Beta Forecasting: A Two Decade Evaluation

Abstract

This paper compares a series of competing models to forecast beta. Realized measures of asset return covariance and variance are computed and applied to forecast beta following Andersen, Bollerslev, Diebold and Wu (2005a and 2005b). This approach is compared with the traditional constant beta model and a variant, the random walk model. It is shown that an autoregressive model with two or three lags that is estimated on the previous 80 quarters of realized beta produces the lowest or close to the lowest error for quarterly stock beta forecasts. In general, the AR(3) model has a mean-squared-forecast-error half that of the constant beta model.

JEL Code: G0 Keywords: Portfolio Management, Realized Beta.

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1. Introduction

Beta, emanating from the pioneering work of Sharpe (1964) and Lintner (1965), is a foundation stone of modern finance theory and is a focal point of countless investment and financing decisions. Forecasting betas has puzzled academics and practitioners for decades as they are recognized to be time-varying in nature [Mandelker (1974), Keim and Stambaugh (1986), Ferson (1989) and Breen, Glosten and Jagannathan (1989)]. To date, there lacks a forecasting technique that can outperform the constant beta model. Ghysels (1998) examined various parametric time varying beta models, including models from Ferson (1989), Ferson and Harvey (1991, 1993) and Ferson and Korajczyk (1995)], yet showed that these well known models are less accurate than the constant beta model even though beta is known to be time-varying. This paper outlines a beta forecasting method that consistently dominates the constant beta model.

The beta of a security represents its sensitivity to movements in the market. The beta of a portfolio is the weighted average of the individual betas of the securities comprising the portfolio. Market players form portfolios with a specific portfolio beta corresponding to their desired purpose, such as tracking portfolios with a beta of one and hedging portfolios with negative betas. Betas also have strong implications in the valuation of cost of capital. Beta forecasting techniques therefore directly benefit portfolio managers and have valuation applications. Wang (2003) emphasizes the importance of having accurate beta forecasts and Ghysels and Jacquier (2005) stress the crucial importance of good beta forecasts for hedge fund managers who need to neutralize risk factors, or pension fund managers. Beta is generally estimated as a constant parameter, despite the extensive empirical research that states beta is time-varying.

The recent advances into non-parametric volatility measurement follows on from the seminal work of French, Schwert and Stambaugh (1987) and Schwert (1989) and is encapsulated in the recent realized beta measurement framework of Andersen, Bollerslev, Diebold and Wu (2005a and 2005b). A realized beta is the ratio of the stock and market return realized covariance and the market realized variance. These non-parametric measures of covariance and variance have been heavily documented recently, such as Andersen and Bollerslev (1998), Andersen, Bollerslev, Diebold and Labys (2000, 2001, 2003) and Barndorff-Nielson and Shephard (2001, 2002a, 2002b, 2004). It has been demonstrated that traditional autoregressive time series models, computed on realized variance outperform popular models such as GARCH [Engle (1982) and Bollerslev (1986)]. These volatility forecasting evaluations were performed by Andersen, Bollerslev, Diebold and Labys (2003), Andersen, Bollerslev, Diebold and Ebens (2001), Maheu and McCurdy (2002), Martens, van Dijk and Pooter (2004), Ghysels, Santa-Clara and Valkanov (2005), Koopman, Jungbacker and Hol (2005).

In this paper we compute British quarterly realized betas, using daily data. Out-of-sample betas are forecasted using the constant, autoregressive and the random walk models. Experimentation with in-sample estimation sizes of 20, 40, 60 and 80 quarters are conducted. This leads to a finding that the autoregressive model with two or three lags, based upon the previous 80 quarterly realized betas are the dominant models. The results demonstrate dramatic improvements in beta forecasting for firms. On average the mean-squared-error of the constant beta model forecasts are dramatically reduced by approximately one half when using the autoregressive models with a specification of two or three lags, and in some cases they were reduced to less than a third. For stocks where data is not available for a long period of time, for example only 5 years, the AR(1) model or random walk model is the most accurate forecaster.

This paper is organized as follows: Section 2 describes the sample of British stocks, section 3 describes realized beta measurement and section 4 provides an evaluation of the constant, autoregressive and random walk models for one-quarter-ahead forecasting of beta for a range of in-sample estimation sizes. The final section concludes the study.

2. Data

Daily security prices are collected from DataStream; prices are also adjusted for dividends and market capitalization changes. The companies are selected based upon having a complete time series of daily data commencing the 4th January 1965 as well as being listed in the FTSE100 Index. Our sample extends through to 30th June 2005 and consists of 40 companies. Table 1 reports our sample of companies. The British market index used is the Financial Times 30 (FT30) index.

3. Beta Measuring

The theoretical framework presented by Andersen, Bollerslev, Diebold and Wu (2005a) provides a solid foundation for computing realized betas, thus their approach is utilized as follows:

The logarithmic $N \times 1$ vector price process, p_t, is assumed to follow a multivariate continuous-time stochastic volatility diffusion,

$$dp_t = \mu_t dt + \Omega_t dW_t \tag{1}$$

where W_t is a standard *N*-dimensional Brownian motion, Ω_t is the $N \times N$ positive definite diffusion matrix and μ_t is the *N*-dimensional instantaneous drift. Ω_t and μ_t are strictly stationary and jointly independent of W_t.

Defining the compounded *h*-period return as $r_{i,t+q,q} \equiv p_{i,t+q} - p_{i,t}$, and following the theory of quadratic variation with the sampling frequency tending to infinity

$$\sum_{j=1,\ldots,[q/d]} r_{t+j.d,d} . r'_{t+j.d,d} - \int_0^q \Omega_{t+\tau} d\tau \to 0 \tag{2}$$

For additional details refer to Andersen, Bollerslev, Diebold and Wu (2005a).

The beta of a security is the covariance of the security with the market divided by the variance of the market. The realized beta of a security is the realized covariance of a security and the market divided by the realized variance of the market. The realized covariance of a security *i* and the market *m* over a period *[t, t+q]* is the sum of the product of the returns of a security *i* and the market *M* for a period *d*, uniformly measured over the period *[t, t+q]*.

$$\hat{v}_{iM,t,t+q} = \sum_{j=1,\ldots,[q/d]} r_{i,t+j.d,d} . r_{M,t+j.d,d} \tag{3}$$

The realized variance over a period *[t, t+q]* is the sum of the squared returns of the market *M* for a period *d* uniformly measured over the period *[t, t+q]*.

$$\hat{v}^2_{M,t,t+q} = \sum_{j=1,\ldots,[q/d]} r^2_{M,t+j.d,d} \tag{4}$$

As discussed, the realized beta is the realized covariance of security and the market divided by the realized variance of the market**.**

$$\hat{\beta}_{i,t,t+q} = \frac{\hat{v}_{iM,t,t+q}}{\hat{v}^2_{M,t,t+q}} = \frac{\sum_{j=1,\ldots,[q/d]} r_{i,t+j.d,d} \cdot r_{M,t+j.d,d}}{\sum_{j=1,\ldots,[q/d]} r^2_{M,t+j.d,d}} \quad (5)$$

In this empirical analysis q will be quarterly and d will be daily, similar to that of Schwert's (1989) seminal contribution. According to Andersen, Bollerslev, Diebold and Wu (2005a) the daily frequency and the quarterly measurement will complement one another as the daily frequency offers equilibrium between microstructure noise and a dense sampling frequency for the quarterly measure. The computation of the realized quarterly betas were performed using the Ox programming language [Doornik (2001)].

First, the realized variance of the market and realized covariances of the security and the market are computed. This is implemented as above and in an identical manner to that of Andersen, Bollerslev, Diebold and Wu (2005a). Figure 1 presents the quarterly realized betas for British companies. The Autocorrelation Functions (ACFs) and Partial Autocorrelation Functions (PACFs) are displayed in Figures 2 and 3, which show the appropriateness of low order autoregressive models.

4. Forecast Evaluation

In this section the techniques to forecast one-quarter-ahead betas are explored. The constant model, autoregressive models and the random walk model are examined.

The constant model, one of the most fundamental approaches to forecast beta is known to have outperformed more sophisticated models [Ghysels (1998)]. Thus we use the constant beta model as a benchmark.

One-quarter-ahead forecasting of beta is conducted for each of the British stocks over a forecast evaluation period from 1986:2 until 2005:2. In-sample estimation sizes of 20, 15, 10 and

5 years are assembled from 80, 60, 40 and 20 quarterly realized betas, respectively and examined. The various in-sample sizes are studied to investigate the optimal horizon. To enable the comparison of the various in-sample sizes and forecasting approaches, the one-quarter-ahead beta forecasts are made over the identical period from the 2nd quarter 1986 through to the 2nd quarter 2005.

For the constant beta model forecast, the mean of the 80, 60, 40 and 20 quarterly realized betas is taken. The mean is then used as the one-quarter-ahead forecast, as shown in the following equation:

$$\beta_{t+1} = \frac{1}{n}\sum_{k=0}^{n-1}\beta_{t-k} \tag{6}$$

where *n* is the in-sample size, either 80, 60, 40 or 20.

