Online Appendix
to
Measuring the Risk-Return Tradeoff with Time-Varying Conditional Covariances

June 18, 2014

1 Distribution of t-statistics for the multi-step estimation

In this section, we analyze the empirical distribution of the t-statistics that arise from our multi-step panel data estimation. We first estimate the model on real data, using monthly data for five different data sets:

1. The market only
2. The market and the 6 size- and book-to-market sorted portfolios
3. The market and the 10 size-sorted portfolios
4. The market and the 10 book-to-market sorted portfolios
5. The market and the 25 size- and book-to-market sorted portfolios

We use monthly data from February 1954 to December 2012, for $T = 707$ observations. For each data set, we estimate an N-dimensional DCC-GARCH model to the data. For instance, for the 10 size-sorted portfolios we estimate a 11-dimensional DCC-GARCH model to the monthly excess returns on the market and the 10 size-sorted portfolios. For each estimation, we save the 707 ($N \times 1$ vectors of) standardized residuals.

To analyze the properties of the estimation procedure, we perform the estimations on simulated data. To simulate data, we simulate $T = 707$ observations from an N-dimensional DCC-GARCH model, drawing with replacement from the standardized residuals from above. In the simulations, we fix the risk-return trade-off to be zero such that there is no relation between the conditional covariances with the market and the conditional expected return on an asset. Finally, we perform the estimation outlined in the main paper on the simulated data sets, using the return on the market as the only state-variable.

1. Estimate GARCH(1,1) models for the conditional variances of the individual (simulated) asset returns.

2. Estimate the DCC model for the correlation matrix process for all assets, using the standardized residuals from step one.

3. Compute the conditional covariance matrix process using the conditional variances from step one and the conditional correlation matrix from step two.

4. Estimate the risk-return parameters in the constrained panel data system.

We perform 1,000 simulations and estimations for each of the five data sets. Figure 1 shows QQ-plots of the t-statistics from this multi-step estimation procedure. Despite the fact that the conditional covariances are estimated in a separate step and used in the panel data estimation, the distribution of the t-statistics is very close to a standard normal distribution.

