case a value weighted average is most relevant. Two indices are constructed to make this measurement. Stocks not satisfying the filter criterion discussed in chapter 6 are removed. Using the remaining stocks equally weighted and value weighted indices are constructed. The indices are constructed to include dividends and other distributions from the stocks.¹

In addition to these indices two market indices constructed by the Oslo Stock Exchange are used. The OBX is a value weighted index consisting of the thirty most liquid stocks at the stock exchange. This index was constructed to be the basis for derivatives contracts, and initiated at the beginning of 1987. In addition we consider a value weighted index of all stock on the exchange, termed TOT. The Oslo Stock Exchange has changed indices during the period, in the period up to 1999 the total index was called the TOTX. In 1999 this index was replaced by the “All Share Index.” TOT is constructed by splicing these two indices. Note that neither of these indices include dividends.

Table 7.1 shows monthly average returns for the various indices for the whole period 1980 till 2016 and for various subperiods.

An alternative view of the difference between equally weighted and value weighted indices is shown in figure 7.1, which illustrates the growth of the two indices in the period from 1980, in nominal terms

Let us also look at this looks in real terms, after correcting for inflation. In figure 7.2 we compare nominal and real numbers.

¹The indices do however not account for repurchases.

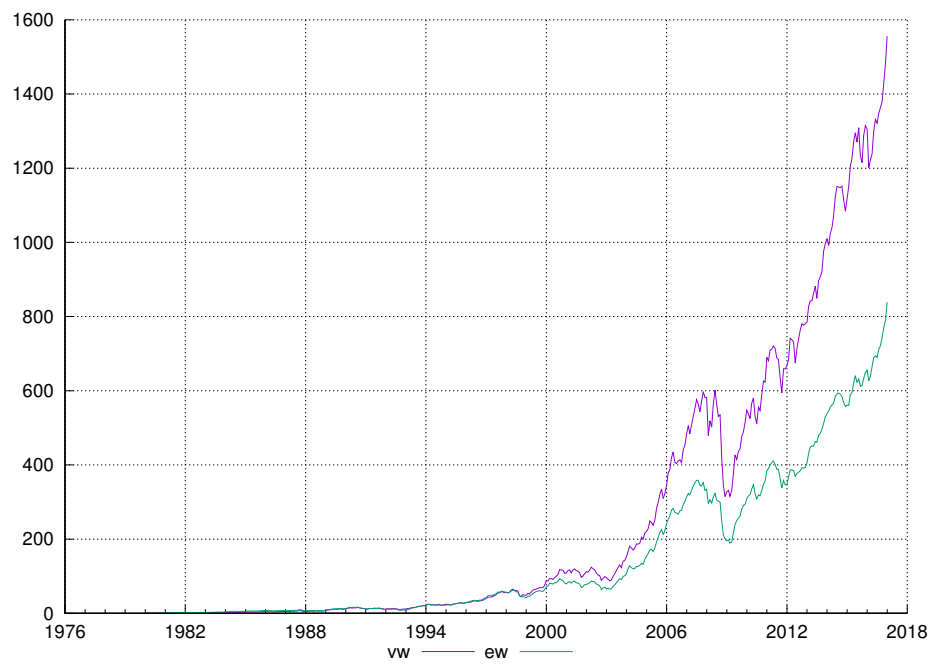
Table 7.1 Describing market indices at the Oslo Stock Exchange from 1980

Monthly returns

Period	index	Returns					Dividend Yield		Capital Gains	
		mean	(std)	min	med	max	mean	med	mean	med
1980–2016	EW	1.67	(5.43)	-18.33	1.88	19.06	0.22	0.07	1.47	1.55
	VW	1.86	(6.13)	-23.78	2.43	19.72	0.22	0.03	1.66	2.16
	OBX	0.94	(6.67)	-29.13	1.50	18.49				
	TOT	1.22	(6.23)	-27.42	1.81	17.45				
1980–1985	EW	3.03	(6.23)	-13.87	2.19	19.06	0.13	0.00	2.98	2.00
	VW	2.32	(7.00)	-18.62	2.88	19.72	0.21	0.00	2.21	2.51
	TOT	3.37	(6.24)	-13.52	3.26	15.91				
1985–1989	EW	1.60	(5.75)	-17.93	2.13	16.96	0.06	0.00	1.53	1.84
	VW	2.57	(6.85)	-23.78	3.33	19.34	0.13	0.00	2.44	3.29
	OBX	2.41	(8.57)	-29.13	3.82	18.49				
	TOT	1.61	(6.98)	-27.42	2.62	17.45				
1990–1994	EW	1.13	(6.79)	-16.51	0.47	15.04	0.14	0.00	0.99	0.37
	VW	1.38	(6.66)	-14.54	2.54	13.47	0.13	0.00	1.24	2.37
	OBX	0.24	(7.16)	-16.78	1.50	13.16				
	TOT	0.60	(6.79)	-16.77	2.00	12.69				
1995–1999	EW	2.07	(4.95)	-18.33	2.39	12.29	0.25	0.05	1.81	2.21
	VW	2.30	(5.49)	-20.55	2.39	16.71	0.19	0.02	2.11	2.14
	OBX	1.13	(5.78)	-23.61	1.49	16.65				
	TOT	1.42	(5.55)	-22.57	1.62	12.49				
2000–2004	EW	1.43	(5.36)	-14.37	2.12	11.58	0.32	0.11	1.13	1.67
	VW	1.73	(5.71)	-12.83	1.64	14.05	0.25	0.05	1.48	1.41
	OBX	0.45	(6.50)	-17.29	1.01	13.17				
	TOT	0.69	(5.79)	-14.64	1.39	11.29				
2005–2009	EW	1.32	(5.42)	-16.23	2.59	12.19	0.24	0.10	1.09	2.43
	VW	1.79	(7.07)	-21.54	3.90	14.39	0.23	0.05	1.56	3.37
	OBX	1.16	(7.88)	-25.35	2.97	17.23				
	TOT	1.18	(7.48)	-23.93	3.33	15.05				
2010–2016	EW	1.24	(2.99)	-7.09	1.36	7.99	0.33	0.15	0.90	1.05
	VW	1.33	(3.90)	-8.55	1.54	10.96	0.34	0.17	0.99	1.16
	OBX	0.87	(4.54)	-10.04	0.88	10.97				
	TOT	0.86	(4.29)	-8.84	0.97	13.15				

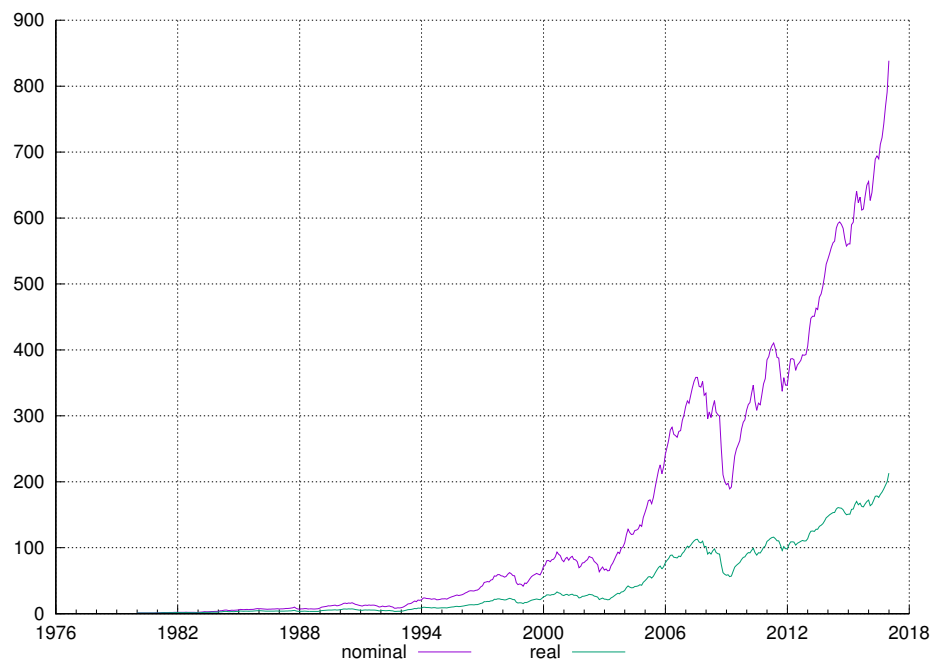
The table describes two indices constructed from Norwegian equity market data, one equally weighted and one value weighted, using data starting in 1980. The numbers are percentage monthly returns. mean: (equally weighted) average. med: median. *EW*: equally weighted index. *VW*: value weighted index. *TOT*: Total index provided by OSE: 1993-1999: TOTX, Afterwards: All Share Index. *OBX*: Index provided by OSE. Contains the 30 most liquid stocks at the OSE. Note that OBX starts in January 1987. Returns are percentage monthly returns. The returns are not annualized. Data for stocks listed at the Oslo Stock Exchange during the period 1980-2016. Calculations use the stocks satisfying the “filter” criteria discussed in chapter 6.

Figure 7.1 The evolution of market indices



The figures illustrates the growth of two OSE stock indices, one equally weighted and one value weighted, using data starting in 1980. Growth is shown by finding how much one NOK invested in January 1980 would have grown to. Data for stocks listed at the Oslo Stock Exchange during the period 1980-2016. Calculations use the stocks satisfying the “filter” criteria discussed in chapter 6.

Figure 7.2 The evolution of market indices correcting for inflation



The figures illustrates the growth of the equally weighted OSE stock indicex, using data starting in 1980. Growth is shown by finding how much one NOK invested in January 1980 would have grown to in respectively nominal and real terms (i.e. in 1980 values). Data for stocks listed at the Oslo Stock Exchange during the period 1980-2016. Calculations use the stocks satisfying the “filter” criteria discussed in chapter 6.

To see how “different” the indices are table 7.2 show the correlations of their returns.

Table 7.2 Correlations between alternative market indices

Panel A: Monthly returns

	ew	vw	tot
vw	0.88		
tot	0.91	0.98	
obx	0.88	0.97	0.98

Panel B: Weekly returns

	ew	vw	tot
vw	0.82		
tot	0.81	0.97	
obx	0.84	0.96	0.98

Panel C: Daily returns

	ew	vw	tot
vw	0.84		
tot	0.84	0.98	
obx	0.83	0.98	0.98

The tables shows correlations between index returns for various market indices at the Oslo Stock Exchange. *EW*: equally weighted index. *VW*: value weighted index. *TOT*: Total index provided by OSE: 1993-1999: TOTX, Afterwards: All Share Index. *OBX*: Index provided by OSE. Contains the 30 most liquid stocks at the OSE. Note that OBX starts in January 1987.

7.2 The equity premium

The equity premium is the return of a stock or a stock portfolio in excess of a risk free return

$$er_i = r_i - r_f$$

where r_i is the return on a stock or a stock index, and r_f a risk free rate. Whether the average return on equity is "too high" to be justified is a long standing issue in finance.² In this section some estimates of the equity premium are calculated .

Let us start by using monthly observations of stock index returns. Let r_{mt} be the market return observed at date t . This is an ex post return calculated as $r_{mt} = \frac{x_t - x_{t-1}}{x_{t-1}}$, where x_t is the index level at time t . If this is a monthly return, the relevant risk free interest rate is the one month interest rate observed at date $t - 1$, because this is the interest rate that can be guaranteed for the period $t - 1$ to t . The excess return is thus calculated as

$$er_t = r_{mt} - r_{f,t-1}$$

where $r_{f,t-1}$ is the one month interest rate observed at date $t - 1$. Table 7.3 shows estimates of this monthly excess market return.