For the autoregressive models, a low order process, as suggested by the ACFs and PACFs [Figures 2 and 3], is fitted to the time series of quarterly realized betas. The coefficients are then used to forecast the next quarterly beta. The following equation is the forecasting equation for the autoregressive model with *p* lags.

$$\beta_{t+1} = \alpha_0 + \alpha_1\beta_t + \alpha_2\beta_{t-1} + ... + +\alpha_n\beta_{t-(p-1)} \tag{7}$$

Finally, a variant of the constant model, the random walk, is used where the current beta is used to forecast the next period's beta. Thus the random walk approach suggests that the best predictor of next period's beta is the contemporaneous beta:

$$\beta_{t+1} = \beta_t \tag{8}$$

To test the forecasting ability of each approach, the mean squared error (MSE) and mean absolute error (MAE) for each company is computed. The MSE and MAE are calculated as follows:

$$MSE = \frac{1}{m}\sum_{j=1}^{m}\left(\beta_j - \hat{\beta}_j\right)^2 \tag{9}$$

$$MAE = \frac{1}{m}\sum_{j=1}^{m}\left|\beta_j - \hat{\beta}_j\right| \tag{10}$$

where m is the number of quarters in the out-of-sample evaluation, and β_j is the realized beta at quarter j and $\hat{\beta}_j$ is the corresponding forecast.

Tables 2 to 9 detail all 40 British company's MSE and MAE from each of the beta forecasting methods, with the lowest error values in bold. The autoregressive models consistently produce the greatest proportion of the lowest MSE and MAE values. The random walk model is the next best, being superior to the constant model in all in-sample sizes. The constant model performs the worst in all in-sample sizes.

By examining the frequency over stocks with which the AR models outperform the constant and random walk models (i.e. having the lowest MSE and MAE and highlighted in bold), a clear pattern emerges. The family of AR models dominate the constant and random walk models. For the in-sample size of eighty, sixty and forty, the autoregressive models dominated the other models by obtaining the lowest MSE and MAE values, this occurred in approximately 90% of stocks. As for the in-sample size of twenty, the autoregressive model also dominates the other models in the majority of stocks.

To provide an alternative viewpoint across all four estimation windows and all stocks, the constant beta model has the more frequent occurrences of the largest error, approximately 90% of stocks [(145/160) based on MSE and (150/160) based on MAE]. For the random walk model this is much lower, less than 5% of stocks. More strikingly, for no stock does the autoregressive model perform poorly.

Subsequently the actual MSE and MAE values are considered by evaluating the magnitude of dominance. Observing some specific companies, the AR models report some substantial reductions in MSE values. Boots Group's MSE was reduced by 67.8%[1] when using the AR(3) over the constant model. When comparing the lowest MSE using the constant model for Boots Group[2] with the AR(3), the AR(3) continues to dominate the constant model by reducing the MSE by 61.7%. Amvescap's MSE was reduced by 62.7%[3] when using the AR(3) over the constant model. Marks & Spencer's MSE was reduced by 62.0%[4] when using the AR(3) over the constant model. Scottish & Newcastle's MSE was reduced by 58.6%[5] when using the AR(3) over the constant model. This shows that the constant model performs very poorly with some companies relative to the AR(3) model. There exist no incidents where the constant model substantially dominates the autoregressive models.

The results demonstrate that the autoregressive models are the superior method of beta forecasting. In particular, the AR(3) based on the previous eighty quarterly realized betas is dominant, as it achieved the lowest average value for both MSE and MAE over all in-sample sizes and stocks [Table 10]. Also of note, the best in-sample size for the constant beta model is 20 quarters of 5 years, which is consistent with Fisher (1970) and Gonedes (1973) results [Tables

[1] Based on Table 2 where estimation is based on eighty quarters [(0.289-0.093)/0.289)].
[2] From Table 8, where forecasts are based on the previous 20 Quarters.
[3] Based on Table 2
[4] Based on Table 2
[5] Based on Table 2

10 and 11]. However, it should be reinforced that the autoregressive model gives far superior results across varying in-sample sizes.

In terms of the MSE results, on average the AR(3) model is 42.8% better than the best constant model [from Table 10, (0.2135-0.1221)/0.2135], which is the constant model based on the previous twenty quarters, and 12.7% better than the random walk model. In terms of the MAE, AR(3) is 25.2% better than the best constant model and 7.0% better than the random walk model from Tables 10 and 11, respectively. It is clear that the autoregressive models consistently outperform the constant and random walk models with the lowest error values.

5. Conclusion

The purpose of this paper was to evaluate over a two decade period competing models for beta forecasting. Beta is a central pillar of finance theory and is used by practitioners, academics and regulators in a wide variety of settings. Whilst sophisticated models have been designed to attempt to beat the constant beta model, they have failed to capture mainstream support as they have underperformed the constant beta model. Thus the constant model has remained the benchmark model and is popular in its usage. However, we find that in general, an autoregressive model with two or three lags, estimated on the previous eighty quarters of realized betas, far surpasses the constant beta model. For some stocks the improvement is phenomenal. For example, Boots Group's MSE was reduced by 61.7% when using the AR(3) over the most accurate constant beta model. Averaged over 40 companies, the MSE values for the AR(3) model are 42.8% lower than the constant beta model. This is a remarkable discovery across all stocks. For stocks where data is not available for a long period of time, for example only 5 years,

the AR(1) model or random walk model is the most accurate forecaster. The findings have fundamental implications for portfolio management, asset pricing, risk management and market regulation. It is hoped that this paper prompts further research activity across all branches of finance that readdresses issues that were previously examined using a constant beta model.

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Table 1: Sample of British Companies

	Ticker	Company	Index
1	AV.	Aviva	FTSE100
2	AVZ	Amvescap	FTSE100
3	BARC	Barclays	FTSE100
4	BATS	British American Tobacco	FTSE100
5	BLND	British Land	FTSE100
6	BOC	BOC Group	FTSE100
7	BOOT	Boots Group	FTSE100
8	BP.	BP PLC	FTSE100
9	BPB	BPB PLC	FTSE100
10	CBRY	Cadbury Schweppes	FTSE100
11	DGE	Diageo	FTSE100
12	DMGT	Daily Mail & General Trust A	FTSE100
13	DXNS	Dixons Group	FTSE100
14	GSK	GlaxoSmithKline	FTSE100
15	GUS	Gus	FTSE100
16	HNS	Hanson PLC	FTSE100
17	ICI	Imperial Chemical Industries	FTSE100
18	ITV	ITV	FTSE100
19	JMAT	Johnson Matthey	FTSE100
20	LAND	Land Securities Group	FTSE100
21	MKS	Marks & Spencer	FTSE100
22	NXT	Next	FTSE100
23	PRU	Prudential	FTSE100
24	RB.	Reckitt Benckiser	FTSE100
25	RBS	Royal Bank of Scotland	FTSE100
26	RDSB	Royal Dutch Shell B Shares	FTSE100
27	REL	Reed Elsevier	FTSE100
28	REX	Rexam	FTSE100
29	RIO	Rio Tinto	FTSE100
30	RSA	Royal & Sun Alliance Ins Group	FTSE100
31	SCTN	Scottish & Newcastle	FTSE100
32	SDR	Schroders PLC VTG Shs	FTSE100
33	SMIN	Smiths Group	FTSE100
34	SN.	Smith & Nephew	FTSE100
35	STAN	Standard Chartered	FTSE100
36	TATE	Tate & Lyle	FTSE100
37	TSCO	Tesco	FTSE100
38	ULVR	Unilever	FTSE100
39	WOS	Wolseley	FTSE100
40	WTB	Whitbread PLC	FTSE100

Table 2: MSE of One-Quarter-Ahead Forecast of Beta
Based on the previous 80 Quarters