Figure 1: QQ-Plots of t-Statistics

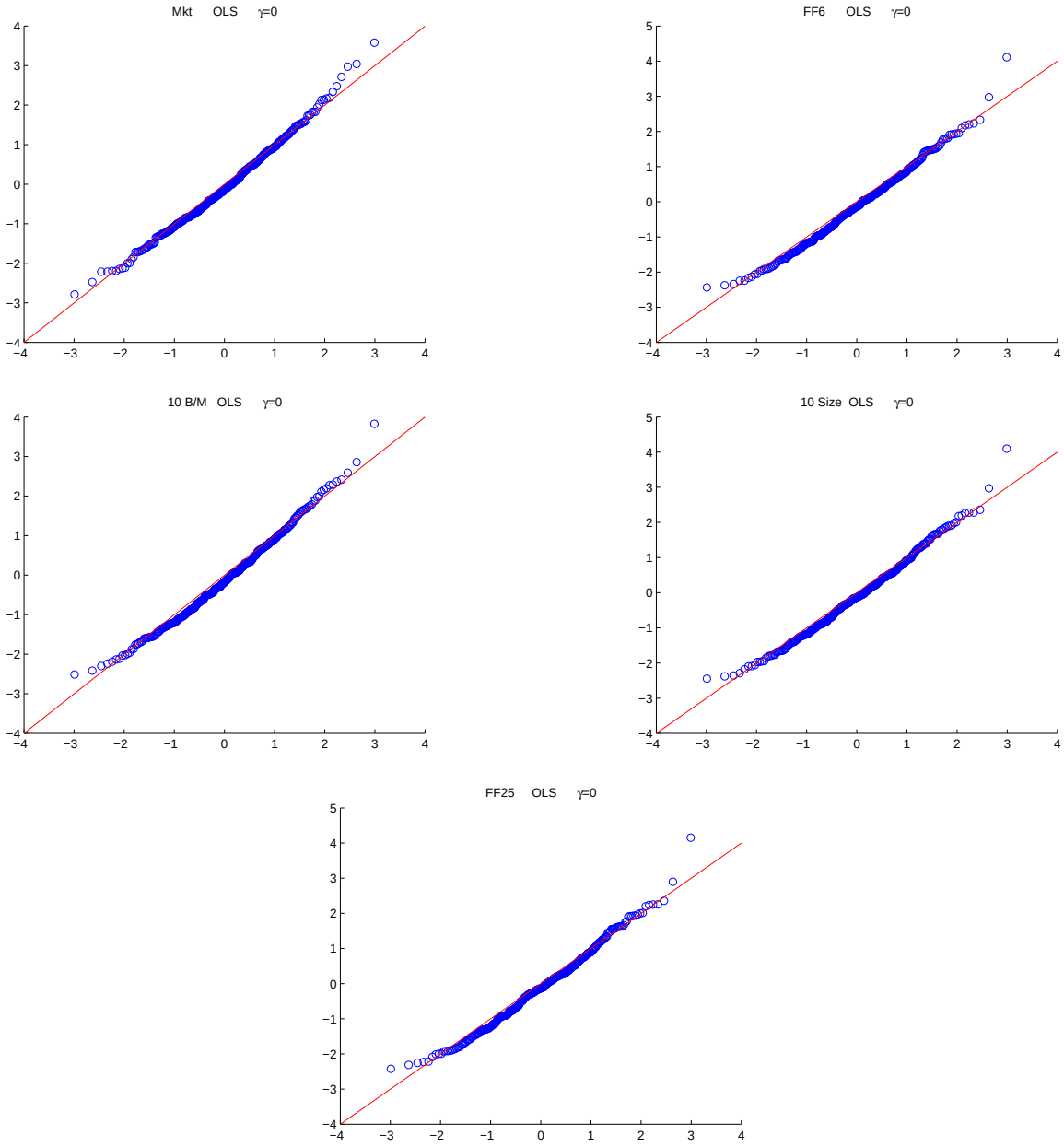

Table 1: Daily excess returns on stock portfolios

Size	Return	BM	Return	MOM	Return	Industry	Return
small	0.0191%	Growth	0.0113%	Loser	−0.0184%	NoDur	0.0280%
2	0.0212%	2	0.0205%	2	0.0081%	Durbl	0.0114%
3	0.0236%	3	0.0216%	3	0.0177%	Manuf	0.0213%
4	0.0223%	4	0.0242%	4	0.0177%	Enrgy	0.0340%
5	0.0248%	5	0.0215%	5	0.0146%	HiTec	0.0202%
6	0.0229%	6	0.0230%	6	0.0206%	Telcm	0.0213%
7	0.0242%	7	0.0267%	7	0.0195%	Shops	0.0209%
8	0.0219%	8	0.0276%	8	0.0307%	Hlth	0.0244%
9	0.0219%	9	0.0320%	9	0.0257%	Utils	0.0202%
Big	0.0175%	Value	0.0371%	Winner	0.0441%	Other	0.0187%

2 Replication of Bali and Engle (2010)

2.1 Data

We first present summary statistics on the data to compare to the summary statistics in Bali and Engle (2010b). Table 1 corresponds to the table in Bali and Engle (2010b, Appendix C) and shows the average *daily* excess returns on the value-weighted 10 Size, Book-to-Market (BM), Momentum (MOM), and Industry portfolios from January 3, 1972 to June 30, 2009. Excess returns on portfolios are obtained by subtracting the daily returns on 1-month Treasury bills (obtained from the daily Fama/French factors file from Ken French' web site) from the raw returns on portfolios. The numbers are virtually identical to those reported by Bali and Engle (2010b).

Table 2 corresponds to the table in Bali and Engle (2010b, Appendix B) and shows the average daily excess return on the 30 Dow stocks over the period July 10, 1986 to to June 30, 2009. Excess returns on portfolios are obtained by subtracting the daily returns on 1-month Treasury bills (obtained from Ken French' web site) from the raw returns. For this table, our results are quite different from the ones reported in Bali and Engle (2010b). In particular, we find that the average returns are positive for all but one stock (GM), whereas Bali and Engle (2010b) report a negative average return for 13 out of the 30 stocks.

2.2 Replication

In the following, we try to replicate the results in Bali and Engle (2010a). In general, we are able to replicate their findings, however, when we calculate the correct GMM standard errors, we find that the parameter estimates are generally not significantly different from zero. Also, for all tables, our results for the size-sorted portfolios are very different from the results in Bali and Engle (2010a).