²See the literature starting with Mehra and Prescott (1985). A survey is provided in Kocherlakota (1996).

Table 7.3 Excess returns of market indices at the Oslo Stock Exchange from 1982

Monthly excess returns

Period	index	Excess Returns					Excess Dividend Yield		Excess Capital Gains	
		mean	(std)	min	med	max	mean	med	mean	med
1980–2016	EW	1.09	(5.44)	-19.08	1.31	17.99	-0.37	-0.38	0.88	1.05
	VW	1.27	(6.14)	-24.93	1.84	18.61	-0.37	-0.39	1.07	1.51
	OBX	0.45	(6.68)	-30.28	1.00	17.47				
	TOT	0.65	(6.24)	-28.57	1.27	16.42				
1980–1985	EW	2.00	(6.23)	-14.94	1.19	17.99	-0.89	-1.01	1.96	0.91
	VW	1.30	(6.99)	-19.45	1.83	18.61	-0.82	-1.03	1.19	1.42
	TOT	2.29	(6.23)	-14.56	2.17	14.81				
1985–1989	EW	0.48	(5.77)	-19.08	0.86	15.95	-1.05	-1.06	0.42	0.74
	VW	1.46	(6.86)	-24.93	2.16	18.32	-0.98	-1.06	1.33	2.18
	OBX	1.31	(8.57)	-30.28	2.75	17.47				
	TOT	0.51	(6.98)	-28.57	1.57	16.42				
1990–1994	EW	0.32	(6.79)	-17.37	-0.00	14.28	-0.68	-0.67	0.18	-0.10
	VW	0.57	(6.65)	-15.41	1.83	12.93	-0.68	-0.83	0.43	1.77
	OBX	-0.61	(7.15)	-17.65	0.43	12.58				
	TOT	-0.25	(6.77)	-17.64	1.01	12.12				
1995–1999	EW	1.63	(4.95)	-18.78	1.90	11.97	-0.19	-0.32	1.37	1.76
	VW	1.86	(5.49)	-21.00	1.95	16.21	-0.25	-0.38	1.66	1.69
	OBX	0.69	(5.79)	-24.06	1.08	15.98				
	TOT	0.98	(5.55)	-23.02	1.23	11.81				
2000–2004	EW	0.98	(5.41)	-14.96	1.58	11.37	-0.13	-0.15	0.68	1.21
	VW	1.27	(5.76)	-13.43	1.30	13.81	-0.20	-0.36	1.02	1.09
	OBX	-0.01	(6.55)	-17.89	0.66	12.93				
	TOT	0.24	(5.85)	-15.24	0.93	11.05				
2005–2009	EW	1.02	(5.50)	-16.75	2.33	11.95	-0.06	-0.14	0.79	2.13
	VW	1.48	(7.13)	-22.05	3.58	14.18	-0.07	-0.18	1.26	3.13
	OBX	0.85	(7.94)	-25.86	2.64	17.02				
	TOT	0.88	(7.55)	-24.44	3.05	14.84				
2010–2016	EW	1.09	(3.00)	-7.27	1.24	7.79	0.18	0.02	0.76	0.94
	VW	1.18	(3.90)	-8.73	1.40	10.73	0.19	0.01	0.84	1.05
	OBX	0.72	(4.54)	-10.22	0.75	10.83				
	TOT	0.71	(4.29)	-9.02	0.88	13.01				
1980–1989	EW	1.29	(6.15)	-19.08	0.96	17.99	-0.96	-1.03	1.23	0.83
	VW	1.30	(7.02)	-24.93	1.89	18.61	-0.89	-1.03	1.18	1.93
	OBX	1.31	(8.57)	-30.28	2.75	17.47				
	TOT	1.15	(6.95)	-28.57	1.73	16.42				
1990–1999	EW	0.97	(5.97)	-18.78	1.49	14.28	-0.43	-0.46	0.77	1.38
	VW	1.21	(6.13)	-21.00	1.85	16.21	-0.46	-0.46	1.05	1.74
	OBX	0.04	(6.54)	-24.06	0.99	15.98				
	TOT	0.37	(6.22)	-23.02	1.20	12.12				
2000–2009	EW	1.00	(5.46)	-16.75	1.79	11.95	-0.10	-0.15	0.73	1.45
	VW	1.38	(6.49)	-22.05	2.35	14.18	-0.14	-0.21	1.14	2.26
	OBX	0.42	(7.29)	-25.86	1.15	17.02				
	TOT	0.56	(6.76)	-24.44	1.58	14.84				
2010–2016	EW	1.09	(3.00)	-7.27	1.24	7.79	0.18	0.02	0.76	0.94
	VW	1.18	(3.90)	-8.73	1.40	10.73	0.19	0.01	0.84	1.05
	OBX	0.72	(4.54)	-10.22	0.75	10.83				
	TOT	0.71	(4.29)	-9.02	0.88	13.01				

The table describes market indices for the Oslo Stock Exchange using data starting in 1982. (The risk free rate is only available from 1982.) The numbers are percentage monthly excess returns, returns in excess of the risk free rate. *EW*: equally weighted index. *VW*: value weighted index. *OBX*: Index provided by OSE. Contains the 30 most liquid stocks at the OSE. Note that *OBX* starts in January 1987. *TOT*: Total index provided by OSE: 1993-1999: *TOTX*, Afterwards: All Share Index. Returns are percentage monthly returns. The returns are not annualized. Data for stocks listed at the Oslo Stock Exchange during the period 1980-2016. Calculations use the stocks satisfying the “filter” criteria discussed in chapter 6.

However, it is not clear that one wants to use this high frequency data to estimate the longer term equity premium. One problem is that the monthly risk free rate is rather volatile.³

An alternative is to use annual index returns and annual interest rates. Table 7.4 gives estimates of annual excess returns using a one year interest rate.

Table 7.4 Annual excess returns

Annual excess returns

Index	Period	Average Annual Excess Return
EW	(1980–2016)	18.38
VW	(1980–2016)	21.49
OBX	(1987–2016)	6.26
TOT	(1983–2016)	9.82

EW: equally weighted index. *VW*: value weighted index. *OBX*: Index provided by OSE. Contains the 30 most liquid stocks at the OSE. Note that *OBX* starts in January 1987. *TOT*: Total index provided by OSE: 1993-1999: *TOTX*, Afterwards: All Share Index. Note that the risk free rate series starts in 1982.

³See chapter 14 for some data on interest rates.

7.3 Sharpe Ratios for market indices

The Sharpe ratio is a relative measure of how much return one gets per unit of risk, where risk is measured by the standard deviation. The Sharpe ratio is defined as

$$SR_i = \frac{E[r_i] - r_f}{\sigma(r_i - r_f)}$$

The Sharpe Ratios in table 7.5 are estimated by replacing $E[r_i - r_f]$ and $\sigma(r_i - r_f)$ by their sample averages.

Table 7.5 Sharpe ratios market indices at the Oslo Stock Exchange from 1980

Monthly returns

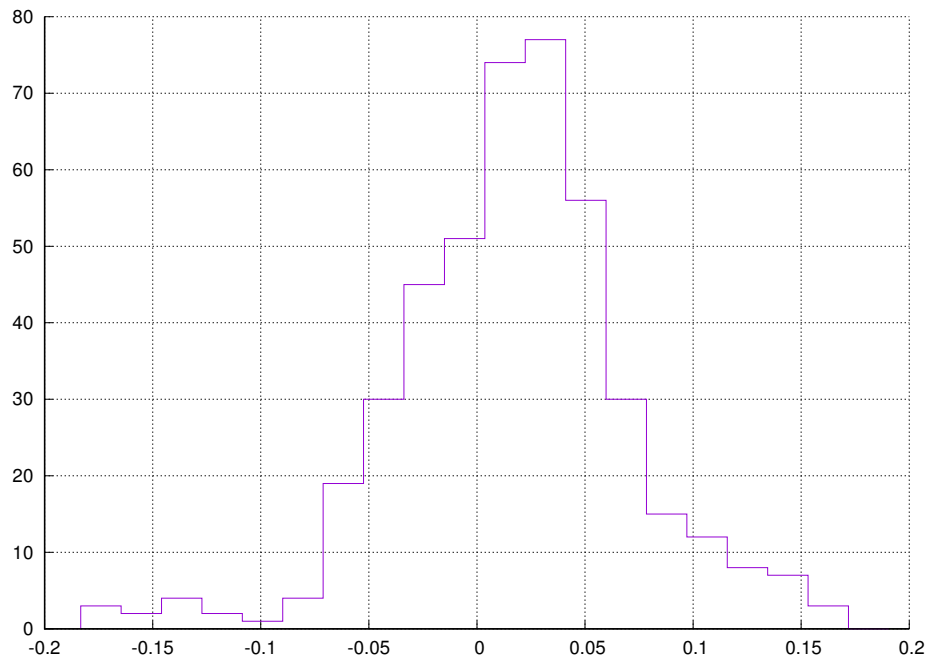
	EW	VW
1980–2016	0.20	0.21
1980–1989	0.21	0.18
1990–1999	0.16	0.20
2000–2016	0.23	0.23
1980–1984	0.33	0.16
1985–1989	0.08	0.21
1990–1994	0.05	0.08
1995–1999	0.33	0.34
2000–2004	0.18	0.22
2005–2009	0.19	0.21
2010–2016	0.37	0.30

The table shows ex post Sharpe ratios for market indices constructed from Norwegian equity market data. Note that the Sharpe ratios are not annualized. *EW*: equally weighted index. *VW*: value weighted index. *OBX*: Index provided by OSE. Contains the 30 most liquid stocks at the OSE. Note that *OBX* starts in January 1987. *TOT*: Total index provided by OSE: 1993-1999: *TOTX*, Afterwards: All Share Index. Returns are percentage monthly returns. The returns are not annualized. Data for stocks listed at the Oslo Stock Exchange during the period 1980-2016. Calculations use the stocks satisfying the “filter” criteria discussed in chapter 6.

7.4 Distribution of market returns

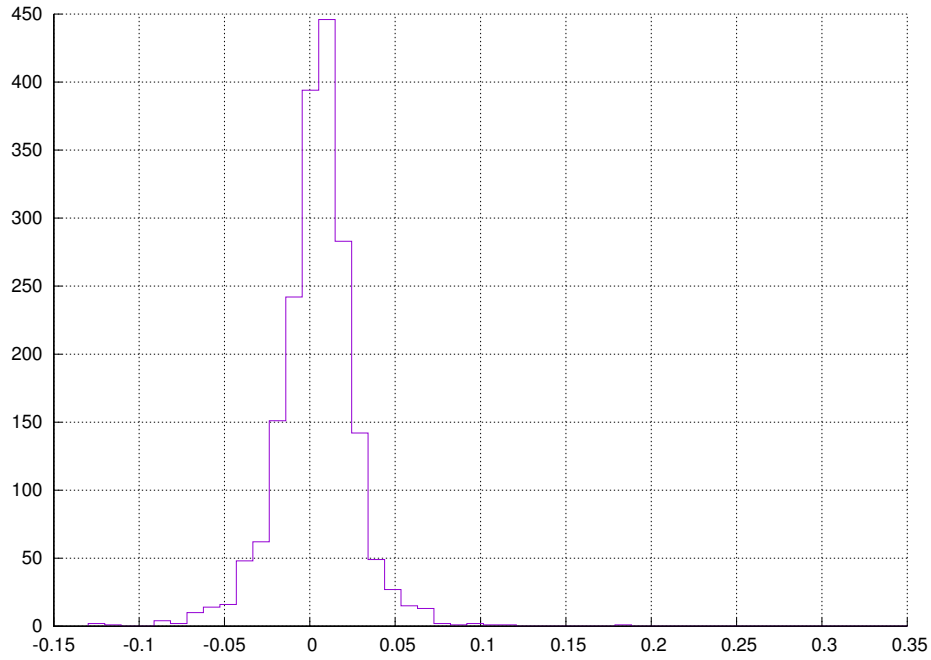
The statistical descriptions of the previous chapters does not give a complete picture of the distributional properties of the market returns. One way to show more detail is to plot the actual distributions. Figures 7.3, 7.4 and 7.5 shows histograms of respectively monthly, weekly and daily returns for the EW index.