Company	Constant	AR(1)	AR(2)	AR(3)	AR(4)	AR(5)	RW
Aviva	0.340	0.184	0.152	**0.147**	0.157	0.158	0.192
Amvescap	0.501	0.209	0.203	0.187	0.186	0.175	**0.171**
Barclays	0.074	**0.071**	0.073	**0.071**	0.073	0.074	0.107
British American Tobacco	0.330	0.162	0.159	**0.158**	**0.158**	0.164	0.172
British Land	0.266	0.114	0.107	**0.097**	0.099	0.103	0.129
BOC Group	0.274	0.123	0.120	**0.117**	**0.117**	**0.117**	**0.117**
Boots Group	0.289	0.099	**0.090**	0.093	0.094	0.094	0.101
BP PLC	0.201	0.104	0.101	**0.098**	0.103	0.105	0.116
BPB PLC	0.187	0.148	**0.130**	0.134	0.137	0.138	0.166
Cadbury Schweppes	0.256	0.147	**0.138**	0.140	0.146	0.148	0.167
Diageo	0.236	0.126	**0.113**	0.115	0.117	0.118	0.131
Daily Mail & General Trust A	0.192	0.156	0.154	0.149	0.147	**0.140**	0.197
Dixons Group	0.259	0.207	0.189	**0.188**	0.192	0.195	0.229
GlaxoSmithKline	0.319	0.146	0.137	0.137	0.136	0.137	**0.130**
Gus	0.188	0.120	**0.097**	0.102	0.102	0.104	0.144
Hanson PLC	0.243	0.145	**0.114**	0.120	0.116	**0.114**	0.143
Imperial Chemical Industries	0.331	0.155	**0.152**	0.154	0.156	0.158	**0.152**
ITV	0.309	0.145	**0.134**	0.141	0.141	0.143	0.156
Johnson Matthey	0.161	0.107	0.103	0.099	0.099	**0.095**	0.129
Land Securities Group	0.165	0.063	**0.058**	0.061	0.062	0.062	0.060
Marks & Spencer	0.298	0.128	0.117	**0.113**	0.114	0.117	0.134
Next	0.286	0.130	**0.125**	0.127	0.130	0.134	0.143
Prudential	0.212	0.149	0.144	**0.142**	0.143	0.148	0.187
Reckitt Benckiser	0.318	0.132	0.119	**0.115**	0.118	0.117	0.140
Royal Bank of Scotland	0.431	0.155	0.154	0.156	**0.153**	0.154	0.156
Royal Dutch Shell B Shares	0.266	0.161	0.152	0.148	0.150	0.149	**0.141**
Reed Elsevier	0.145	0.107	0.101	**0.096**	**0.096**	0.097	0.136
Rexam	0.187	0.117	**0.105**	**0.105**	0.108	0.111	0.131
Rio Tinto	0.196	0.103	0.104	0.103	0.105	**0.101**	0.109
Royal & Sun Alliance Ins Group	0.211	0.164	0.161	**0.155**	0.161	0.162	0.175
Scottish & Newcastle	0.401	0.197	**0.162**	0.166	0.169	0.174	0.205
Schroders PLC VTG Shs	0.192	0.078	0.077	**0.076**	0.078	0.078	0.078
Smiths Group	0.140	0.080	**0.074**	0.075	0.076	0.078	0.090
Smith & Nephew	0.197	0.133	**0.112**	0.118	0.113	**0.112**	0.130
Standard Chartered	0.420	0.165	**0.159**	0.164	0.167	0.167	0.166
Tate & Lyle	0.144	0.094	0.088	0.089	**0.086**	0.087	0.110
Tesco	0.229	0.128	**0.124**	0.125	0.127	0.129	0.135
Unilever	0.198	0.106	**0.095**	0.100	0.102	0.103	0.118
Wolseley	0.152	0.112	0.108	0.113	0.114	0.117	**0.105**
Whitbread PLC	0.183	0.095	**0.086**	0.089	0.089	0.089	0.093

The forecast period covers the period from 1986:2 through 2005:2.

Table 3: MAE of One-Quarter-Ahead Forecast of Beta
Based on the previous 80 Quarters

Company	Constant	AR(1)	AR(2)	AR(3)	AR(4)	AR(5)	RW
Aviva	0.478	0.339	0.294	**0.288**	0.294	0.295	0.334
Amvescap	0.551	0.345	0.336	0.321	**0.319**	0.321	0.331
Barclays	0.222	0.215	0.214	0.213	0.216	**0.207**	0.264
British American Tobacco	0.462	0.323	0.320	0.320	0.323	0.326	**0.319**
British Land	0.401	0.261	0.249	**0.238**	0.240	0.245	0.279
BOC Group	0.395	0.280	0.272	0.265	0.264	**0.262**	0.264
Boots Group	0.407	0.261	0.235	0.237	0.234	**0.233**	0.257
BP PLC	0.353	0.257	0.246	**0.242**	0.250	0.251	0.257
BPB PLC	0.350	0.316	**0.297**	**0.297**	0.301	0.303	0.318
Cadbury Schweppes	0.372	0.277	**0.257**	0.259	0.266	0.263	0.263
Diageo	0.388	0.258	**0.252**	0.256	0.265	0.267	0.270
Daily Mail & General Trust A	0.339	0.299	0.293	0.284	0.279	**0.275**	0.327
Dixons Group	0.398	0.352	**0.317**	**0.317**	0.318	0.320	0.359
GlaxoSmithKline	0.441	0.309	0.297	0.294	**0.292**	0.296	0.295
Gus	0.380	0.267	**0.243**	0.252	0.249	0.252	0.265
Hanson PLC	0.389	0.303	0.269	0.265	0.256	**0.251**	0.294
Imperial Chemical Industries	0.459	0.312	**0.299**	0.303	0.304	0.307	0.311
ITV	0.439	0.286	0.279	0.284	**0.278**	0.280	0.312
Johnson Matthey	0.327	0.254	0.245	0.242	0.244	**0.233**	0.260
Land Securities Group	0.306	0.192	**0.185**	0.188	0.188	0.187	0.195
Marks & Spencer	0.455	0.290	0.285	**0.280**	0.281	0.288	0.295
Next	0.412	0.287	**0.279**	**0.279**	0.284	0.289	0.294
Prudential	0.352	0.288	**0.267**	0.274	0.275	0.280	0.334
Reckitt Benckiser	0.486	0.291	0.279	**0.271**	0.276	**0.271**	0.302
Royal Bank of Scotland	0.543	0.320	0.323	0.326	0.312	**0.311**	0.340
Royal Dutch Shell B Shares	0.422	0.317	0.304	0.295	0.298	0.295	**0.293**
Reed Elsevier	0.308	0.263	0.261	0.250	**0.249**	0.253	0.292
Rexam	0.358	0.279	**0.258**	0.260	0.260	0.259	0.278
Rio Tinto	0.359	0.257	0.256	0.249	0.248	**0.242**	0.260
Royal & Sun Alliance Ins Group	0.371	0.298	0.295	**0.292**	0.300	0.307	0.308
Scottish & Newcastle	0.463	0.292	**0.259**	0.265	0.269	0.278	0.322
Schroders PLC VTG Shs	0.351	0.219	0.215	0.211	0.212	0.216	**0.209**
Smiths Group	0.294	0.227	**0.222**	**0.222**	0.225	0.228	0.250
Smith & Nephew	0.351	0.280	0.259	0.264	0.257	**0.256**	0.269
Standard Chartered	0.459	0.308	**0.301**	0.308	0.309	0.309	0.321
Tate & Lyle	0.300	0.246	0.233	0.230	0.228	**0.227**	0.260
Tesco	0.357	0.278	0.273	**0.272**	0.274	0.277	0.278
Unilever	0.358	0.251	**0.236**	0.243	0.244	0.248	0.258
Wolseley	0.282	0.246	**0.243**	0.248	0.252	0.258	0.260
Whitbread PLC	0.329	0.227	**0.225**	0.227	0.228	0.230	0.234

The forecast period covers the period from 1986:2 through 2005:2.

Table 4: MSE of One-Quarter-Ahead Forecast of Beta based on the previous 60 Quarters

Company	Constant	AR(1)	AR(2)	AR(3)	AR(4)	AR(5)	RW
Aviva	0.353	0.190	0.154	**0.149**	0.160	0.161	0.192
Amvescap	0.453	0.195	0.195	0.179	0.179	**0.170**	0.171
Barclays	0.078	**0.074**	0.077	0.077	0.080	0.080	0.107
British American Tobacco	0.327	0.169	0.164	**0.160**	0.163	0.168	0.172
British Land	0.222	0.111	0.107	**0.097**	0.099	0.101	0.129
BOC Group	0.265	0.117	**0.112**	**0.112**	**0.112**	**0.112**	0.117
Boots Group	0.270	0.101	**0.092**	0.094	0.096	0.099	0.101
BP PLC	0.217	0.106	0.104	**0.101**	0.107	0.109	0.116
BPB PLC	0.188	0.143	**0.131**	0.135	0.139	0.141	0.166
Cadbury Schweppes	0.240	0.151	**0.141**	0.145	0.149	0.148	0.167
Diageo	0.237	0.128	**0.115**	0.119	0.125	0.127	0.131
Daily Mail & General Trust A	0.186	0.150	0.146	0.143	0.145	**0.140**	0.197
Dixons Group	0.256	0.199	**0.186**	0.187	0.192	0.195	0.229
GlaxoSmithKline	0.335	0.147	0.138	0.138	0.137	0.140	**0.130**
Gus	0.204	0.120	**0.101**	0.105	0.105	0.109	0.144
Hanson PLC	0.252	0.132	**0.101**	0.107	0.111	0.110	0.143
Imperial Chemical Industries	0.348	0.155	**0.151**	0.154	0.155	0.157	0.152
ITV	0.309	0.148	**0.140**	0.147	0.146	0.149	0.156
Johnson Matthey	0.185	0.114	0.109	0.107	0.109	**0.105**	0.129
Land Securities Group	0.148	0.058	**0.056**	0.058	0.059	0.059	0.060
Marks & Spencer	0.302	0.128	0.119	**0.117**	0.119	0.122	0.134
Next	0.285	0.132	**0.129**	0.131	0.136	0.141	0.143
Prudential	0.202	**0.147**	0.148	0.148	0.148	0.154	0.187
Reckitt Benckiser	0.313	0.132	**0.121**	0.124	0.129	0.129	0.140
Royal Bank of Scotland	0.426	**0.155**	**0.155**	0.157	0.157	0.161	0.156
Royal Dutch Shell B Shares	0.266	0.175	0.172	0.172	0.179	0.173	**0.141**
Reed Elsevier	0.147	0.108	0.102	**0.099**	**0.099**	**0.099**	0.136
Rexam	0.190	0.117	**0.106**	0.108	0.109	0.110	0.131
Rio Tinto	0.180	**0.101**	0.103	0.104	0.106	0.105	0.109
Royal & Sun Alliance Ins Group	0.221	**0.157**	**0.157**	0.158	0.163	0.166	0.175
Scottish & Newcastle	0.354	0.192	**0.160**	0.163	0.170	0.173	0.205
Schroders PLC VTG Shs	0.199	0.079	**0.078**	0.079	0.079	0.079	**0.078**
Smiths Group	0.143	0.082	**0.078**	0.081	0.083	0.086	0.090
Smith & Nephew	0.199	0.114	**0.104**	**0.104**	0.108	0.113	0.130
Standard Chartered	0.392	0.161	**0.157**	0.163	0.169	0.172	0.166
Tate & Lyle	0.133	0.090	0.087	0.087	**0.086**	**0.086**	0.110
Tesco	0.217	0.127	**0.123**	0.125	0.129	0.130	0.135
Unilever	0.203	0.109	**0.099**	0.101	0.103	0.105	0.118
Wolseley	0.143	**0.104**	**0.104**	0.108	0.111	0.112	0.105
Whitbread PLC	0.174	0.091	**0.087**	0.088	0.090	0.091	0.093

The forecast period covers the period from 1986:2 through 2005:2.