For all tables, we first present the results reported in Bali and Engle (2010a). Next, we

Table 2: Daily excess returns on Dow 30 stocks

Stock	Mean	Median	Maximum	Minimum	Std. Dev.
MMM	0.000330	−0.00015	0.1151	−0.2601	0.0158
AA	0.000353	−0.00021	0.2321	−0.2413	0.0239
MO	0.000606	0.00041	0.1637	−0.2301	0.0184
AIG	0.000083	−0.00020	0.6600	−0.6080	0.0308
AXP	0.000396	−0.00020	0.2065	−0.2626	0.0242
BA	0.000296	−0.00018	0.1546	−0.1764	0.0196
CAT	0.000416	−0.00019	0.1472	−0.2165	0.0208
C	0.000466	−0.00021	0.5782	−0.3903	0.0301
KO	0.000435	−0.00012	0.1965	−0.2472	0.0167
DIS	0.000378	−0.00019	0.1907	−0.2912	0.0207
DD	0.000249	−0.00020	0.1146	−0.1830	0.0183
XOM	0.000481	−0.00011	0.1788	−0.2346	0.0162
GE	0.000339	−0.00018	0.1970	−0.1751	0.0187
GM	−0.000219	−0.00030	0.3511	−0.3304	0.0290
HPQ	0.000577	−0.00014	0.2090	−0.2032	0.0253
HD	0.000816	−0.00018	0.1406	−0.2876	0.0225
HON	0.000360	−0.00020	0.3119	−0.2942	0.0215
IMB	0.000275	−0.00015	0.1315	−0.2299	0.0189
INTC	0.000866	−0.00013	0.2635	−0.2206	0.0278
JNJ	0.000480	−0.00012	0.1223	−0.1838	0.0155
JPM	0.000464	−0.00020	0.2510	−0.2775	0.0259
MCD	0.000424	−0.00018	0.1084	−0.1665	0.0173
MRK	0.000400	−0.00012	0.1302	−0.2679	0.0184
MSFT	0.001098	−0.00011	0.1954	−0.3014	0.0237
PFE	0.000396	−0.00019	0.1022	−0.1733	0.0187
PG	0.000467	−0.00010	0.2217	−0.3140	0.0163
UTX	0.000471	−0.00018	0.1364	−0.2827	0.0180
VZ	0.000258	−0.00018	0.1463	−0.1757	0.0171
WMT	0.000519	−0.00019	0.1242	−0.1181	0.0189
T	0.000345	−0.00019	0.2022	−0.2196	0.0180

present our replication using the SUR estimation procedure used in Bali and Engle (2010a). For this estimation, we report both the usual SUR standard errors—which do not account for time-varying volatilty—as well as GMM standard errors. The SUR standard errors are close to the standard errors reported in Bali and Engle (2010a), whereas the GMM standard errors are typically much larger. Next, we report the results for the OLS estimation and the CMLE estimation.

For the replication of Table 1 in Bali and Engle (2010a), our SUR estimates are very close to the results reported in Bali and Engle (2010a), except for the 10 size-sorted portfolios. However, our replication in Panel B shows how using the incorrect SUR standard errors give the false impression that there is a significant risk-return trade-off: The correct standard errors are more than four times larger, and the point estimates are no longer significantly different from zero. Panel C and D report the results for the OLS and CMLE estimations, and neither estimation procedure results in significant estimates.

For Table 2, our results are again close to theirs, with two exceptions. First, we get different results for the size-sorted portfolios. Second, the coefficients on ΔFED are also quite different. The coefficients and t-stats for σ_{iM}, ΔDEF, and ΔTerm are very close to their results. Again, Panel B shows how the incorrect SUR standard errors give the false impression that the market, ΔDEF, and ΔTERM are all significant state-variables. When correcting the standard errors, the point estimates are no longer significantly different from zero. Panel C and D show the estimation results from the OLS and CMLE estimation, and here the point estimates are not significantly different from zero.

In our replication of Table 3 in Bali and Engle (2010a), the results are again close. Note that when using GLS, the sign on ΔVOL switches in several cases. For the SUR and OLS estimations, there is some evidence that returns are related to innovations in volatility.

In our replication of Table 4 Bali and Engle (2010a), in which the market, the default spread, the term spread, and the FED funds rate are state-variables, our results are quite different. We generally do not get the same coefficients for the default spread, the term spread, or the FED funds rate.

For the replication of Table 5 in Bali and Engle (2010a), our results are quite different from the ones presented in Bali and Engle (2010a). We do not find that any of the state-variables carry a significant price of risk.

Finally, for the replication of Table 6 in Bali and Engle (2010a), we get very similar results for the momentum portfolios, and somewhat similar results for the 30 DOW stocks. However, correcting the standard errors, we do not find that the market, or volatility, is a priced state-variable.