Figure 7.3 Histogram of monthly stock returns



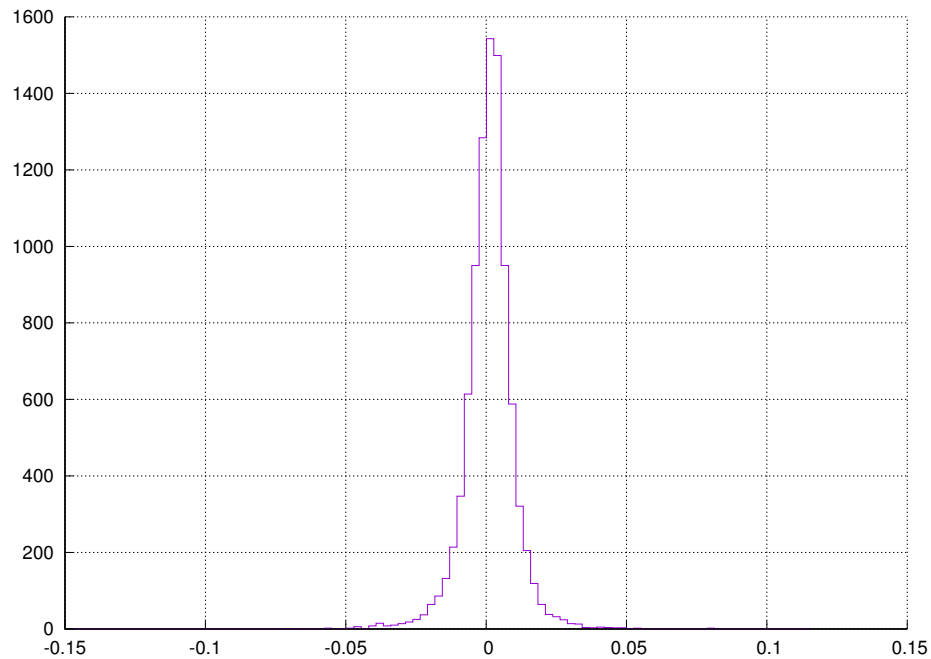
The figure shows the distribution of monthly stock return for the EW index. *EW*: equally weighted index. Data for stocks listed at the Oslo Stock Exchange during the period 1980-2016. Calculations use the stocks satisfying the “filter” criteria discussed in chapter 6.

Figure 7.4 Histogram of weekly stock returns



The figure shows the distribution of weekly stock return for the EW index. *EW*: equally weighted index. Data for stocks listed at the Oslo Stock Exchange during the period 1980-2016. Calculations use the stocks satisfying the “filter” criteria discussed in chapter 6.

Figure 7.5 Histogram of daily stock returns



The figure shows the distribution of daily stock return for the EW index. *EW*: equally weighted index. Data for stocks listed at the Oslo Stock Exchange during the period 1980-2016. Calculations use the stocks satisfying the “filter” criteria discussed in chapter 6.

7.5 Some alternative portfolios

In addition to the broad market indices *EW* and *VW* a couple of alternative indices are constructed. If we want to make an investment in the market, but worry about transaction costs, one solution is to invest in a lower number of stocks. To look at how representative such portfolios are we construct indices using the 20 largest stocks at the OSE. Two such portfolios are calculated, *20EW* and *20VW*. For both indices we choose the 20 largest stocks at the beginning of the year. These stocks are then used to create portfolios for the next year, either equally weighted or value weighted. At each yearend the sample of stocks is changed to be the 20 largest stocks at that time.

Table 7.6 Some special indices at the Oslo Stock Exchange from 1980

Average returns

Period	index	Returns				
		mean	(std)	min	med	max
1980–2016	20EW	1.00	(6.82)	-29.82	1.54	17.81
	20VW	1.55	(6.44)	-28.07	1.90	21.78
1980–1985	20EW	1.99	(6.15)	-14.41	1.49	17.81
	20VW	1.77	(7.33)	-19.23	1.90	21.78
1985–1989	20EW	1.46	(7.34)	-28.71	2.40	17.03
	20VW	2.36	(7.58)	-28.07	2.89	17.92
1990–1994	20EW	0.43	(7.29)	-18.83	1.50	12.59
	20VW	1.18	(6.65)	-14.67	2.45	12.69
1995–1999	20EW	1.48	(5.71)	-24.98	1.42	14.50
	20VW	1.78	(5.55)	-23.11	1.80	14.57
2000–2004	20EW	0.41	(7.69)	-24.37	1.26	16.44
	20VW	1.54	(5.93)	-16.43	1.67	14.78
2005–2009	20EW	0.97	(8.22)	-29.82	2.81	14.31
	20VW	1.54	(7.55)	-22.90	3.89	14.75
2010–2016	20EW	0.52	(5.07)	-13.46	0.37	12.33
	20VW	1.10	(4.18)	-9.04	1.22	11.32

Correlations with other indices

	20ew	20vw
20vw	0.92	
ew	0.88	0.81
vw	0.93	0.98
tot	0.95	0.96
obx	0.96	0.97

The table describes indices for the Oslo Stock Exchange using data starting in 1980. The numbers are percentage monthly returns.

Chapter 8

Industry sectors (GICS)

8.1 The GICS standard

The *Global Industry Classification Standard* (GICS) is a grouping of companies into industry sectors. The GICS standard was introduced by Morgan Stanley Capital International (MSCI). It has since been adopted by many stock exchanges throughout the world. The Oslo Stock Exchange groups the companies on the exchange using the industry categories of the standard. The standard groups companies into one of the 10 groups listed in table 8.1.

Table 8.1 The GICS standard

	English	Norwegian
10	Energy and consumption	Energi
15	Material/labor	Materialer
20	Industrials	Industri
25	Consumer Discretionary	Forbruksvarer
30	Consumer Staples	Konsumentvarer
35	Health Care/liability	Helsevern
40	Financials	Finans
45	Information Technology	Informasjonsteknologi (IT)
50	Telecommunication Services	Telekommunikasjon og tjenester
55	Utilities	Forsyningsselskaper

In the fall of 2016 the GICS standard was amended by adding a sector 60, Real Estate. Some of the industries on the OSE was reclassified into this sector. In the following tables we do not include this reclassification. It will be added for the 2017 data.

8.2 Grouping firms on the Oslo Stock Exchange

The Oslo Stock Exchange has since 1997 been using the GICS standard to group the firms on the exchange. We use the OSE classification. For firms delisted before 1997 the OSE does not provide a classification. The classification for the missing firms have been backfilled manually for the period 1980–1997. To see how the firms on the OSE distributes by category table 8.3 shows, for each year, the number of active firms in each of the 10 categories. The companies are clearly concentrated into a few sectors. For the early part of the period, the two sectors with most companies are 20, Industrials, and 40, Financials. This pattern changes in the last 15 years, with 10, Energy (which includes oil related companies), and 45, IT, showing a marked increase. For some sectors, there is a paucity of companies on the OSE. Both categories Health Care (35)

and Utilites (55) are in fact empty till the mid nineties. The OSE is concentrated in only a few of the 10 GICS categories.

Table 8.2 The distribution across industries

Panel A: Number of Companies

Industry	Whole				
	Period	1980-89	1990-99	2000-09	2010-
10 Energy	30.7	14.7	25.5	52.0	67.6
15 Material	10.8	11.4	10.5	10.5	10.1
20 Industry	50.3	42.9	58.9	49.0	44.1
25 ConsDisc	16.7	13.0	19.2	17.8	11.0
30 ConsStapl	8.6	9.1	4.4	12.4	15.1
35 Health	5.5	1.7	3.3	11.4	16.4
40 Finan	37.7	33.3	36.6	43.2	42.7
45 IT	23.5	8.3	18.9	43.2	26.7
50 Telecom	1.0	0.5	0.5	1.9	2.6
55 Util	0.7	0.0	0.4	1.7	3.0

Panel B: Fraction of value

Industry	Whole				
	Period	1980-89	1990-99	2000-09	2010-
10 Energy	24.0	9.9	19.2	43.0	39.9
15 Material	6.4	10.3	6.0	2.8	0.7
20 Industry	29.7	40.0	35.4	13.6	12.5
25 ConsDisc	5.8	4.0	7.2	6.1	8.9
30 ConsStapl	7.4	6.9	8.8	6.5	8.1
35 Health	5.4	4.0	7.8	4.3	1.1
40 Finan	16.3	21.3	15.6	12.1	16.6
45 IT	5.4	6.5	3.8	6.0	2.9
50 Telecom	3.4	0.0	0.8	9.4	11.2
55 Util	0.5	0.0	0.4	1.1	1.0

In the table we first calculate numbers for each year, and then report averages across years. The top table counts the number of firms on the exchange. The second the fraction of the value of the exchange (at yearend) in each sector.

8.3 Sector indices

The company distribution listed in table 8.3 is the basis for construction of sector indices for the OSE. Using the standard liquidity criteria discussed in chapter 6. Table 8.5 describes average monthly returns for the 10 indices. In table 8.6 the correlations between the same 10 indices are calculated.

8.4 References

The GICS standard is described in the Wikipedia (en.wikipedia.org), as well as at the homepages of Morgan Stanley (www.msci.com) and Standard and Poors (www.standardandpoors.com).

Table 8.3 The number of companies in the different GICS Industry Sectors

Panel A: Subperiod 1980–1989

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
Energy and consumption	9	9	12	12	14	17	18	20	19	17
Material/labor	10	11	12	11	12	12	12	12	11	11
Industrials	29	29	34	39	45	52	55	51	49	46
Consumer Discretionary	6	7	12	13	15	18	18	16	14	11
Consumer Staples	9	9	9	9	10	11	11	9	7	7
Health Care/liability	1	1	1	2	2	2	2	2	2	2
Financials	27	28	29	30	36	37	39	39	32	36
Information Technology	2	2	3	6	7	13	13	13	12	12
Telecommunication Services	0	0	0	0	0	0	1	2	2	0
Utilities	0	0	0	0	0	0	0	0	0	0
All	93	96	112	122	141	162	169	164	148	142

Panel B: Subperiod 1990–1999

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Energy and consumption	21	22	21	20	20	21	25	38	35	32
Material/labor	9	9	9	9	10	11	12	13	12	11
Industrials	50	45	46	54	59	61	58	69	75	72
Consumer Discretionary	10	9	14	17	18	21	22	25	28	28
Consumer Staples	7	5	3	4	3	2	3	5	6	6
Health Care/liability	2	2	2	2	3	3	3	5	5	6
Financials	36	30	30	29	32	39	39	39	45	47
Information Technology	11	10	10	10	11	14	21	29	34	39
Telecommunication Services	0	0	0	0	0	0	1	1	1	2
Utilities	0	0	0	0	0	0	1	1	1	1
All	146	132	135	145	156	172	185	225	242	244

Panel C: Subperiod 2000–2009

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Energy and consumption	33	35	35	36	34	52	61	84	79	71
Material/labor	13	9	9	8	9	9	10	14	12	12
Industrials	60	58	49	42	41	43	45	50	52	50
Consumer Discretionary	25	22	20	21	18	16	18	13	13	12
Consumer Staples	6	8	9	8	9	13	14	18	20	19
Health Care/liability	7	7	7	8	10	11	13	16	18	17
Financials	48	45	44	42	38	43	40	46	43	43
Information Technology	49	44	43	40	41	46	47	43	43	36
Telecommunication Services	3	2	2	2	1	1	2	2	2	2
Utilities	1	1	1	2	2	2	2	2	2	2
All	245	231	219	209	203	236	252	288	284	264

Panel D: Subperiod 2010–2016

	2010	2011	2012	2013	2014	2015	2016
Energy and consumption	68	72	67	71	70	64	61
Material/labor	12	12	11	10	10	9	7
Industrials	47	45	45	42	45	43	42
Consumer Discretionary	13	11	11	10	11	11	10
Consumer Staples	19	18	18	18	13	10	10
Health Care/liability	17	18	17	17	15	16	15
Financials	44	45	45	41	40	41	43
Information Technology	32	28	25	27	26	27	22
Telecommunication Services	2	2	2	3	3	3	3
Utilities	2	2	2	3	4	4	4
All	256	253	243	242	237	228	217

The tables list, for each year, the number of active firms on the exchange in each GICS sector. Data for stocks listed at the Oslo Stock Exchange during the period 1980-2016.