Table 5: MAE of One-Quarter-Ahead Forecast of Beta based on the previous 60 Quarters

Company	Constant	AR(1)	AR(2)	AR(3)	AR(4)	AR(5)	RW
Aviva	0.492	0.339	0.296	**0.292**	0.297	0.296	0.334
Amvescap	0.508	0.343	0.338	0.317	0.317	**0.314**	0.331
Barclays	0.228	0.218	0.219	0.219	0.226	**0.216**	0.264
British American Tobacco	0.459	0.328	0.326	**0.318**	0.324	0.324	0.319
British Land	0.368	0.262	0.249	**0.237**	0.238	0.240	0.279
BOC Group	0.402	0.272	0.261	**0.256**	0.257	0.259	0.264
Boots Group	0.380	0.257	0.236	0.238	**0.235**	0.239	0.257
BP PLC	0.372	0.259	0.247	**0.244**	0.253	0.254	0.257
BPB PLC	0.353	0.309	0.296	**0.293**	0.297	0.301	0.318
Cadbury Schweppes	0.358	0.277	**0.258**	0.265	0.273	0.264	0.263
Diageo	0.385	0.260	**0.255**	0.264	0.276	0.280	0.270
Daily Mail & General Trust A	0.331	0.289	0.283	0.273	0.275	**0.270**	0.327
Dixons Group	0.399	0.345	**0.318**	0.319	0.323	0.327	0.359
GlaxoSmithKline	0.453	0.308	0.298	0.293	**0.289**	0.294	0.295
Gus	0.399	0.265	**0.247**	0.256	0.253	0.257	0.265
Hanson PLC	0.403	0.287	0.255	0.254	0.258	**0.253**	0.294
Imperial Chemical Industries	0.476	0.312	**0.300**	0.304	0.304	0.308	0.311
ITV	0.436	0.287	0.285	0.292	**0.283**	0.287	0.312
Johnson Matthey	0.363	0.267	0.257	0.252	0.255	**0.240**	0.260
Land Securities Group	0.291	0.185	0.183	0.184	0.185	**0.182**	0.195
Marks & Spencer	0.457	0.292	0.285	**0.282**	0.286	0.294	0.295
Next	0.413	0.284	**0.280**	0.284	0.292	0.297	0.294
Prudential	0.349	0.284	**0.272**	0.279	0.282	0.287	0.334
Reckitt Benckiser	0.482	0.291	0.281	**0.280**	0.288	0.283	0.302
Royal Bank of Scotland	0.539	0.323	0.326	0.328	**0.317**	0.319	0.340
Royal Dutch Shell B Shares	0.427	0.335	0.324	0.317	0.324	0.315	**0.293**
Reed Elsevier	0.312	0.262	0.263	0.254	**0.250**	0.256	0.292
Rexam	0.363	0.276	**0.258**	0.263	0.263	**0.258**	0.278
Rio Tinto	0.342	**0.254**	0.256	**0.254**	0.256	0.256	0.260
Royal & Sun Alliance Ins Group	0.380	**0.289**	**0.289**	**0.289**	0.300	0.306	0.308
Scottish & Newcastle	0.432	0.287	**0.260**	0.265	0.272	0.276	0.322
Schroders PLC VTG Shs	0.363	0.218	0.215	0.215	0.215	0.218	**0.209**
Smiths Group	0.300	0.234	**0.230**	0.233	0.236	0.240	0.250
Smith & Nephew	0.358	0.260	0.253	**0.252**	0.255	0.257	0.269
Standard Chartered	0.443	0.305	**0.298**	0.306	0.310	0.314	0.321
Tate & Lyle	0.287	0.241	0.233	0.229	0.228	**0.225**	0.260
Tesco	0.357	0.275	0.272	**0.272**	0.276	0.278	0.278
Unilever	0.362	0.253	**0.238**	0.244	0.246	0.250	0.258
Wolseley	0.274	**0.242**	0.246	0.252	0.255	0.260	0.260
Whitbread PLC	0.326	**0.223**	0.224	0.226	0.228	0.231	0.234

The forecast period covers the period from 1986:2 through 2005:2.

Table 6: MSE of One-Quarter-Ahead Forecast of Beta based on the previous 40 Quarters

Company	Constant	AR(1)	AR(2)	AR(3)	AR(4)	AR(5)	RW
Aviva	0.338	0.190	0.158	**0.155**	0.169	0.174	0.192
Amvescap	0.378	0.167	0.179	0.170	0.169	**0.165**	0.171
Barclays	0.088	**0.080**	0.082	0.082	0.087	0.090	0.107
British American Tobacco	0.333	0.168	**0.164**	**0.164**	0.171	0.178	0.172
British Land	0.150	0.103	0.104	**0.096**	0.105	0.109	0.129
BOC Group	0.269	0.118	**0.115**	0.117	0.119	0.120	0.117
Boots Group	0.264	**0.097**	**0.097**	0.100	0.106	0.115	0.101
BP PLC	0.231	0.113	**0.112**	0.113	**0.112**	0.117	0.116
BPB PLC	0.198	0.142	**0.135**	0.138	0.146	0.155	0.166
Cadbury Schweppes	0.240	0.153	**0.145**	0.150	0.158	0.165	0.167
Diageo	0.240	0.129	**0.118**	0.120	0.136	0.145	0.131
Daily Mail & General Trust A	0.186	**0.154**	0.155	0.158	0.175	0.174	0.197
Dixons Group	0.279	0.196	**0.183**	0.198	0.205	0.218	0.229
GlaxoSmithKline	0.357	0.148	0.138	0.138	0.136	0.140	**0.130**
Gus	0.198	0.127	**0.103**	0.112	0.107	0.113	0.144
Hanson PLC	0.276	0.130	**0.102**	**0.102**	0.108	0.110	0.143
Imperial Chemical Industries	0.306	0.155	0.154	0.158	0.160	0.165	**0.152**
ITV	0.297	0.150	**0.143**	0.146	0.146	0.155	0.156
Johnson Matthey	0.190	0.122	0.117	**0.116**	0.123	0.118	0.129
Land Securities Group	0.128	**0.056**	**0.056**	0.057	0.060	0.060	0.060
Marks & Spencer	0.289	0.123	0.118	**0.117**	0.121	0.125	0.134
Next	0.283	**0.136**	0.139	0.142	0.149	0.160	0.143
Prudential	0.205	**0.150**	0.157	0.159	0.164	0.175	0.187
Reckitt Benckiser	0.285	0.132	**0.124**	0.126	0.130	0.135	0.140
Royal Bank of Scotland	0.388	**0.152**	0.158	0.162	0.162	0.167	0.156
Royal Dutch Shell B Shares	0.269	0.158	0.161	0.166	0.176	0.170	**0.141**
Reed Elsevier	0.132	0.103	0.102	**0.099**	**0.099**	0.103	0.136
Rexam	0.182	0.119	**0.109**	0.110	0.111	0.110	0.131
Rio Tinto	0.158	**0.100**	0.101	0.103	0.107	0.106	0.109
Royal & Sun Alliance Ins Group	0.220	**0.150**	0.158	0.157	0.163	0.172	0.175
Scottish & Newcastle	0.282	0.184	**0.162**	0.163	0.170	0.182	0.205
Schroders PLC VTG Shs	0.195	0.079	0.080	0.082	0.085	0.085	**0.078**
Smiths Group	0.146	**0.082**	**0.082**	0.086	0.091	0.096	0.090
Smith & Nephew	0.204	**0.095**	0.096	0.100	0.105	0.107	0.130
Standard Chartered	0.375	0.161	**0.159**	0.166	0.174	0.176	0.166
Tate & Lyle	0.114	**0.088**	0.090	0.093	0.095	0.096	0.110
Tesco	0.213	0.127	**0.123**	0.125	0.129	0.131	0.135
Unilever	0.206	0.106	**0.098**	0.099	0.101	0.103	0.118
Wolseley	0.138	**0.099**	**0.099**	0.111	0.112	0.113	0.105
Whitbread PLC	0.150	0.084	**0.081**	0.084	0.088	0.094	0.093

The forecast period covers the period from 1986:2 through 2005:2.