Table 3: Replication of Table 1 in Bali and Engle (2010a)

The table shows estimation results for the risk-return relation with the return on the market as the only state variable. The model estimated is

$$R_{i,t+1} = \mu_i + \gamma_M \operatorname{cov}_t(R_{i,t+1}, R_{M,t+1}) + \varepsilon_{i,t+1}, \quad \varepsilon_{i,t+1} \sim D(0, h_{i,t})$$

$\boldsymbol{H}_t$ is estimated in a first stage using a DCC model. The system is then estimated using SUR in Panel B, OLS in Panel C, and conditional MLE in Panel D. Sample: Daily data from January 3, 1972 to June 20, 2009, for 9462 observations. For the DOW 30 stocks, the sample is daily from July 10, 1986 to June 20, 2009, for 5926 observations.

Test Assets	$\hat{\gamma}$
Panel A	
Original Results	
Size	1.8558
t-stat	(5.07)
Book-to-Market	2.0546
t-stat	(5.29)
Momentum	3.3187
t-stat	(8.68)
Industry	1.8532
t-stat	(4.86)
Dow Stocks	2.2139
t-stat	(7.53)
Panel B	
SUR with incorrect/correct standard errors	
Size	−0.1786
t-OLS	(−0.4522)
t-White	(−0.1265)
Book-to-Market	1.7824
t-OLS	(4.7898)
t-White	(1.0946)
Momentum	3.0420
t-OLS	(8.1925)
t-White	(1.9370)
Industry	1.7397
t-OLS	(4.6671)
t-White	(1.0893)
Dow Stocks	3.8421
t-OLS	(9.0874)
t-White	(1.7579)

continued...

Table 1 continued...

Panel C OLS with GMM standard errors	
Size	−0.1786
t	(−0.0877)
Book-to-Market	1.7824
t	(0.8929)
Momentum	3.0420
t	(1.5737)
Industry	1.7397
t	(0.8692)
Dow Stocks	3.8421
t	(1.7596)

Panel C CGLS/CMLE	
Size	−1.5355
t	(−1.2818)
Book-to-Market	−0.4303
t	(−0.3450)
Momentum	1.1678
t	(0.9442)
Industry	−0.0847
t	(−0.0674)
Dow Stocks	−0.7784
t	(−0.5149)

Table 4: Replication of Table 2 in Bali and Engle (2010a)

The table shows estimation results for the risk-return relation with the market as a state-variable, and changes in the default spread, the term spread, and the FED funds rate as 'control variables.' The model estimated is

$$\begin{aligned} R_{i,t+1} &= \mu_i + \gamma_M \operatorname{cov}_t(R_{i,t+1}, R_{M,t+1}) + \beta_{DEF}\Delta DEF + \\ &\quad + \beta_{TERM}\Delta TERM + \beta_{FED}\Delta FED + \varepsilon_{i,t+1}, \quad \varepsilon_{i,t+1} \sim D(0, h_{i,t}) \end{aligned}$$

$\boldsymbol{H}_t$ is estimated in a first stage using a DCC model. The system is then estimated using SUR in Panel B, OLS in Panel C, and conditional MLE in Panel D. Sample: Daily data from July 10, 1986 to June 20, 2009, for 5926 observations.

Test Assets	σ_{iM}	ΔDEF	ΔTERM	ΔFED
Original Results				
Size	1.9343	1.5479	−0.2412	0.0043
t-OLS	(3.17)	(2.49)	(−1.29)	(0.20)
Book-to-Market	2.1126	1.7678	−0.2516	0.0126
t-OLS	(4.70)	(2.93)	(−1.31)	(0.35)
Momentum	3.0663	2.1292	−0.4722	0.0263
t-OLS	(6.97)	(3.61)	(−2.52)	(0.74)
Industry	1.5785	2.0149	−0.4478	−0.0154
t-OLS	(3.49)	(3.87)	(−2.71)	(−0.49)
Dow Stocks	2.1424	2.1514	−0.2737	−0.0734
t-OLS	(7.27)	(3.67)	(−1.53)	(−1.62)
Replication (SUR with incorrect/correct standard errors)				
Size	−0.4499	0.3007	−0.0277	−0.0144
t-OLS	(−1.0170)	(0.6892)	(−0.2036)	(−0.3477)
t-White	(−0.3063)	(0.3793)	(−0.1143)	(−0.3023)
Book-to-Market	1.9876	1.9048	−0.2947	−0.0208
t-OLS	(4.7241)	(3.0502)	(−1.5137)	(−0.3506)
t-White	(1.2464)	(1.4204)	(−0.8545)	(−0.3126)
Momentum	2.9269	2.2732	−0.4974	0.0093
t-OLS	(7.0829)	(3.7255)	(−2.6134)	(0.1593)
t-White	(1.8038)	(1.7564)	(−1.5875)	(0.1504)
Industry	1.4846	2.0999	−0.4451	−0.0180
t-OLS	(3.4140)	(3.8963)	(−2.6490)	(−0.3501)
t-White	(0.9174)	(1.6092)	(−1.4396)	(−0.3020)
Dow Stocks	3.7653	2.3280	−0.0847	−0.0407
t-OLS	(8.8990)	(3.7644)	(−0.4387)	(−0.6903)
t-White	(1.7252)	(1.7900)	(−0.2611)	(−0.6353)