Table 8.4 The fraction of market values in the different GICS Industry Sectors

Panel A: Subperiod 1980–1989

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
Energy and consumption	10.80	9.50	8.46	8.77	8.93	8.14	7.00	10.01	10.42	16.58
Material/labor	8.86	8.95	8.25	10.10	10.82	11.08	11.09	11.75	10.47	12.03
Industrials	57.95	50.83	39.25	36.68	32.60	32.87	34.30	32.93	42.69	40.36
Consumer Discretionary	1.01	1.53	3.19	2.38	3.55	5.73	7.68	6.31	5.31	3.40
Consumer Staples	2.30	4.75	5.50	5.02	6.87	6.45	10.00	11.42	7.80	8.50
Health Care/liability	1.13	1.23	2.34	3.43	3.31	4.43	3.62	5.91	9.34	5.67
Financials	18.29	23.89	27.13	21.40	21.78	20.91	23.61	24.96	14.47	16.56
Information Technology	0.81	3.73	5.96	12.23	12.15	10.49	10.11	5.27	2.74	1.85
Telecommunication Services	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.18	0.10	0.00
Utilities	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Panel B: Subperiod 1990–1999

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Energy and consumption	21.72	22.63	19.10	17.80	15.76	16.37	23.57	24.57	15.46	15.38
Material/labor	8.14	6.49	6.04	8.02	8.13	6.66	4.57	2.95	3.69	5.17
Industrials	39.32	40.16	40.23	36.94	40.88	37.97	35.38	27.84	27.40	28.05
Consumer Discretionary	2.63	2.15	4.91	5.82	5.24	5.00	5.70	9.33	15.08	16.45
Consumer Staples	10.45	11.53	15.32	11.81	6.41	6.49	6.84	6.28	6.38	6.23
Health Care/liability	6.58	11.19	12.29	5.69	5.36	6.15	2.59	8.38	14.20	5.60
Financials	16.40	8.54	8.52	16.54	18.16	20.32	17.36	14.70	18.40	17.16
Information Technology	1.81	1.50	1.76	1.98	1.35	3.59	4.62	4.69	5.37	11.27
Telecommunication Services	0.00	0.00	0.00	0.00	0.00	0.00	0.70	1.33	2.04	3.74
Utilities	0.00	0.00	0.00	0.00	0.00	0.00	1.28	0.75	1.04	0.76

Panel C: Subperiod 2000–2009

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Energy and consumption	9.84	25.94	42.41	42.58	42.96	51.70	51.13	50.39	60.86	52.21
Material/labor	5.25	4.72	3.94	3.59	3.23	2.70	1.72	1.28	0.59	0.57
Industrials	27.17	26.36	9.49	6.85	10.32	11.26	10.49	10.84	11.99	11.40
Consumer Discretionary	10.04	5.78	6.47	8.31	9.07	6.17	4.48	3.46	3.24	3.81
Consumer Staples	7.92	6.73	7.04	5.09	5.62	5.77	6.36	7.01	6.52	7.00
Health Care/liability	7.49	7.94	8.01	8.56	7.59	0.38	0.38	0.70	1.17	0.97
Financials	17.20	14.51	14.91	12.81	13.90	11.21	10.32	9.20	6.48	10.67
Information Technology	10.62	7.17	3.69	4.30	4.40	3.87	6.20	8.58	6.32	4.93
Telecommunication Services	13.26	9.20	8.54	9.94	9.65	7.63	9.91	9.63	7.66	8.85
Utilities	0.60	0.54	0.91	1.03	0.92	1.10	1.33	1.54	1.72	1.14

Panel C: Subperiod 2000–2016

	2010	2011	2012	2013	2014	2015	2016
Energy and consumption	44.04	51.42	46.62	42.28	32.85	26.90	35.53
Material/labor	1.43	1.14	0.56	0.29	0.44	0.45	0.72
Industrials	12.72	12.16	13.14	11.22	11.81	13.43	13.27
Consumer Discretionary	6.52	4.92	5.95	6.40	11.96	16.06	10.48
Consumer Staples	7.49	5.56	6.66	6.58	8.55	9.54	12.04
Health Care/liability	0.95	1.16	1.05	1.38	1.16	0.47	1.67
Financials	14.15	12.92	14.41	17.35	18.45	18.44	20.80
Information Technology	4.27	2.15	1.95	2.92	3.31	3.14	2.34
Telecommunication Services	9.56	11.20	11.75	12.26	12.62	11.73	9.53
Utilities	1.05	1.07	0.84	0.71	0.91	0.99	1.35

The tables list, for each year, the percentage fraction of the value of the OSE is in each GICS sector. Measurement done at yearend. Data for the period 1980–2016.

Table 8.5 Industry returns

Panel A: Equally weighted industry indices

	First year	Last year	Average return	Standard deviation	average n	T
10 Energy(ew)	1980	2016	1.94	9.18	20.5	444
15 Material(ew)	1980	2016	1.89	11.70	6.1	444
20 Industry(ew)	1980	2016	1.70	5.97	31.7	444
25 ConsDisc(ew)	1980	2016	1.64	6.97	10.3	444
30 ConsStapl(ew)	1980	2016	2.08	6.49	7.0	444
35 Health(ew)	1980	2016	1.70	8.82	4.6	444
40 Finan(ew)	1980	2016	1.25	4.84	28.3	444
45 IT(ew)	1980	2016	2.43	10.54	11.3	444
50 Telecom(ew)	1987	2016	1.19	9.61	1.6	260
55 Util(ew)	1996	2016	0.98	6.11	2.7	252

Panel B: Value weighted industry indices

	First year	Last year	Average return	Standard deviation	average n	T
10 Energy(vw)	1980	2016	1.72	7.89	20.5	444
15 Material(vw)	1980	2016	1.73	11.93	6.1	444
20 Industry(vw)	1980	2016	1.71	7.26	31.6	444
25 ConsDisc(vw)	1980	2016	2.33	10.24	10.3	444
30 ConsStapl(vw)	1980	2016	2.16	7.28	7.0	444
35 Health(vw)	1980	2016	1.89	8.55	4.6	444
40 Finan(vw)	1980	2016	1.54	6.83	28.3	444
45 IT(vw)	1980	2016	3.07	13.04	11.3	444
50 Telecom(vw)	1987	2016	1.26	10.21	1.6	260
55 Util(vw)	1996	2016	1.01	6.68	2.7	252

The table describes portfolio returns of 10 industry portfolios grouped by GICS. We report the first and last years of each index, the average monthly return (in percent), the average number of equities in the portfolio (avg n), and the number of months of returns used in the calculation (T). The index described in Panel A is an equally weighted index using all stocks in a given industry.

Table 8.6 Correlations across industry sectors

Panel A: Equally weighted industry indices

	10	15	20	25	30	35	40	45	50
15 Material(ew)	0.37								
20 Industry(ew)	0.73	0.48							
25 ConsDisc(ew)	0.47	0.50	0.60						
30 ConsStapl(ew)	0.53	0.41	0.59	0.49					
35 Health(ew)	0.40	0.28	0.47	0.38	0.36				
40 Finan(ew)	0.61	0.45	0.68	0.57	0.58	0.36			
45 IT(ew)	0.54	0.26	0.49	0.45	0.43	0.46	0.45		
50 Telecom(ew)	0.39	0.18	0.36	0.37	0.27	0.46	0.39	0.55	
55 Util(ew)	0.39	0.26	0.48	0.30	0.43	0.31	0.43	0.35	0.26

Panel B: Value weighted industry indices

	10	15	20	25	30	35	40	45	50
15 Material(vw)	0.41								
20 Industry(vw)	0.71	0.46							
25 ConsDisc(vw)	0.38	0.48	0.50						
30 ConsStapl(vw)	0.55	0.40	0.58	0.45					
35 Health(vw)	0.42	0.32	0.43	0.32	0.42				
40 Finan(vw)	0.56	0.50	0.61	0.56	0.61	0.36			
45 IT(vw)	0.40	0.27	0.43	0.36	0.44	0.33	0.39		
50 Telecom(vw)	0.36	0.20	0.47	0.36	0.35	0.41	0.41	0.52	
55 Util(vw)	0.34	0.27	0.43	0.29	0.44	0.39	0.43	0.37	0.33

The table shows correlations between monthly returns for 10 industry portfolios grouped by GICS.

Chapter 9

A few large stocks

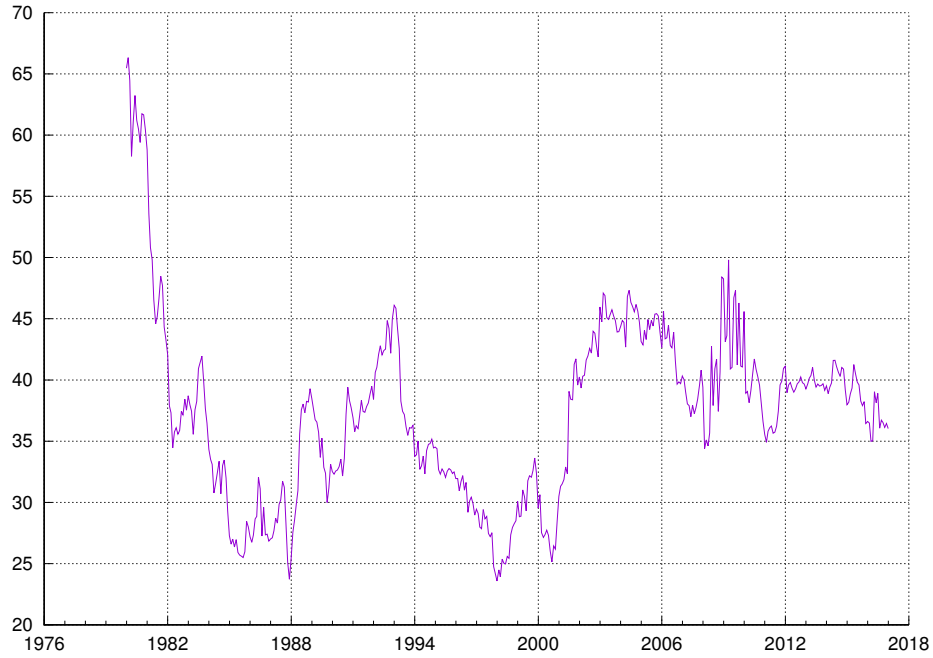
The OSE has always had a few large companies which in terms of market capitalization have a dominant position on the exchange. For many years it was Norsk Hydro, but with the listing of the large, state dominated companies Telenor and Statoil this changed. To illustrate to what degree the exchange is likely to be affected by these large companies table 9.1 shows, for each year, the four largest companies, and each company's fraction of the value of the exchange.