Table 7: MAE of One-Quarter-Ahead Forecast of Beta based on the previous 40 Quarters

Company	Constant	AR(1)	AR(2)	AR(3)	AR(4)	AR(5)	RW
Aviva	0.474	0.334	0.297	**0.293**	0.298	0.305	0.334
Amvescap	0.448	0.321	0.321	0.306	**0.301**	0.306	0.331
Barclays	0.240	**0.225**	0.230	0.226	0.236	0.232	0.264
British American Tobacco	0.469	0.333	0.328	0.321	0.329	0.335	**0.319**
British Land	0.298	0.250	0.247	**0.238**	0.241	0.242	0.279
BOC Group	0.407	0.272	0.264	**0.262**	0.265	0.268	0.264
Boots Group	0.379	0.250	**0.245**	**0.245**	**0.245**	0.253	0.257
BP PLC	0.385	0.258	**0.251**	0.254	0.255	0.259	0.257
BPB PLC	0.357	0.302	0.294	**0.290**	0.300	0.316	0.318
Cadbury Schweppes	0.358	0.275	**0.257**	0.266	0.275	0.275	0.263
Diageo	0.388	0.261	**0.252**	0.262	0.279	0.288	0.270
Daily Mail & General Trust A	0.327	0.289	0.285	**0.279**	0.289	0.285	0.327
Dixons Group	0.410	0.334	**0.306**	0.320	0.326	0.342	0.359
GlaxoSmithKline	0.469	0.306	0.295	0.290	**0.288**	0.293	0.295
Gus	0.375	0.268	0.249	0.261	**0.245**	0.248	0.265
Hanson PLC	0.412	0.286	0.251	**0.249**	0.263	0.266	0.294
Imperial Chemical Industries	0.456	0.310	**0.303**	0.309	0.310	0.317	0.311
ITV	0.429	**0.296**	**0.296**	0.306	0.300	0.307	0.312
Johnson Matthey	0.362	0.273	0.262	**0.259**	0.265	0.260	0.260
Land Securities Group	0.270	0.183	**0.181**	0.182	0.183	0.184	0.195
Marks & Spencer	0.435	0.284	0.283	**0.282**	0.287	0.297	0.295
Next	0.426	**0.283**	0.289	0.296	0.305	0.315	0.294
Prudential	0.341	0.284	**0.274**	0.284	0.288	0.297	0.334
Reckitt Benckiser	0.454	0.291	0.285	**0.281**	0.287	0.291	0.302
Royal Bank of Scotland	0.512	0.324	0.334	0.337	0.324	**0.323**	0.340
Royal Dutch Shell B Shares	0.431	0.316	0.313	0.313	0.325	0.325	**0.293**
Reed Elsevier	0.301	0.256	0.264	0.256	**0.251**	0.258	0.292
Rexam	0.358	0.280	**0.261**	0.268	0.269	0.262	0.278
Rio Tinto	0.307	**0.253**	0.254	0.256	0.257	0.255	0.260
Royal & Sun Alliance Ins Group	0.379	**0.278**	0.290	0.288	0.294	0.304	0.308
Scottish & Newcastle	0.366	0.282	**0.260**	0.262	0.273	0.286	0.322
Schroders PLC VTG Shs	0.354	0.213	0.213	0.218	0.220	0.224	**0.209**
Smiths Group	0.300	**0.233**	0.236	0.242	0.249	0.255	0.250
Smith & Nephew	0.369	**0.252**	0.254	0.258	0.264	0.260	0.269
Standard Chartered	0.454	0.306	**0.301**	0.310	0.318	0.324	0.321
Tate & Lyle	0.270	**0.239**	**0.239**	0.241	0.243	0.243	0.260
Tesco	0.361	**0.268**	0.271	0.270	0.275	0.277	0.278
Unilever	0.357	0.245	**0.239**	0.245	0.244	0.252	0.258
Wolseley	0.271	0.240	**0.239**	0.253	0.256	0.254	0.260
Whitbread PLC	0.304	**0.219**	0.222	0.224	0.228	0.236	0.234

The forecast period covers the period from 1986:2 through 2005:2.

Table 8: MSE of One-Quarter-Ahead Forecast of Beta based on the previous 20 Quarters

Company	Constant	AR(1)	AR(2)	AR(3)	AR(4)	AR(5)	RW
Aviva	0.284	0.174	**0.162**	0.170	0.190	0.201	0.192
Amvescap	0.254	**0.154**	0.179	0.182	0.186	0.185	0.171
Barclays	**0.082**	**0.082**	0.089	0.093	0.100	0.102	0.107
British American Tobacco	0.334	0.182	0.185	0.187	0.198	0.222	**0.172**
British Land	0.177	**0.123**	0.129	0.125	0.149	0.158	0.129
BOC Group	0.224	0.121	0.124	0.131	0.137	0.141	**0.117**
Boots Group	0.243	0.124	0.123	0.131	0.136	0.143	**0.101**
BP PLC	0.217	0.128	0.135	0.135	0.137	0.153	**0.116**
BPB PLC	0.188	**0.144**	0.152	0.147	0.159	0.171	0.166
Cadbury Schweppes	0.250	0.180	0.174	0.193	0.216	0.228	**0.167**
Diageo	0.269	0.160	0.156	0.171	0.187	0.208	**0.131**
Daily Mail & General Trust A	**0.144**	0.147	0.163	0.170	0.198	0.201	0.197
Dixons Group	0.249	**0.212**	0.221	0.253	0.294	0.320	0.229
GlaxoSmithKline	0.362	0.156	0.160	0.170	0.172	0.190	**0.130**
Gus	0.153	0.112	**0.100**	0.115	0.129	0.192	0.144
Hanson PLC	0.217	0.130	0.117	**0.116**	0.124	0.135	0.143
Imperial Chemical Industries	0.236	0.174	0.193	0.213	0.227	0.260	**0.152**
ITV	0.214	0.157	0.163	0.176	0.178	0.189	**0.156**
Johnson Matthey	0.141	**0.108**	0.111	0.122	0.129	0.132	0.129
Land Securities Group	0.142	0.064	0.065	0.068	0.071	0.075	**0.060**
Marks & Spencer	0.286	**0.132**	0.138	0.149	0.157	0.162	0.134
Next	0.253	**0.137**	0.151	0.155	0.167	0.196	0.143
Prudential	0.220	**0.181**	0.186	0.216	0.225	0.243	0.187
Reckitt Benckiser	0.248	**0.138**	0.143	0.149	0.160	0.171	0.140
Royal Bank of Scotland	0.308	0.164	0.178	0.195	0.188	0.189	**0.156**
Royal Dutch Shell B Shares	0.239	0.142	0.150	0.164	0.179	0.185	**0.141**
Reed Elsevier	0.147	**0.121**	0.132	0.146	0.149	0.167	0.136
Rexam	0.190	**0.124**	0.128	0.139	0.147	0.153	0.131
Rio Tinto	0.141	**0.099**	0.109	0.118	0.119	0.114	0.109
Royal & Sun Alliance Ins Group	0.204	**0.144**	0.158	0.165	0.187	0.205	0.175
Scottish & Newcastle	0.191	0.164	**0.159**	0.164	0.183	0.193	0.205
Schroders PLC VTG Shs	0.194	0.082	0.092	0.101	0.104	0.108	**0.078**
Smiths Group	0.158	0.087	**0.085**	0.093	0.104	0.115	0.090
Smith & Nephew	0.181	**0.090**	0.094	0.099	0.104	0.106	0.130
Standard Chartered	0.337	0.183	0.200	0.205	0.218	0.240	**0.166**
Tate & Lyle	0.111	**0.089**	0.095	0.105	0.112	0.119	0.110
Tesco	0.217	0.147	0.171	0.177	0.195	0.204	**0.135**
Unilever	0.231	0.123	**0.117**	0.124	0.130	0.138	0.118
Wolseley	0.156	**0.104**	0.113	0.120	0.129	0.131	0.105
Whitbread PLC	0.149	0.102	0.104	0.116	0.128	0.151	**0.093**

The forecast period covers the period from 1986:2 through 2005:2.