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Table 2 continued...

OLS with GMM standard errors				
Size	−0.6966	1.5900	−0.3651	−0.0113
t	(−0.3377)	(1.1837)	(−1.0030)	(−0.1622)
Book-to-Market	0.1404	1.8135	−0.2514	0.0073
t	(0.0706)	(1.2982)	(−0.6792)	(0.1048)
Momentum	1.0002	1.5556	−0.2679	0.0138
t	(0.5157)	(1.0455)	(−0.6778)	(0.1728)
Industry	0.4559	2.0864	−0.3562	−0.0041
t	(0.2257)	(1.4650)	(−1.0111)	(−0.0594)
Dow Stocks	1.4739	2.0583	−0.3521	0.0076
t	(0.6845)	(1.3711)	(−0.8634)	(0.0967)
CGLS/MLE Estimates				
Size	−1.9875	−0.0938	0.0593	−0.0192
t	(−1.4825)	(−0.3393)	(0.6515)	(−0.7792)
Book-to-Market	−1.1814	0.0504	−0.4065	−0.0132
t	(−0.8388)	(0.1253)	(−3.1494)	(−0.4082)
Momentum	1.0255	−0.2340	−0.3357	0.0055
t	(0.7299)	(−0.5631)	(−2.5223)	(0.1619)
Industry	−0.9170	−0.2751	−0.4453	0.0403
t	(−0.6523)	(−0.7679)	(−3.7879)	(1.3837)
Dow Stocks	−0.7756	−0.0315	−0.2769	−0.0394
t	(−0.5129)	(−0.0668)	(−1.9271)	(−0.9412)

Table 5: Replication of Table 3 in Bali and Engle (2010a)

The table shows estimation results for the risk-return relation with the market as a state-variable, and changes in the volatility as a 'control variable.' The model estimated is

$$R_{i,t+1} = \mu_i + \gamma_M \operatorname{cov}_t(R_{i,t+1}, R_{M,t+1}) + \beta_{Vol}\Delta Vol + \varepsilon_{i,t+1}, \quad \varepsilon_{i,t+1} \sim D(0, h_{i,t})$$

$\boldsymbol{H}_t$ is estimated in a first stage using a DCC model. The system is then estimated using SUR in Panel B, OLS in Panel C, and conditional MLE in Panel D. Sample: Daily data from July 10, 1986 to June 20, 2009, for 5926 observations.

Test Assets	σ_{iM}	ΔVOL
Original Results		
Size	2.1969	0.0344
t-OLS	(5.95)	(2.36)
Book-to-Market	2.2008	0.0121
t-OLS	(4.92)	(2.16)
Momentum	3.1630	0.0307
t-OLS	(7.20)	(5.60)
Industry	1.7042	0.0247
t-OLS	(3.78)	(5.90)
Dow Stocks	2.1800	0.0181
t-OLS	(7.40)	(3.53)
SUR with incorrect/correct standard errors		
Size	−0.4248	−0.0346
t-OLS	(−0.9631)	(−8.8693)
t-White	(−0.2697)	(−3.0944)
Book-to-Market	2.0811	0.0133
t-OLS	(4.9580)	(2.3599)
t-White	(1.3055)	(1.3604)
Momentum	3.0044	0.0314
t-OLS	(7.2835)	(5.7064)
t-White	(1.9317)	(2.9523)
Industry	1.6050	0.0265
t-OLS	(3.6980)	(5.4485)
t-White	(0.9691)	(3.0266)
Dow Stocks	3.8439	0.0541
t-OLS	(9.1108)	(9.7513)
t-White	(1.8855)	(3.9108)

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Table 3 continued...