Table 9.1 The four largest companies each year

year	Largest							
1980	Norsk Hydro	52.6	Saga Petroleum	9.4	Den norske Creditbank	4.5	Christiania Bank og Kreditkasse	3.8
1981	Norsk Hydro	33.7	Den norske Creditbank	5.3	Saga Petroleum	4.8	Actinor	4.3
1982	Norsk Hydro	29.4	Den norske Creditbank	6.9	Norsk Data	5.7	Storebrand	4.4
1983	Norsk Hydro	23.1	Norsk Data	7.4	Den norske Creditbank	4.7	Alcatel STK	4.2
1984	Norsk Hydro	16.2	Norsk Data	7.9	Den norske Creditbank	3.5	Alcatel STK	3.4
1985	Norsk Hydro	16.0	Norsk Data	7.4	Den norske Creditbank	3.9	Hafslund	3.7
1986	Norsk Hydro	14.8	Norsk Data	7.0	Den norske Creditbank	3.6	Christiania Bank og Kreditkasse	3.2
1987	Norsk Hydro	14.9	Hafslund	5.3	Bergesen d.y	3.7	Norsk Data	3.2
1988	Norsk Hydro	23.7	Hafslund	9.1	Bergesen d.y	5.8	NCL Holding	3.6
1989	Norsk Hydro	20.3	Bergesen d.y	6.4	Hafslund	5.3	Saga Petroleum	5.2
1990	Norsk Hydro	23.1	Saga Petroleum	7.1	Hafslund	6.0	Orkla	4.1
1991	Norsk Hydro	20.2	Hafslund	10.6	Saga Petroleum	7.8	Kværner	5.7
1992	Norsk Hydro	26.2	Hafslund	11.0	Saga Petroleum	7.8	Orkla	6.8
1993	Norsk Hydro	23.2	Kværner	8.1	Orkla	7.3	Hafslund	5.9
1994	Norsk Hydro	24.7	Kværner	5.5	Hafslund	5.2	Orkla	4.9
1995	Norsk Hydro	21.4	Hafslund	5.8	Orkla	5.4	Saga Petroleum	4.0
1996	Norsk Hydro	19.3	Orkla	5.2	Transocean Offshore	5.2	Den norske Bank	3.8
1997	Norsk Hydro	13.4	Transocean Offshore	5.5	Nycomed Amersham	5.4	Orkla	5.0
1998	Norsk Hydro	13.1	Royal Caribbean Cruises	10.3	Nycomed Amersham	7.5	Orkla	4.9
1999	Norsk Hydro	13.7	Royal Caribbean Cruises	9.4	Nycomed Amersham	4.8	Den norske Bank	3.9
2000	Norsk Hydro	15.1	Nycomed Amersham	6.9	Royal Caribbean Cruises	6.0	Orkla	5.8
2001	Statoil ASA	18.4	Norsk Hydro	13.7	Telenor ASA	9.5	Nycomed Amersham	7.5
2002	Statoil ASA	22.8	Norsk Hydro	14.7	Telenor ASA	8.5	Nycomed Amersham	7.7
2003	Statoil ASA	21.4	Norsk Hydro	14.3	Telenor ASA	10.2	Nycomed Amersham	8.5
2004	Statoil ASA	20.1	Norsk Hydro	12.2	Telenor ASA	9.3	Den norske Bank	7.7
2005	Statoil ASA	23.6	Norsk Hydro	12.5	Telenor ASA	7.9	Den norske Bank	6.7
2006	Statoil ASA	18.4	Norsk Hydro	12.8	Telenor ASA	10.1	Den norske Bank	6.1
2007	Statoil ASA	24.0	Telenor ASA	9.7	Renewable Energy Corporation ASA	6.1	Den norske Bank	4.9
2008	Statoil ASA	36.0	Telenor ASA	7.6	Orkla	4.6	Yara International ASA	4.3
2009	Statoil ASA	33.0	Telenor ASA	9.6	Den norske Bank	7.3	Yara International ASA	5.5
2010	Statoil ASA	19.6	Telenor ASA	10.3	Den norske Bank	8.8	Yara International ASA	6.4
2011	Statoil ASA	24.7	Telenor ASA	11.8	Den norske Bank	7.1	Seadrill Limited	7.0
2012	Statoil ASA	21.0	Telenor ASA	12.3	Den norske Bank	8.1	Seadrill Limited	6.7
2013	Statoil ASA	18.8	Telenor ASA	13.1	Den norske Bank	10.5	Seadrill Limited	6.9
2014	Statoil ASA	16.4	Telenor ASA	13.2	Den norske Bank	10.5	Royal Caribbean Cruises	8.4
2015	Statoil ASA	14.3	Telenor ASA	12.0	Royal Caribbean Cruises	11.4	Den norske Bank	9.6
2016	Statoil ASA	16.8	Den norske Bank	10.3	Telenor ASA	9.6	Royal Caribbean Cruises	7.1

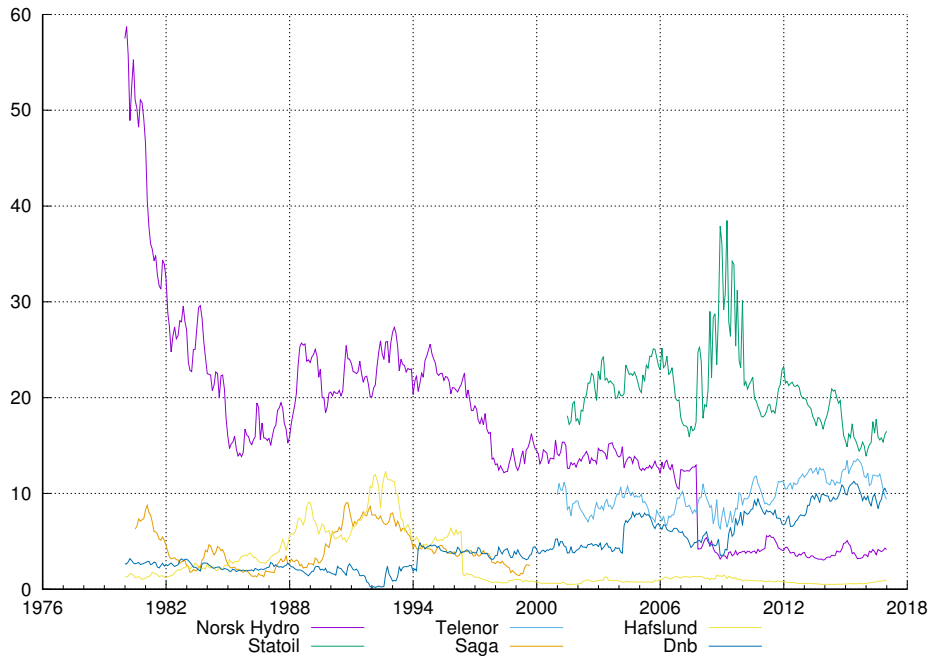
The table lists the four largest companies on the exchange in terms of the market capitalization. For each company we list the name and the fraction of the market capitalization this company had at yearend.

Figure 9.1 The three largest companies at the OSE



The figure plots the time series evolution of what fraction of the exchange the three largest companies at the OSE have.

Figure 9.2 The largest companies at the OSE



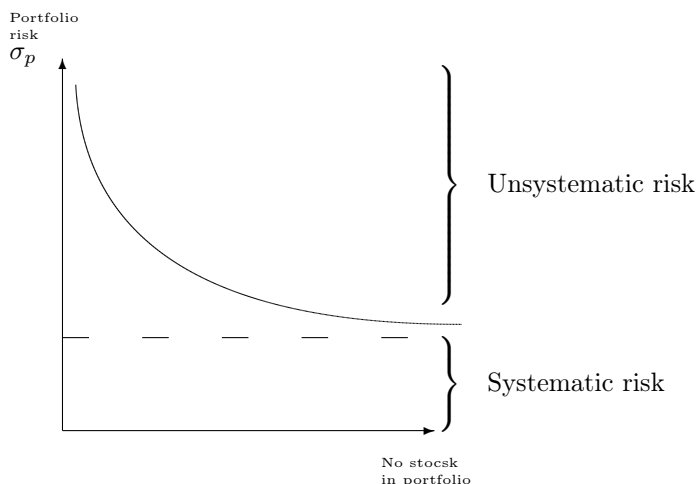
The figure plots the time series evolution of what fraction of the exchange the largest companies at the OSE have.

Chapter 10

How many stocks are necessary for a well diversified portfolio?

In a first course in finance the concept of risk is usually introduced using a picture like figure 10.1, which illustrates the relationship between the number of stocks in an equally weighted portfolio and the standard deviation of the portfolio. This picture is then used to introduce the difference between systematic and unsystematic risk, where the unsystematic risk is the risk that can be diversified away by increasing the number of stocks in the portfolio. We will not go this route, we will instead look directly at the relationship between number of stocks and standard deviation. This difference can namely be used to say something about when we have achieved “most” of the relevant diversification.

Figure 10.1 Relationship between number of stocks in an equally weighted portfolio and the portfolios standard deviation



Empirical curves like this can be found in any number of classical empirical papers. By creating random portfolios by the well known “Throwing Darts at The Wall Street Journal” method, and increasing the number of stocks in the portfolio, one find empirical versions of the curve in figure 10.1. The curve always has the same shape, the portfolio standard deviation decreases with the number of stocks, but flattens out after a while. The number of stocks at which the curve flattens out is used as a measure of how many stocks are “enough” to achieve most of the diversification. In US papers there is some variation in this number, for example Evans and Archer (1968) argues for 10 stocks being enough, Wagner and Lau (1971) concludes that most of the diversification is achieved at 15 stocks, while Statman (1987) argues for 30 stocks.

We here perform similar calculations as the US papers using data for the Oslo Stock Exchange.

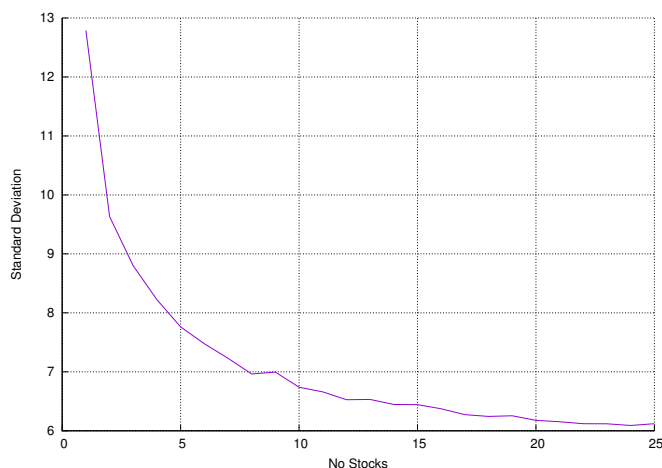
10.1 Methods

All stock at the OSE in the period 1980-2016 with a minimum of liquidity is included.¹ A portfolio is simulated by randomly drawing n shares at the first date. Going forward, each month the return of an equally weighted portfolio of the chosen stocks is calculated. If a stock is delisted, the last observed price is used as the price for realizing the stock, and the stock is replaced by randomly drawing another stock. Stock returns of the simulated trading strategies are calculated for the period 1980 to 2016, and the standard deviation of the portfolio is calculated. This random portfolio construction is repeated 100 times. Finally we calculate the average of these estimated standard deviations.