Table 9: MAE of One-Quarter-Ahead Forecast of Beta based on the previous 20 Quarters

Company	Constant	AR(1)	AR(2)	AR(3)	AR(4)	AR(5)	RW
Aviva	0.424	0.319	**0.298**	0.313	0.325	0.330	0.334
Amvescap	0.372	**0.314**	0.335	0.330	0.332	0.334	0.331
Barclays	0.223	**0.219**	0.235	0.241	0.253	0.251	0.264
British American Tobacco	0.473	0.343	0.335	0.334	0.349	0.361	**0.319**
British Land	0.335	**0.270**	0.277	0.273	0.293	0.300	0.279
BOC Group	0.372	0.266	**0.261**	0.272	0.283	0.287	0.264
Boots Group	0.372	0.272	0.262	0.267	0.270	0.277	**0.257**
BP PLC	0.356	0.262	0.267	0.268	0.270	0.277	**0.257**
BPB PLC	0.345	0.310	0.316	**0.308**	0.325	0.339	0.318
Cadbury Schweppes	0.369	0.290	**0.272**	0.293	0.318	0.331	0.263
Diageo	0.409	0.297	0.295	0.313	0.337	0.345	**0.270**
Daily Mail & General Trust A	**0.270**	0.273	0.286	0.284	0.305	0.305	0.327
Dixons Group	0.379	0.352	**0.341**	0.369	0.379	0.397	0.359
GlaxoSmithKline	0.478	0.311	0.313	0.313	0.317	0.336	**0.295**
Gus	0.305	0.247	**0.236**	0.251	0.246	0.283	0.265
Hanson PLC	0.356	0.283	**0.266**	**0.266**	0.277	0.288	0.294
Imperial Chemical Industries	0.365	**0.308**	0.325	0.340	0.356	0.378	0.311
ITV	0.352	**0.299**	0.300	0.328	0.322	0.330	0.312
Johnson Matthey	0.296	**0.252**	0.255	0.264	0.276	0.280	0.260
Land Securities Group	0.292	**0.195**	0.196	0.205	0.207	0.217	**0.195**
Marks & Spencer	0.438	0.306	0.317	0.322	0.327	0.328	**0.295**
Next	0.402	**0.287**	0.295	0.308	0.318	0.345	0.294
Prudential	0.343	0.303	**0.296**	0.308	0.320	0.339	0.334
Reckitt Benckiser	0.408	**0.296**	0.303	0.309	0.318	0.333	0.302
Royal Bank of Scotland	0.441	**0.326**	0.342	0.358	0.342	0.343	0.340
Royal Dutch Shell B Shares	0.386	0.298	0.308	0.313	0.339	0.348	**0.293**
Reed Elsevier	0.315	**0.270**	0.282	0.288	0.287	0.308	0.292
Rexam	0.349	0.281	**0.277**	0.284	0.290	0.297	0.278
Rio Tinto	0.288	**0.248**	0.257	0.266	0.269	0.262	0.260
Royal & Sun Alliance Ins Group	0.343	**0.280**	0.301	0.312	0.330	0.343	0.308
Scottish & Newcastle	0.290	0.263	**0.252**	0.260	0.282	0.303	0.322
Schroders PLC VTG Shs	0.354	0.220	0.232	0.239	0.243	0.250	**0.209**
Smiths Group	0.314	0.244	**0.237**	0.246	0.258	0.274	0.250
Smith & Nephew	0.331	**0.235**	0.244	0.252	0.255	0.249	0.269
Standard Chartered	0.440	0.323	0.325	0.333	0.343	0.365	**0.321**
Tate & Lyle	0.270	**0.235**	0.244	0.264	0.275	0.288	0.260
Tesco	0.359	0.280	0.296	0.306	0.321	0.343	**0.278**
Unilever	0.378	0.270	**0.253**	0.263	0.272	0.278	0.258
Wolseley	0.307	**0.256**	0.263	0.273	0.278	0.275	0.260
Whitbread PLC	0.320	0.253	0.251	0.260	0.269	0.290	**0.234**

The forecast period covers the period from 1986:2 through 2005:2.

Table 10: Average MSE of One-Quarter-Ahead Forecast of Beta
British Companies

In-Sample Size	Constant	AR(1)	AR(2)	AR(3)	AR(4)	AR(5)	RW
80	0.248	0.132	**0.122**	**0.122**	0.123	0.124	0.140
60	0.244	0.130	0.123	0.123	0.126	0.127	0.140
40	0.235	0.128	0.124	0.126	0.131	0.135	0.140
20	0.214	0.135	0.140	0.149	0.160	0.172	0.140

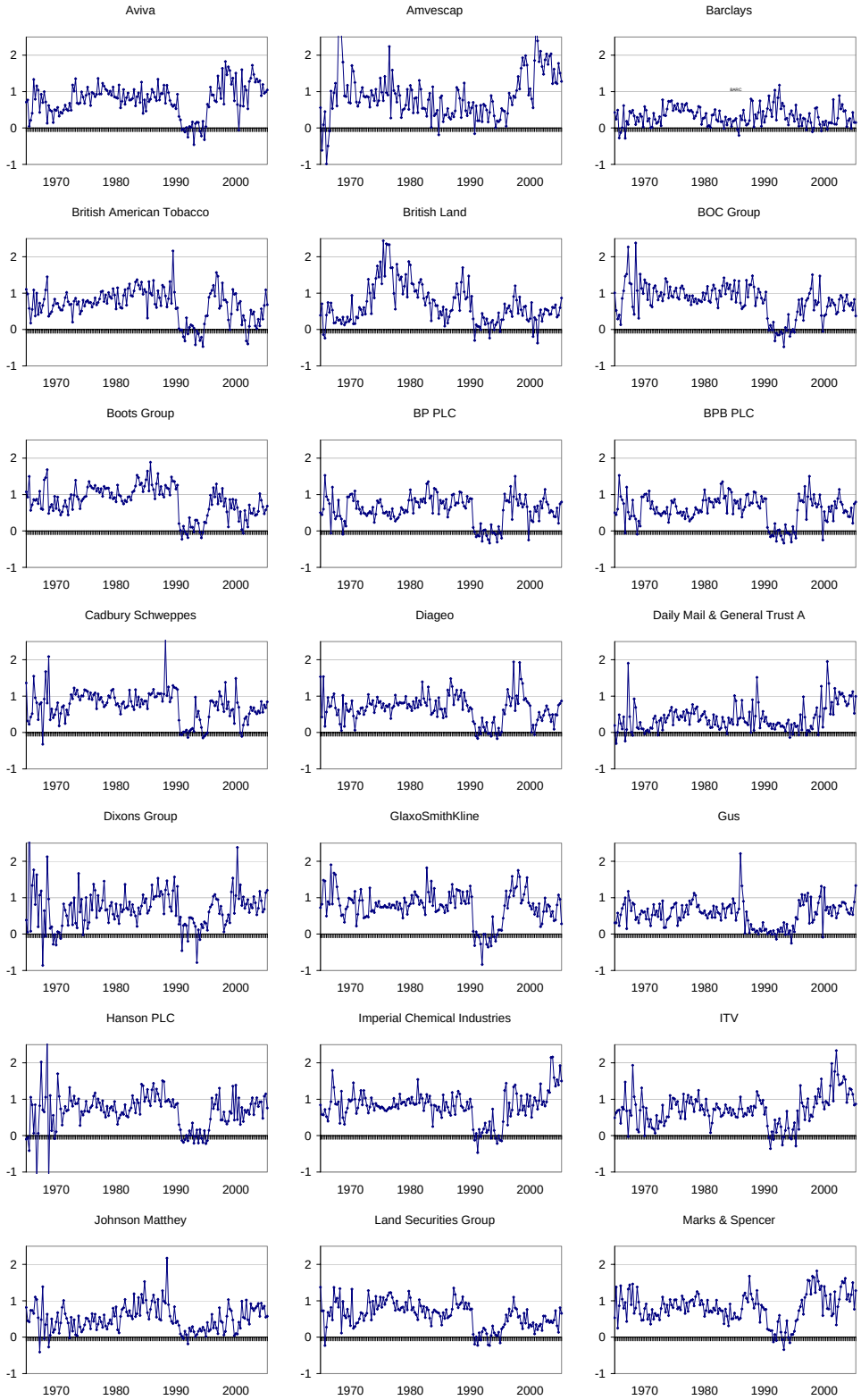
Values are computed by taking the mean of the 40 British company's MSE values in each of the various in-sample sizes and for each model. The minimum value is indicated in bold.

Table 11: Average MAE of One-Quarter-Ahead Forecast of Beta
British Companies

In-Sample Size	Constant	AR(1)	AR(2)	AR(3)	AR(4)	AR(5)	RW
80	0.387	0.279	0.267	**0.266**	0.267	0.267	0.286
60	0.386	0.277	0.268	0.267	0.270	0.271	0.286
40	0.377	0.274	0.268	0.270	0.274	0.278	0.286
20	0.356	0.279	0.281	0.290	0.299	0.310	0.286

Values are computed by taking the mean of the 40 British company's MAE values in each of the various in-sample sizes and for each model. The minimum value is indicated in bold.