OLS with GMM standard errors		
Size	−0.4248	−0.0346
t	(−0.2697)	(−3.0944)
Book-to-Market	2.0811	0.0133
t	(1.3055)	(1.3604)
Momentum	3.0044	0.0314
t	(1.9317)	(2.9523)
Industry	1.6050	0.0265
t	(0.9691)	(3.0266)
Dow Stocks	3.8439	0.0541
t	(1.8855)	(3.9108)
CMLE/CGLS with GMM standard errors		
Size	−1.8962	−0.0562
t	(−1.4160)	(−11.3286)
Book-to-Market	−1.1994	−0.0236
t	(−0.8517)	(−3.5561)
Momentum	0.9281	−0.0026
t	(0.6607)	(−0.3976)
Industry	−1.0062	0.0119
t	(−0.7158)	(2.0070)
Dow Stocks	−0.8703	−0.0071
t	(−0.5757)	(−1.0872)

Table 6: Replication of Table 4 in Bali and Engle (2010a)

The table shows estimation results for the risk-return relation with the market, the default spread, the term spread, and the FED funds rate as state-variables. The model estimated is

$$\begin{aligned} R_{i,t+1} &= \mu_i + \gamma_M \operatorname{cov}_t(R_{i,t+1}, R_{M,t+1}) + \gamma_{DEF} \operatorname{cov}_t(R_{i,t+1}, \Delta DEF_{t+1}) \\ &\quad + \gamma_{TERM} \operatorname{cov}_t(R_{i,t+1}, \Delta TERM_{t+1}) + \gamma_{FED} \operatorname{cov}_t(R_{i,t+1}, \Delta FED_{t+1}) + \varepsilon_{i,t+1}, \quad \varepsilon_{i,t+1} \sim D(0, h_{i,t}) \end{aligned}$$

$\boldsymbol{H}_t$ is estimated in a first stage using a DCC model. The system is then estimated using SUR in Panel B, OLS in Panel C, and conditional MLE in Panel D. Sample: Daily data from July 10, 1986 to June 20, 2009, for 5926 observations.

Test Assets	σ_{iM}	$\sigma_{i,\Delta DEF}$	$\sigma_{i,\Delta TERM}$	$\sigma_{i,\Delta FED}$
Original Results				
Momentum	3.7563	12.527	−2.2856	−0.4076
t-White	(6.20)	(2.48)	(−2.45)	(−1.82)
Dow Stocks	2.5524	11.884	−2.5583	−0.1403
t-White	(5.87)	(3.58)	(−3.67)	(−0.32)
SUR with incorrect/correct standard errors				
Size	−0.2344	156.3174	19.2084	4.6650
t-OLS	(−0.4980)	(1.1376)	(0.7095)	(0.2695)
t-White	(−0.1589)	(0.3998)	(0.2962)	(0.1642)
Book-to-Market	2.4087	376.0032	17.4863	−4.1682
t-OLS	(5.4863)	(2.9358)	(0.6372)	(−0.1417)
t-White	(1.5387)	(1.1224)	(0.2553)	(−0.0564)
Momentum	3.1124	−98.2099	50.0829	10.6385
t-OLS	(7.2036)	(−0.6657)	(1.8164)	(0.2880)
t-White	(1.9202)	(−0.2436)	(0.5976)	(0.1063)
Industry	1.6779	84.7710	−6.2028	9.3188
t-OLS	(3.6074)	(0.5237)	(−0.2189)	(0.3345)
t-White	(1.0457)	(0.1635)	(−0.0896)	(0.1212)
Dow Stocks	3.3915	29.5699	−51.3143	−68.4363
t-OLS	(7.2473)	(0.2172)	(−2.2044)	(−2.7948)
t-White	(1.6916)	(0.0603)	(−0.6078)	(−0.5951)

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Table 4 continued...