10.2 Results

Figure 10.2 shows results for the whole period. The shape of the curve is similar to what is found in other stock markets. The gains to diversification are obvious, and particularly strong up to five stocks. There is a marked fall down to 10-15 stocks, but after that the curve levels out, even though it is still decreases down to the maximal portfolio of 40 stocks.

Figure 10.2 Relation between number of stocks and standard deviation for portfolios at OSE



Average standard deviation of monthly portfolio returns for 100 simulated stock portfolio at OSE. Each portfolio is an equally weighted portfolio of n stocks, where n varies along the horizontal axis. Numbers in percent.

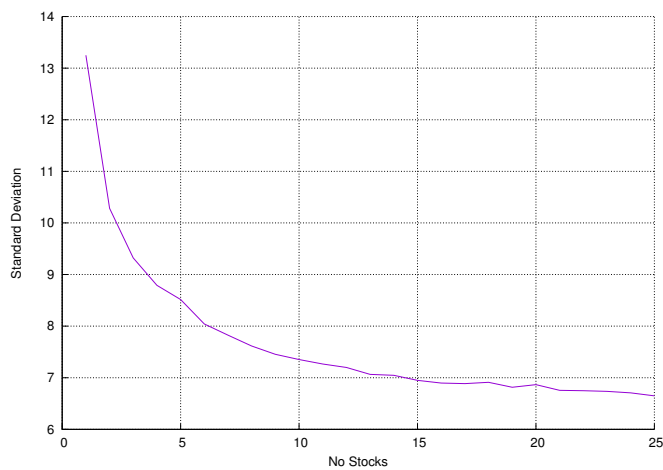
In figure 10.3 we split the simulations into two subperiods, 1980–1994 and 1995–2016.

10.3 How close do we get to a stock market index?

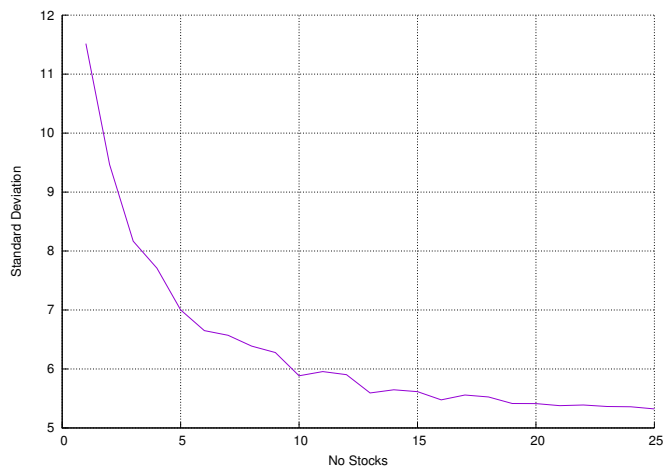
Table 10.1 show detailed results for the various simulations. In addition it shows comparable numbers for two stock market indices, one equally weighted (EW) and one value weighted (VW).

¹The filter criteria discussed in chapter 6 are applied, stocks traded less than 20 days a year, and stocks with prices below 10 are removed.

Figure 10.3 Relation between number of stocks and standard deviation for portfolios at OSE for subperiods
Subperiod 1980-1995



Subperiod 1996-2016



Average standard deviation of monthly portfolio returns for 100 simulated stock portfolio at OSE. Each portfolio is an equally weighted portfolio of n stocks, where n varies along the horizontal axis. Numbers in percent. Two subperiods: 1980–1995, 1996–2016

Table 10.1 Relation between number of stocks and standard deviation for portfolios at OSE

No stocks in portfolio	Standard Deviation (%)		
	1980–2016	1980–1999	2000–2016
1	12.79	13.25	11.52
2	9.63	10.28	9.47
3	8.80	9.32	8.17
4	8.22	8.79	7.71
5	7.76	8.52	7.00
6	7.48	8.04	6.65
7	7.23	7.83	6.57
8	6.96	7.62	6.39
9	6.99	7.45	6.28
10	6.74	7.35	5.88
11	6.66	7.27	5.96
12	6.53	7.20	5.90
13	6.53	7.07	5.59
14	6.45	7.05	5.65
15	6.44	6.95	5.62
16	6.37	6.90	5.48
17	6.27	6.89	5.56
18	6.24	6.91	5.53
19	6.26	6.82	5.41
20	6.18	6.87	5.41
21	6.15	6.76	5.38
22	6.12	6.75	5.39
23	6.12	6.74	5.36
24	6.09	6.71	5.36
25	6.12	6.65	5.32
EW	5.43	6.06	4.55
VW	6.13	6.59	5.53

Average standard deviation of monthly portfolio returns for 100 simulated stock portfolio at OSE. Each portfolio is an equally weighted portfolio of n stocks, where n varies along the horizontal axis. Numbers in percent. Three subperiods: 1980–1999, 2000–2016 and 1980–2016. At the bottom of the table results for two indices. *EW*: equally weighted index. *VW*: value weighted index.

10.4 Conclusion

We have seen how many stock are necessary to get a reasonably “well diversified” stock portfolio at the Oslo Stock Exchange. The numbers are essentially comparable to US results, with most of the relevant diversification achieved after 10 stocks. Even though Oslo Stock Exchange is very much smaller than the NYSE, and concentrated in only a few sectors, that the magic number 10 should appear to be valid here too *is* surprising. The Law of Large Numbers appears to work also at the Oslo Stock Exchange.

Chapter 11

The variability of the Oslo Stock Exchange

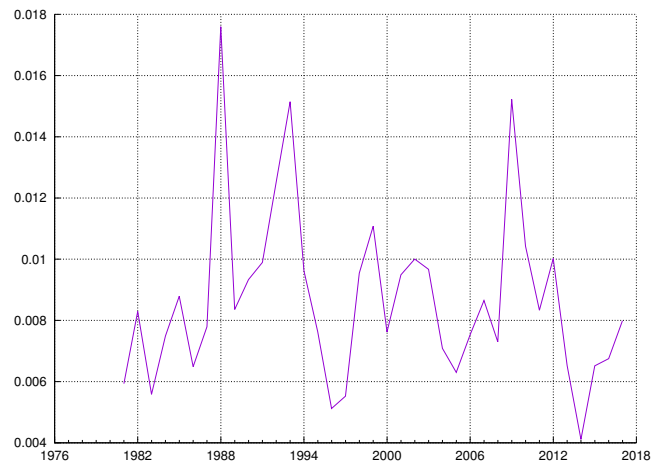
In this chapter we discuss the variability of stock returns at the OSE. There are different ways of measuring variability. The most common is to look at the *volatility*, or standard deviation, of returns. We will look at some time series of volatility. Let us first consider the market as a whole, and look at the volatility of market indices. The next way to investigate volatility is to consider individual stocks, and calculate the volatility across stocks.

11.0.1 The volatility of market indices

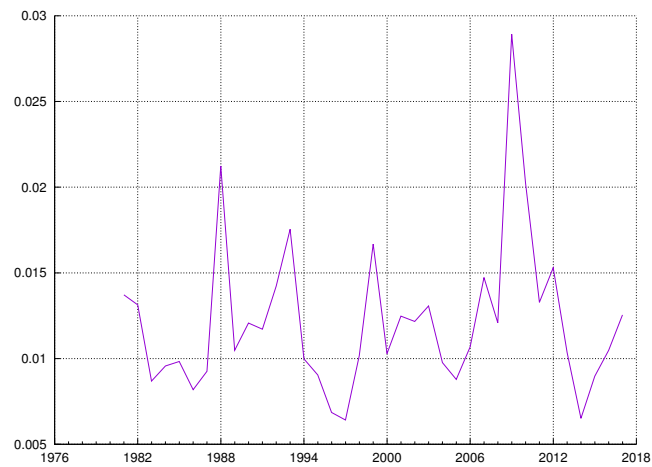
Let us look at the time series evolution of the two indices VW and EW which we have calculated earlier. In figure 11.1 we each year calculate the volatility of that years returns on the market index. In figure 11.2 we do similar calculations at higher frequencies.

Figure 11.1 The annual volatility of market indices at the OSE

EW index

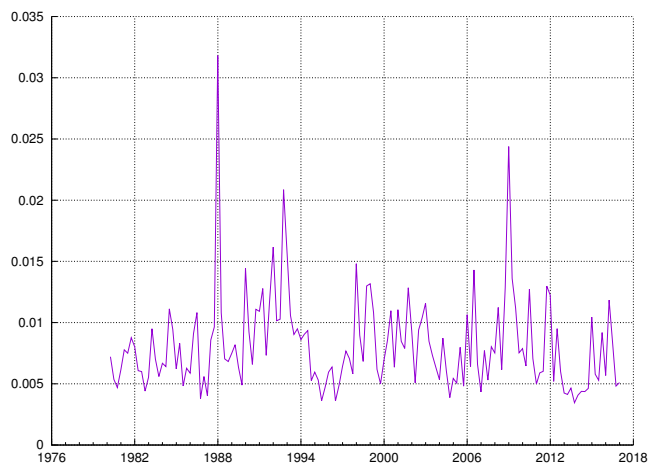


VW index

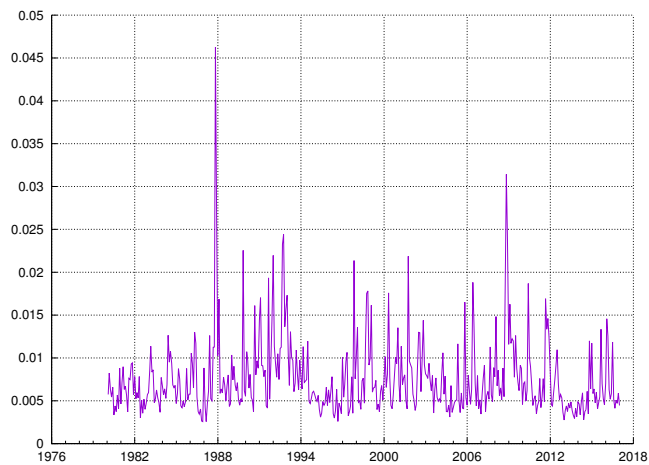


For each of the indices EW and VW we calculate the volatility of one year of daily returns, and plot the time series of resulting estimates.

Figure 11.2 Higher frequency estimates of volatility of market indices at the OSE
Quarterly estimates



Monthly estimates



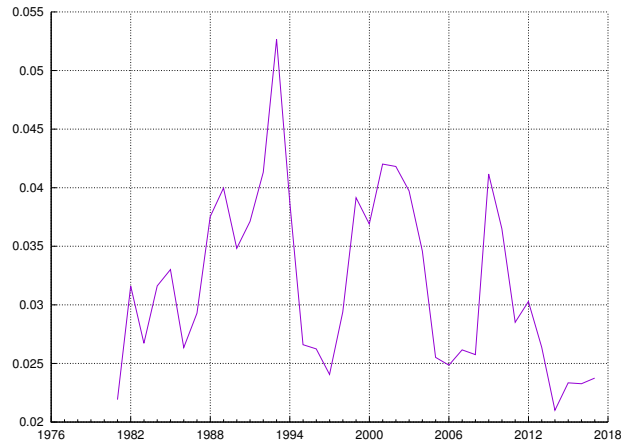
For the index EW we calculate the volatility of one quarter(top figure) and one month(bottom figure) of daily returns, and plot the time series of resulting estimates.