Figure 1: Quarterly Realized Betas for British Companies



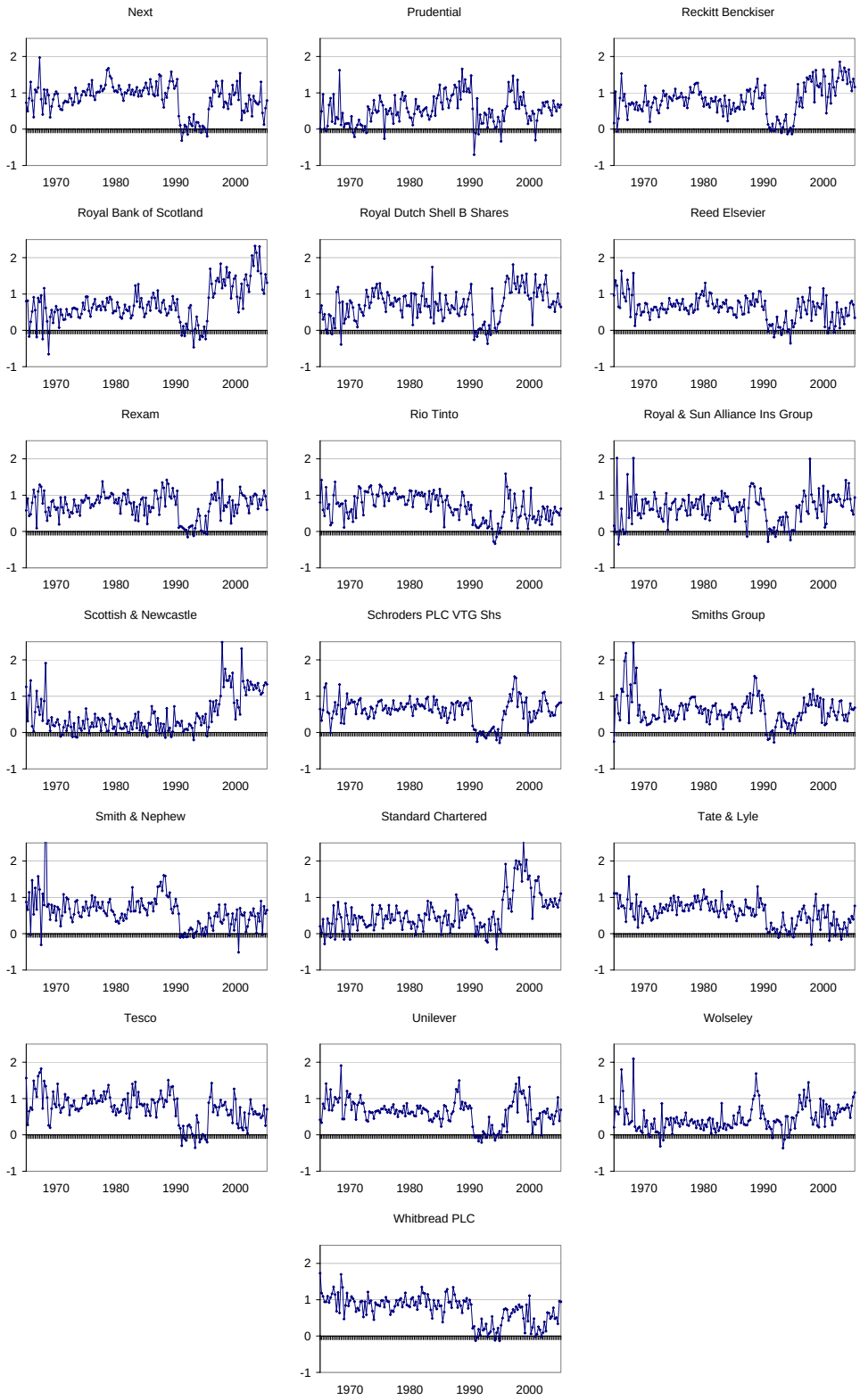


Figure 1: The sample covers from 4th January 1965 to the 30th June 2005.. The sample size is 162.

Figure 2: Autocorrelation Functions - Quarterly Realized Betas for UK Companies

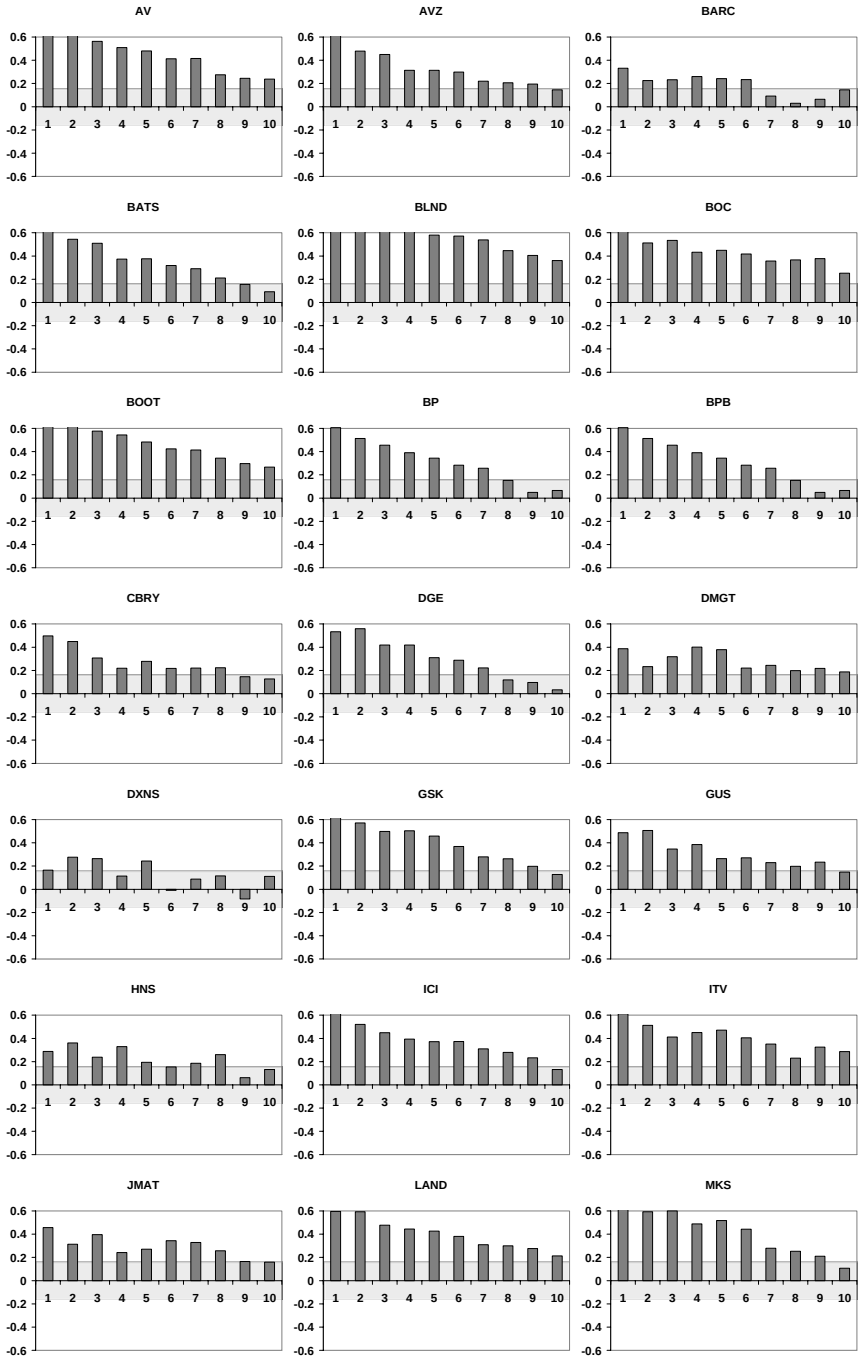


Figure 2: The sample covers from 4th January 1965 to the 30th June 2005.. The sample size is 162. The graphs include a 95% significance interval band.

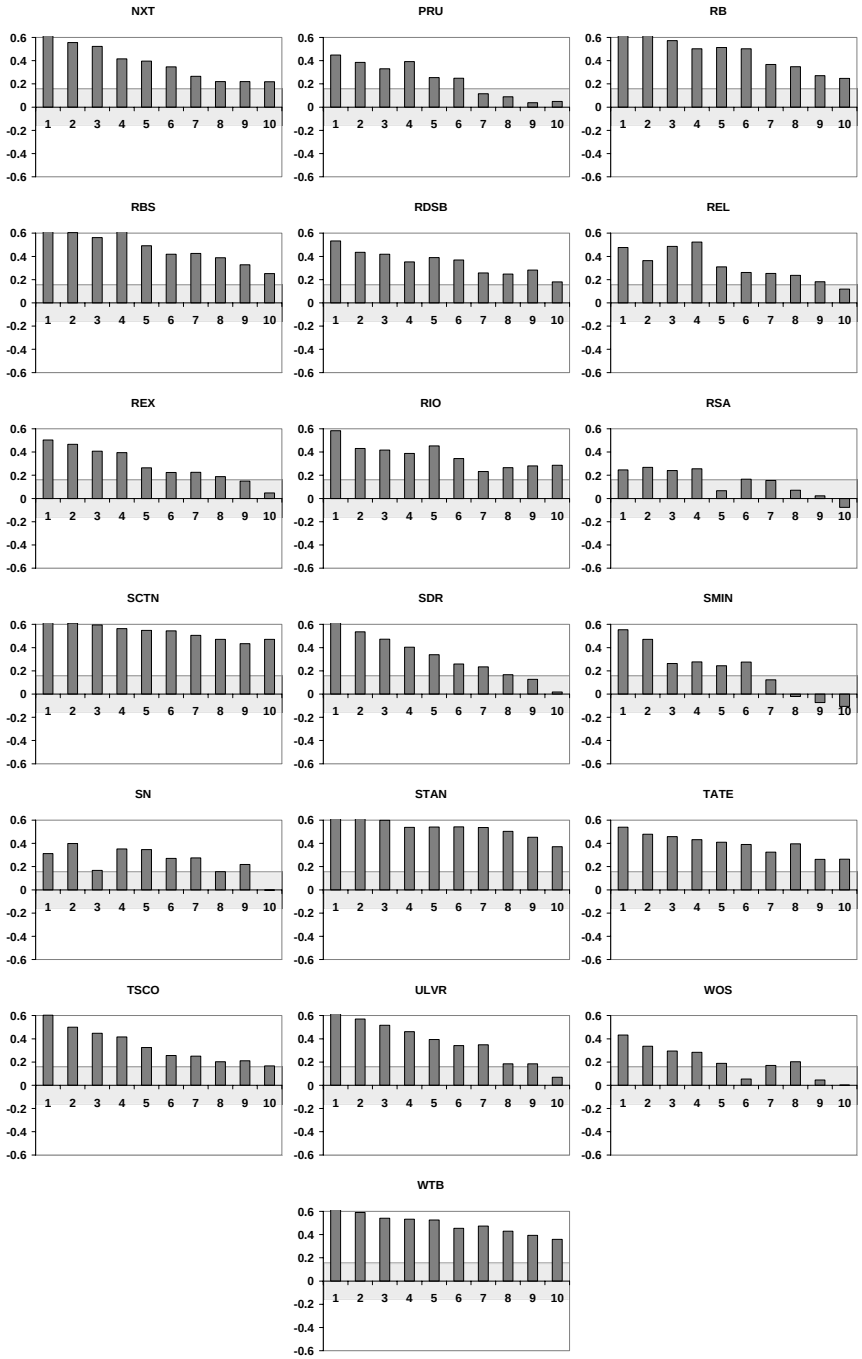


Figure 2: The sample covers from 4th January 1965 to the 30th June 2005.. The sample size is 162. The graphs include a 95% significance interval band.