OLS with GMM standard errors				
Size	−0.6249	−312.1407	95.3779	169.1520
t	(−0.2789)	(−0.2868)	(0.7077)	(0.5886)
Book-to-Market	0.3486	−268.2963	13.6953	246.0092
t	(0.1702)	(−0.2605)	(0.1168)	(0.8140)
Momentum	1.7209	121.2723	71.6848	270.7571
t	(0.8568)	(0.1150)	(0.5897)	(0.8214)
Industry	0.6604	−262.9692	3.0077	212.8443
t	(0.3262)	(−0.2267)	(0.0262)	(1.3173)
Dow Stocks	1.5680	242.5799	−41.7599	−35.2564
t	(0.7297)	(0.2372)	(−0.3651)	(−0.1857)
CMLE/CGLS with GMM standard errors				
Size	−1.8405	291.4162	15.6596	−18.3695
t	(−1.3721)	(1.1611)	(0.2629)	(−0.8919)
Book-to-Market	−1.0788	218.5208	−23.1648	4.5431
t	(−0.7700)	(1.0689)	(−0.4751)	(0.2212)
Momentum	0.6545	−187.5671	−22.9986	−6.8538
t	(0.4682)	(−0.9468)	(−0.4636)	(−0.3138)
Industry	−0.8605	−151.5114	−45.6682	38.2022
t	(−0.6125)	(−0.7260)	(−0.9354)	(1.7661)
Dow Stocks	−1.0214	40.7041	−75.6565	−7.0713
t	(−0.6567)	(0.1576)	(−0.8886)	(−0.2380)

Table 7: Replication of Table 5 in Bali and Engle (2010a)

The table shows estimation results for the risk-return relation with the market, the return on the SMB portfolio, the return the HML portfolio, and the return on the UMD portfolio as state-variables. The model estimated is

$$\begin{aligned} R_{i,t+1} &= \mu_i + \gamma_M \operatorname{cov}_t(R_{i,t+1}, R_{M,t+1}) + \gamma_{SMB} \operatorname{cov}_t(R_{i,t+1}, R_{SMB,t+1}) \\ &\quad + \gamma_{HML} \operatorname{cov}_t(R_{i,t+1}, R_{HML,t+1}) + \gamma_{UMD} \operatorname{cov}_t(R_{i,t+1}, R_{UMD,t+1}) + \varepsilon_{i,t+1}, \quad \varepsilon_{i,t+1} \sim D(0, h_{i,t}) \end{aligned}$$

$\boldsymbol{H}_t$ is estimated in a first stage using a DCC model. The system is then estimated using SUR in Panel B, OLS in Panel C, and conditional MLE in Panel D. Sample: Daily data from January 3, 1972 to June 20, 2009, for 9462 observations. For the DOW 30 stocks, the sample is daily from July 10, 1986 to June 20, 2009, for 5926 observations.

Test Assets	σ_{iM}	$\sigma_{i,SMB}$	$\sigma_{i,HML}$	$\sigma_{i,UML}$
Original Results				
Momentum	2.3999	0.3258	0.6487	−4.3437
t-OLS	(2.42)	(0.10)	(0.17)	(−1.71)
Dow Stocks	2.7215	−3.8006	8.5071	3.9670
t-OLS	(5.75)	(−1.27)	(2.72)	(2.01)
SUR with incorrect/correct standard errors				
Size	−1.0562	−4.3144	−0.3302	−2.0797
t-OLS	(−2.2807)	(−3.8858)	(−0.2528)	(−2.6622)
t-White	(−0.6173)	(−1.1051)	(−0.0870)	(−0.8395)
Book-to-Market	0.8395	−4.2167	−0.3082	−0.7458
t-OLS	(1.4634)	(−2.7025)	(−0.2810)	(−0.9259)
t-White	(0.4441)	(−1.0508)	(−0.0859)	(−0.3235)
Momentum	1.8668	−1.7720	−0.6502	−2.6639
t-OLS	(3.7361)	(−1.3107)	(−0.6098)	(−4.1533)
t-White	(0.9234)	(−0.3645)	(−0.1751)	(−1.1554)
Industry	0.6648	−3.4190	0.2845	−1.4174
t-OLS	(1.2395)	(−2.2255)	(0.2758)	(−2.0268)
t-White	(0.3451)	(−0.7036)	(0.0796)	(−0.6527)
Dow Stocks	4.3380	1.3240	4.1267	1.9612
t-OLS	(6.2229)	(0.7242)	(2.7441)	(2.0988)
t-White	(1.4691)	(0.3010)	(0.9632)	(0.6532)

continued...

Table 5 continued...