11.0.2 The average volatility across stocks

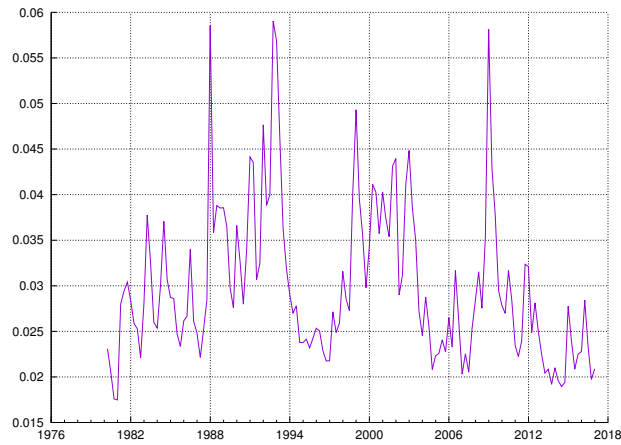
Instead of looking at the market, it may be more informative to look at the volatility of individual stocks, and ask: What is the average volatility for individual stocks. In figure 11.3 we show such averages, where we calculate the volatility for each stock on the OSE, and then report various averages.

Figure 11.3 Average volatility for all firms at the OSE

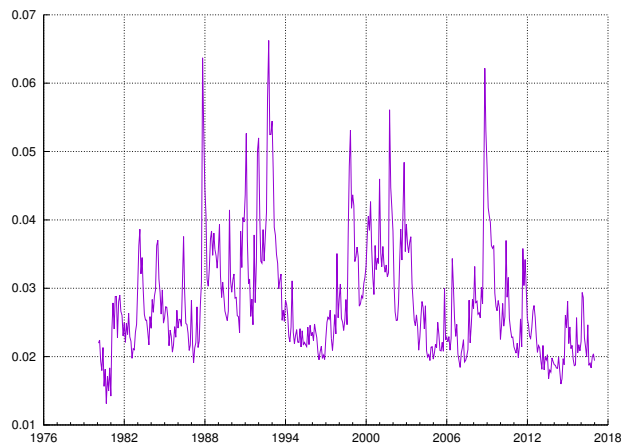
Annual calculations



Quarterly calculations



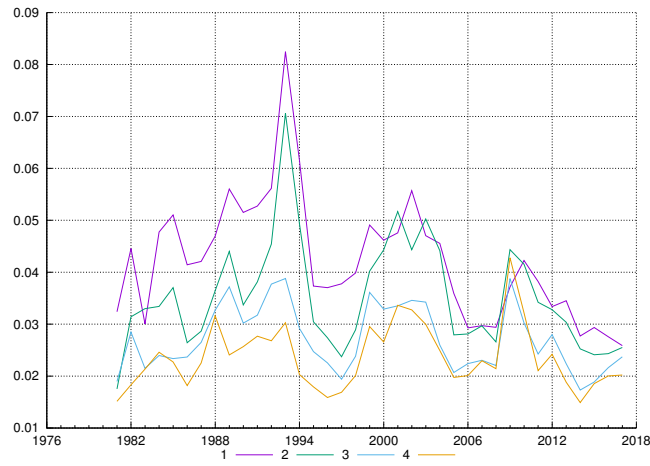
Monthly calculations



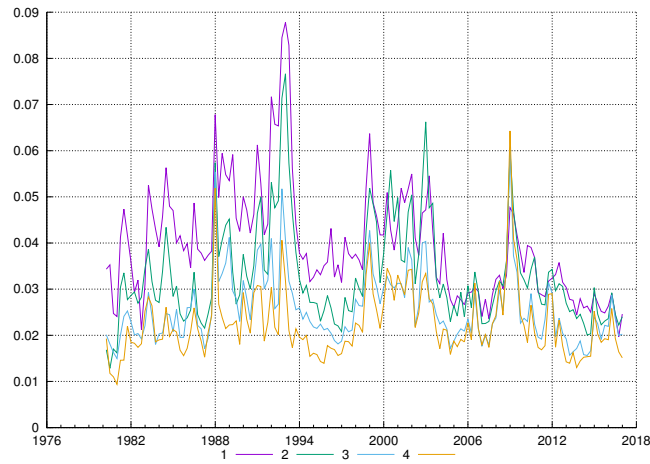
The tables show averages of estimated volatility across stocks. For each stock the standard deviation of stock returns is calculated using one year's worth of daily returns (top figure), one quarters worth (middle figure) or one month's worth (bottom figure). These estimates are then averaged across stocks. The calculation is done at the ends of respectively years, quarters and months. When taking the average we Windsorize the data by removing the most extreme one percent. Data for stocks listed at the Oslo Stock Exchange during the period 1980-2016.

Figure 11.4 Average volatility for size sorted portfolios, firms at the OSE

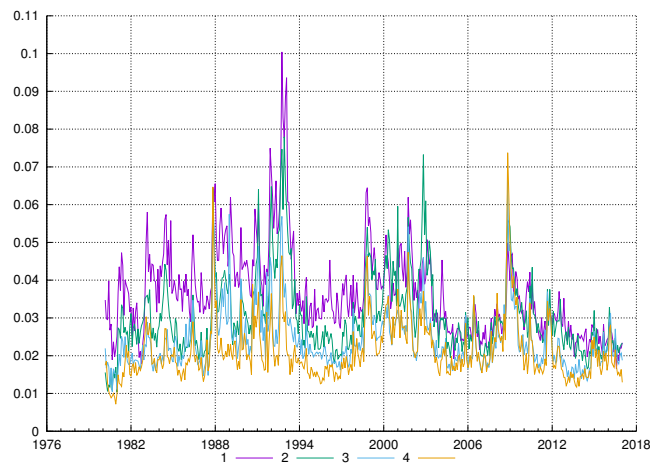
Annual data



Quarterly data



Monthly data



The tables show averages of estimated volatility across stocks. For each stock the standard deviation of stock returns is calculated using one year's worth of daily returns (top figure), one quarters worth (middle figure) or one month's worth (bottom figure). We then group stocks into four portfolios based on firm size, and average across these portfolios. Data for stocks listed at the Oslo Stock Exchange during the period 1980-2016.

Chapter 12

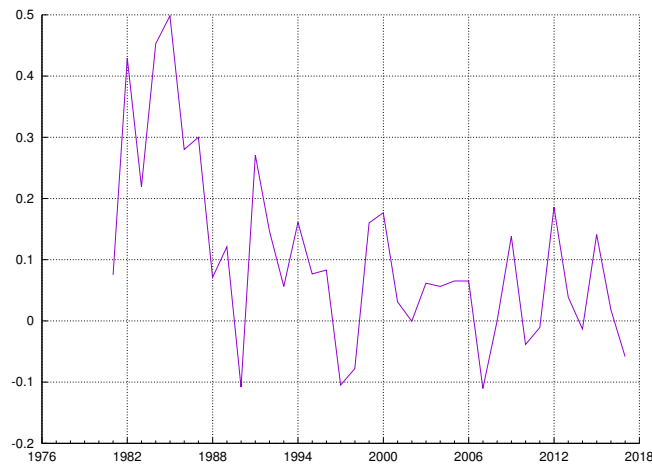
Time series properties at the Oslo Stock Exchange

12.0.1 Observations on market indices

Let us look at the time series evolution of the two indices VW and EW which we have calculated earlier. In figure 12.1 we each year calculate the (first order) autocorrelation of that years returns.

Figure 12.1 The annual autocorrelations of market indices at the OSE

EW index



For each of the indices EW and VW we calculate the autocorrelation (lag one) of one year of daily returns, and plot the time series of resulting estimates.

Table 12.1 shows estimates of autocorrelations for various market indices, for the whole period 1980 to 2016, and for subperiods.

Table 12.1 Autocorrelation of market returns

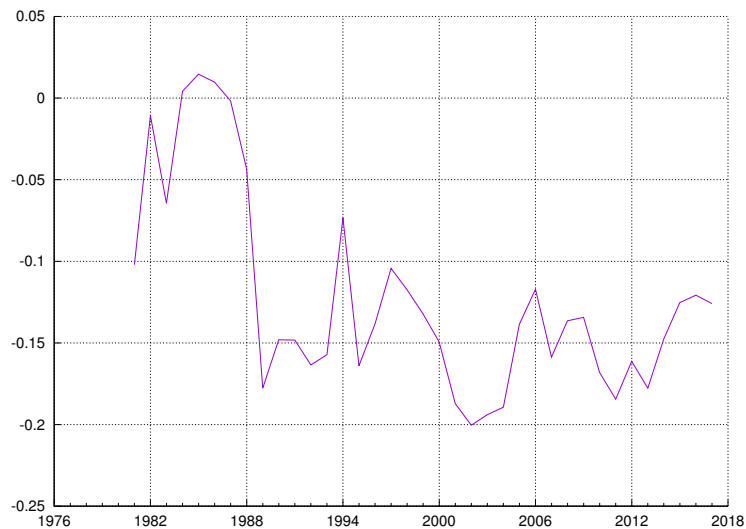
Index		1980–2016	1980–1989	1990–1999	2000–2016
ew(daily)	Mean	0.0011	0.0013	0.0012	0.0009
	Stdev	0.009	0.009	0.010	0.009
	Autocorr(1)	0.12	0.19	0.12	0.06
	Autocorr(2)	0.04	0.07	0.04	0.03
ew(weekly)	Mean	0.0045	0.0062	0.0046	0.0034
	Stdev	0.024	0.027	0.025	0.021
	Autocorr(1)	0.11	0.15	0.17	0.01
	Autocorr(2)	0.09	0.08	0.15	0.04
ew(monthly)	Mean	0.0167	0.0235	0.0160	0.0132
	Stdev	0.054	0.061	0.060	0.046
	Autocorr(1)	0.28	0.22	0.30	0.30
	Autocorr(2)	0.09	-0.05	0.17	0.11
vw(daily)	Mean	0.0010	0.0012	0.0010	0.0009
	Stdev	0.013	0.012	0.012	0.014
	Autocorr(1)	0.06	0.15	0.11	-0.00
	Autocorr(2)	-0.02	-0.02	-0.02	-0.02
vw(weekly)	Mean	0.0045	0.0054	0.0046	0.0040
	Stdev	0.030	0.029	0.029	0.030
	Autocorr(1)	-0.01	0.10	0.05	-0.09
	Autocorr(2)	0.04	0.14	0.09	-0.04
vw(monthly)	Mean	0.0186	0.0236	0.0184	0.0158
	Stdev	0.061	0.070	0.061	0.055
	Autocorr(1)	0.15	0.16	0.10	0.17
	Autocorr(2)	-0.04	-0.18	-0.02	0.04

We provide some estimates of autocorrelation for market indices at the OSE.