Figure 3 : Partial Autocorrelation Functions - Quarterly Realized Betas for UK Companies

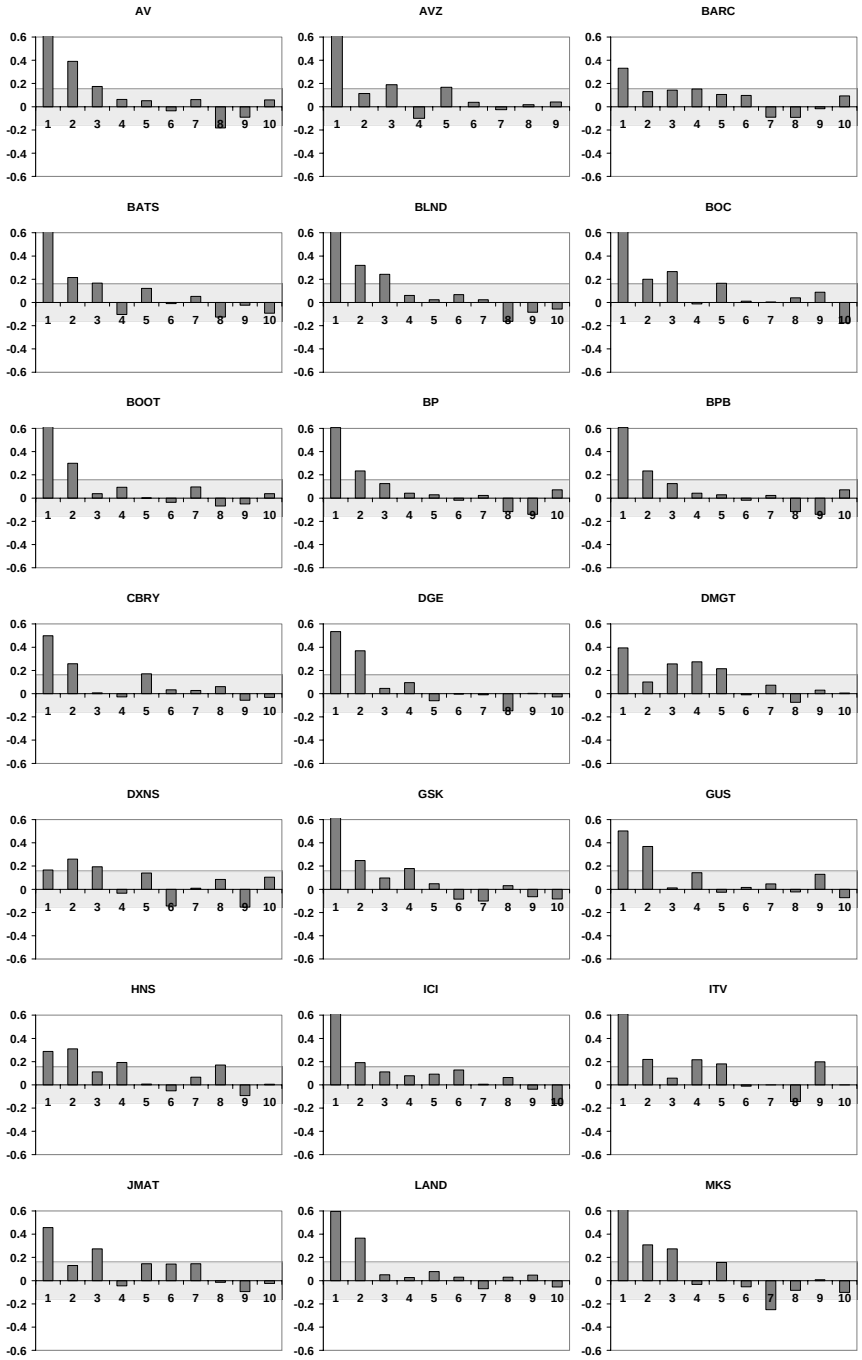


Figure 3: The sample covers from 4th January 1965 to the 30th June 2005. The sample size is 162. The graphs include a 95% significance interval band.

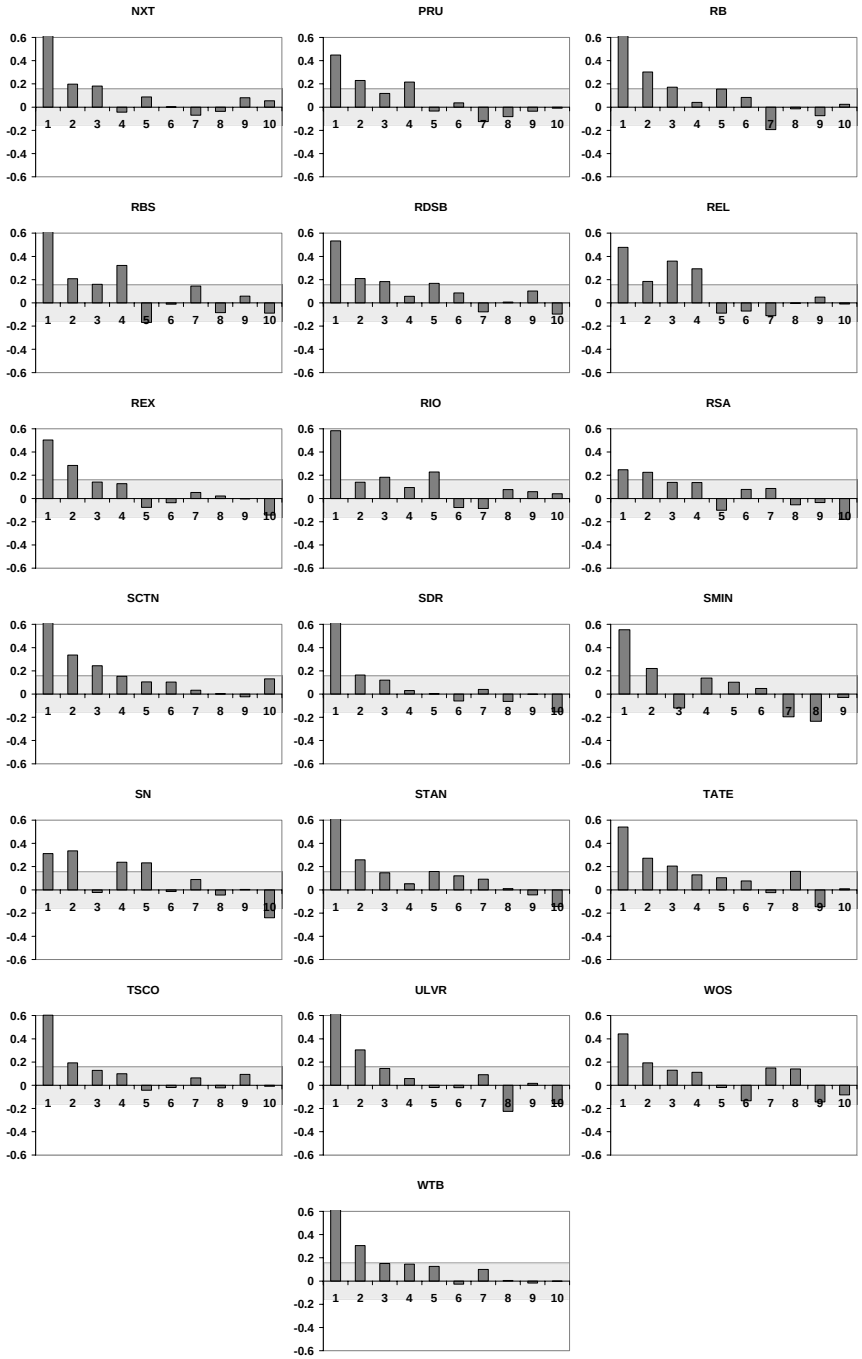


Figure 3: The sample covers from 4th January 1965 to the 30th June 2005.. The sample size is 162. The graphs include a 95% significance interval band.