OLS with GMM Standard errors				
Size	−1.3518	−1.2598	−8.1554	−5.2105
t	(−0.6041)	(−0.1628)	(−1.3075)	(−1.5894)
Book-to-Market	0.0984	−0.9700	−8.0069	−3.0998
t	(0.0330)	(−0.0912)	(−1.1025)	(−0.8248)
Momentum	−0.9740	−4.4018	−4.3059	−4.7272
t	(−0.3638)	(−0.5053)	(−0.8480)	(−1.5822)
Industry	−0.2967	−3.0422	−4.5813	−2.2059
t	(−0.1091)	(−0.3381)	(−0.8752)	(−0.7939)
Dow Stocks	0.8918	−2.9903	−1.2868	−0.9230
t	(0.2593)	(−0.2972)	(−0.2251)	(−0.2412)
CMLE/CGLS Estimates with GMM standard errors				
Size	−1.4934	−0.7999	2.7887	−2.2660
t	(−1.0056)	(−0.2687)	(0.7385)	(−0.9280)
Book-to-Market	0.1552	1.2884	1.1035	1.8163
t	(0.1028)	(0.3944)	(0.3540)	(0.8487)
Momentum	0.2181	−3.4616	−0.3028	−2.0892
t	(0.1426)	(−1.0706)	(−0.0906)	(−1.0716)
Industry	−0.4437	−2.0391	−0.2452	0.0576
t	(−0.2894)	(−0.6193)	(−0.0775)	(0.0286)
Dow Stocks	−2.9171	−4.7384	−5.1481	−5.6752
t	(−1.3109)	(−0.7812)	(−0.9465)	(−1.4324)

Table 8: Replication of Table 6 in Bali and Engle (2010a)

The table shows estimation results for the risk-return relation with the market and volatility as state-variables. The model estimated is

$$R_{i,t+1} = \mu_i + \gamma_M \operatorname{cov}_t(R_{i,t+1}, R_{M,t+1}) + \gamma_{Vol} \operatorname{cov}_t(R_{i,t+1}, Vol_{t+1}) + \varepsilon_{i,t+1}, \quad \varepsilon_{i,t+1} \sim D(0, h_{i,t})$$

$\boldsymbol{H}_t$ is estimated in a first stage using a DCC model. The system is then estimated using SUR in Panel B, OLS in Panel C, and conditional MLE in Panel D. Sample: Daily data from January 3, 1972 to June 20, 2009, for 9462 observations. For the DOW 30 stocks, the sample is daily from July 10, 1986 to June 20, 2009, for 5926 observations.

Test Assets	σ_{iM}	$\sigma_{i,\Delta VOL}$
Original Results		
Momentum	1.6810	−0.7550
t-OLS	(2.76)	(−4.30)
Dow Stocks	1.5712	−0.3073
t-OLS	(4.02)	(−2.60)
SUR with incorrect/correct standard errors		
Size	−2.4897	−0.8095
t-OLS	(−4.4041)	(−5.4179)
t-White	(−1.3156)	(−1.3659)
Book-to-Market	−0.2054	−1.1319
t-OLS	(−0.3900)	(−6.9944)
t-White	(−0.1018)	(−1.7575)
Momentum	1.1577	−0.7663
t-OLS	(2.1721)	(−5.5428)
t-White	(0.5805)	(−1.1266)
Industry	2.3164	0.3240
t-OLS	(4.2305)	(2.0662)
t-White	(1.2051)	(0.5645)
Dow Stocks	0.6029	−1.0937
t-OLS	(1.1138)	(−9.6477)
t-White	(0.2728)	(−1.4010)

continued...

Table 6 continued...

OLS with GMM standard errors		
Size	1.1368	0.8090
t	(0.3863)	(0.6541)
Book-to-Market	−0.2914	−0.2357
t	(−0.1045)	(−0.2518)
Momentum	1.3172	0.1020
t	(0.4872)	(0.1063)
Industry	0.1186	−0.2127
t	(0.0425)	(−0.2091)
Dow Stocks	−0.0793	−0.7076
t	(−0.0287)	(−0.7023)
OLS with GMM standard errors		
Size	−2.5746	−0.4568
t	(−1.3939)	(−0.4892)
Book-to-Market	−2.2962	−0.7280
t	(−1.1671)	(−0.7421)
Momentum	0.8652	−0.0916
t	(0.4515)	(−0.0973)
Industry	−1.1444	−0.2138
t	(−0.6006)	(−0.2293)
Dow Stocks	−1.7113	−0.6098
t	(−0.8325)	(−0.6170)

Bali, Turan G., and Robert F. Engle, 2010a, The intertemporal capital asset pricing model with dynamic conditional correlations, *Journal of Monetary Economics* 57, 377-390.

Bali, Turan G., and Robert F. Engle, 2010b, The intertemporal capital asset pricing model with dynamic conditional correlations: Online Supplement.