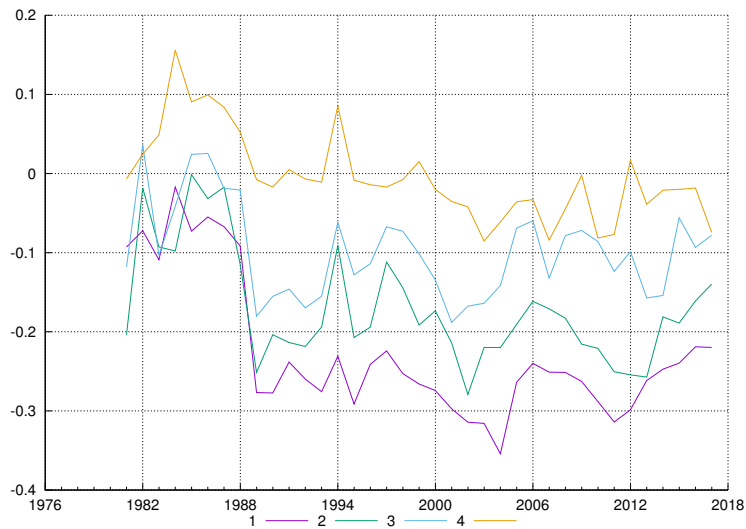
12.0.2 Autocorrelation of individual stocks

Table 12.2 Autocorrelation of individual stock returns

Panel A: Averages across all stocks



Panel B: Quartile plots



Chapter 13

Calendar effects

There is a large empirical literature in finance on the general topic of *calendar effects*, which can be summarized as predictable variation in stock returns based on calendar time. At first glance such effects may sound like a violation of market efficiency, if we have in mind the classical “random walk” theory of efficient markets. However, such effects may be consistent with a version of market efficiency where risk premia changes over time, or with some market imperfections inducing such predictability. In particular, there are some predictability in returns based on the month

In this chapter we replicate some of the standard investigations using data from the OSE.

13.1 Variations in daily returns over the week

We calculate daily stock returns and group the returns by the day of the week.

Table 13.1 Day of the week effects

Weekday	EW	VW	TOTINDEX	OBX
Monday	0.05	0.04	0.00	-0.04
Tuesday	0.06	0.05	0.03	0.03
Wednesday	0.10	0.09	0.03	0.03
Thursday	0.13	0.15	0.09	0.08
Friday	0.22	0.17	0.14	0.12

The table shows percentage daily returns split on day of the week.

Table 13.2 Friday the thirteenth

	EW	VW	TOT	OBX				
All Fridays	0.22	0.17	0.14	0.12				
Friday thirteenths	0.28	62	0.24	62	0.27	56	0.26	49
Other Fridays	0.22	1793	0.17	1793	0.14	1623	0.12	1430

The table shows percentage daily returns.

13.2 Variation in daily returns over the month

Ariel (1987) looks at this in the US.

Table 13.3 Day of the month effects

Day	EW	VW	TOTINDX	OBX
1	0.05	0.12	0.18	0.23
2	0.20	0.29	0.25	0.28
3	0.15	0.10	0.08	0.09
4	0.13	0.12	0.08	0.07
5	0.09	0.05	-0.01	-0.07
6	0.20	0.20	0.11	0.09
7	0.09	0.11	0.04	-0.01
8	0.09	0.04	-0.03	-0.04
9	0.14	0.07	0.07	0.09
10	0.08	0.06	-0.01	-0.06
11	0.11	0.11	0.05	0.01
12	0.08	-0.00	-0.06	-0.15
13	0.12	0.13	0.10	0.13
14	0.15	0.15	0.06	0.12
15	0.06	0.01	-0.03	-0.05
16	0.07	0.12	0.05	0.06
17	0.21	0.15	0.14	0.13
18	0.04	0.09	0.02	0.05
19	0.02	0.05	-0.02	-0.03
20	-0.03	-0.04	-0.12	-0.14
21	0.11	0.16	0.13	0.13
22	0.07	0.06	0.03	-0.02
23	0.13	0.12	0.05	0.08
24	-0.00	-0.06	-0.11	-0.12
25	0.07	0.03	0.01	-0.02
26	0.10	0.08	0.04	0.04
27	0.18	0.20	0.17	0.14
28	0.09	0.00	0.01	-0.00
29	0.17	0.17	0.17	0.16
30	0.36	0.27	0.25	0.18
31	0.23	0.18	0.15	0.14

The table shows percentage daily returns split on day of the month.

13.3 Variation in monthly returns over the year

The best known empirical regularity in the US is the January effect.

Table 13.4 Monthly effects

Month	EW	VW	TOT	OBX
Jan	5.4	3.7	3.1	1.7
Feb	2.9	2.1	1.8	2.1
Mar	2.3	1.9	2.2	2.3
Apr	3.2	4.3	3.6	2.8
May	1.5	2.2	1.4	1.0
Jun	-0.6	-0.2	-0.8	-0.5
Jul	2.7	3.1	2.6	2.7
Aug	0.1	0.6	-0.5	-1.1
Sep	-0.9	-0.6	-1.5	-2.2
Oct	0.9	1.7	0.5	0.3
Nov	0.4	0.3	-0.4	-0.5
Dec	2.2	3.2	2.8	2.9

The table shows percentage monthly returns split by month.

Table 13.5 Monthly effects, by size portfolios

Whole period, 1980–2016

Month	1(small)	2	3	4	5(large)
Jan	8.6	5.5	5.7	4.1	2.8
Feb	4.7	2.9	3.6	2.3	1.2
Mar	3.1	2.5	2.1	2.1	1.7
Apr	3.5	3.2	3.4	2.9	3.0
May	1.9	1.5	1.5	1.9	1.0
Jun	0.3	-0.3	-0.6	-1.0	-1.4
Jul	3.4	2.2	2.3	2.5	3.3
Aug	1.1	0.1	0.0	-0.3	-0.8
Sep	0.7	-0.6	-1.1	-2.0	-1.7
Oct	0.4	1.2	1.2	0.9	0.7
Nov	1.7	-0.1	0.2	0.6	-0.1
Dec	1.0	0.8	2.9	3.5	2.7

Table 13.6 Monthly effects, by size portfolios, split in subperiods

Panel A: Subperiod 1980–1989

Month	1(small)	2	3	4	5(large)
Jan	15.4	9.8	9.9	6.8	7.0
Feb	6.3	1.9	4.2	1.6	0.7
Mar	6.4	4.2	2.6	1.9	1.7
Apr	4.2	5.1	4.0	3.3	4.2
May	0.3	-1.3	0.3	0.1	-0.7
Jun	-0.8	-1.8	-1.5	-2.5	-1.2
Jul	5.6	4.2	3.3	3.7	5.0
Aug	2.5	1.4	0.2	2.4	2.0
Sep	4.1	0.2	1.5	1.6	1.1
Oct	-0.6	0.1	2.1	-0.6	-2.5
Nov	3.9	-0.5	0.0	-0.2	-1.0
Dec	0.2	0.6	2.2	4.6	1.7

Panel B: Whole period, 1990–1999

Month	1(small)	2	3	4	5(large)
Jan	8.0	6.3	6.1	4.6	3.9
Feb	5.8	5.5	3.6	1.2	1.0
Mar	3.6	3.1	2.8	3.2	2.6
Apr	5.7	2.6	4.3	2.7	2.6
May	4.6	3.3	2.4	3.7	2.1
Jun	0.5	-0.5	-0.9	-1.5	-1.6
Jul	3.7	1.7	2.4	2.6	3.5
Aug	-0.3	-1.5	-1.8	-4.3	-4.6
Sep	-0.7	-1.3	-2.6	-5.1	-2.9
Oct	-0.0	1.2	0.9	1.3	2.6
Nov	-0.5	-1.1	-0.9	-0.9	-1.2
Dec	2.2	0.7	2.6	2.5	4.2

Panel C: Subperiod 2000–2016

Month	1(small)	2	3	4	5(large)
Jan	5.0	2.4	3.0	2.2	-0.3
Feb	3.2	2.0	3.2	3.2	1.6
Mar	0.9	1.2	1.3	1.6	1.1
Apr	1.8	2.5	2.6	2.9	2.6
May	1.2	2.0	1.7	1.9	1.3
Jun	0.7	0.7	0.2	0.2	-1.3
Jul	2.0	1.3	1.6	1.8	2.2
Aug	1.2	0.3	1.1	0.5	-0.3
Sep	-0.5	-0.7	-1.9	-2.4	-2.7
Oct	1.2	1.8	1.0	1.5	1.5
Nov	1.6	0.8	1.0	2.0	1.0
Dec	0.8	0.9	3.4	3.5	2.5

The table shows percentage monthly returns split by month. Size portfolios.

Chapter 14

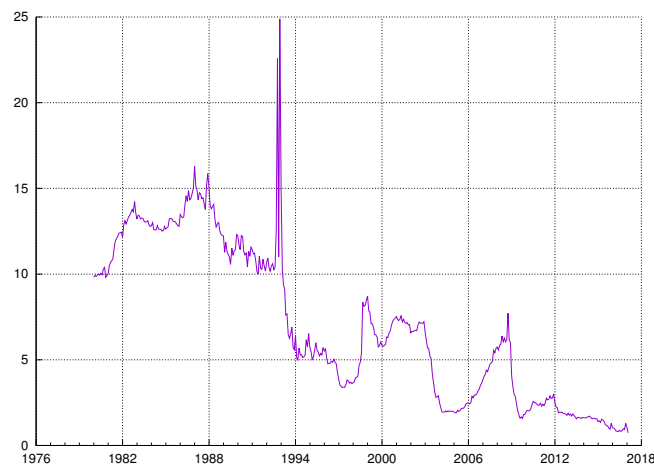
Interest Rates

In this chapter we discuss interest rate data.

For this paper we limit ourselves to estimates of two different interest rate series, a short term (monthly) risk free rate and an annual risk free rate. For details about Norwegian interest rate data we refer to (Eitrheim et al., 2006, Ch 6). For most of the period we use interbank rates, NIBOR as the estimate of the risk free rate. Both monthly and annual NIBOR rates are available from 1986. The period before 1986 is slightly “messy” regarding interest rate data, and we need to use some imperfect proxies. For monthly risk free interest from 1982 to 1986 we use the overnight NIBOR rate as an approximation. Before 1982 for the monthly data, and before 1986 for the annual data, we use the shortest possible bond yield for treasuries in Eitrheim et al. (2006) as estimates for interest rates. For the 1980 to 86 period this means we use the two year bond yield as an estimate of the risk free rate.

Figure 14 plots the monthly risk free interest rate. The “spike” in the interest rate in 1992 is due to a currency crisis.

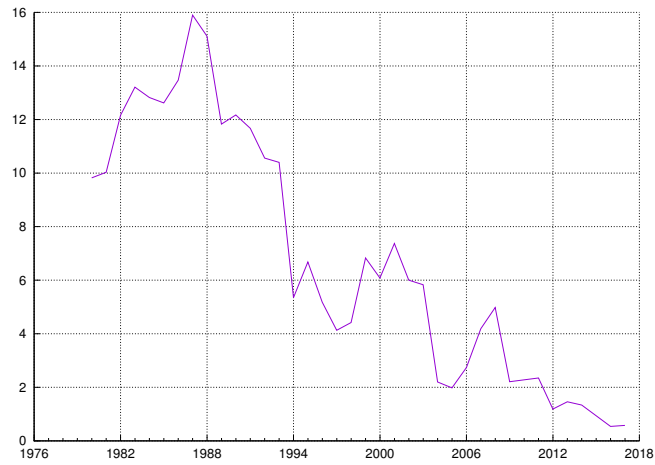
Figure 14.1 Short term (monthly) risk free interest rate



The figure plots annualized percentage one month interest rate for the period 1980 to 2016.

For some of the longer term calculations we also use the annual (one year) interest rate. Figure 14 illustrates this interest rate.

Figure 14.2 One year risk free interest rate



The figure plots annualized percentage one year interest rate for the period 1980 to 2016.

14.1 Sources

All interest rate data is available from the website of the Central Bank of Norway (www.norges-bank.no).

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