Daily Data is Bad for Beta: Opacity and Frequency-Dependent Betas

Online Appendix*

Thomas Gilbert   Christopher Hrdlicka   Jonathan Kalodimos
Stephan Siegel

December 17, 2013

Abstract

In this Online Appendix, we present additional results to our paper on beta, opacity and factor models across return frequencies. In particular, we report results on betas and alphas using the Fama-French-Carhart four factor model. We also report summary statistics for our panel regressions linking differences in betas to proxies for opacity. Finally, we report tests of the relative performance of factor models across return frequencies using the Hansen-Jagannathan distance. These results show that augmenting the CAPM or the Fama-French-Carhart four factor model with our $\Delta\beta$-factor greatly improves the fit of both models at high frequency and that this improvement diminishes as the return frequency is decreased.

*All authors are at the Michael G. Foster School of Business, University of Washington, PACCAR Hall, Box 353226, Seattle, WA 98195-3226, USA. Corresponding author: Christopher Hrdlicka, Phone: 206-616-0332, Email: hrdlicka@u.washington.edu, Web: http://faculty.washington.edu/hrdlicka/

O Online Appendix: Additional Tables

Table O-1: Fama-French-Carhart α for Portfolios Formed on $\Delta\beta$

This table presents estimates of α (in basis points) for five portfolios formed annually based on the difference between quarterly and daily CAPM β (estimated at the end of the previous year using 60 months of data) as well as a $5-1$ portfolio that is long portfolio 5 and short portfolio 1. α represents the average pricing error relative to the Fama-French-Carhart four factor model. Each panel reports time series estimates of average pricing errors for each portfolio at the daily, monthly and quarterly return frequency as well as the difference between them. Panel A uses value-weighted portfolios and panel B uses equal-weighted portfolios. The sample period is 1969 - 2010. All alphas are compounded to quarterly alphas to facilitate comparison. Standard errors for the differences in alphas across frequency are bootstrapped as described in Appendix A of the paper. ***,**,* indicate significance at the 1%, 5% and 10% levels.

Panel A: Fama-French-Carhart α (value-weighted)

	Portfolios formed on $\Delta\beta$					
	Port. 1	Port. 2	Port. 3	Port. 4	Port. 5	Port. 5 − Port. 1
Daily Returns α	12.8	40.1**	46.9**	102.3***	121.6***	108.6**
Monthly Returns α	-10.4	19.5	13.4	63.9***	65.2*	75.6
Quarterly Returns α	-17.0	10.0	-0.3	65.8**	74.3	91.3
Daily α − Monthly α	23.2***	20.7***	33.5***	38.4***	56.4***	33.0***
Monthly α − Quarterly α	6.6	9.5*	13.7**	-1.9	-9.1	-15.7
Daily α − Quarterly α	29.8***	30.1***	47.2***	36.5***	47.3***	17.3

Panel B: Fama-French-Carhart α (equal-weighted)

	Portfolios formed on $\Delta\beta$					
	Port. 1	Port. 2	Port. 3	Port. 4	Port. 5	Port. 5 − Port. 1
Daily Returns α	174.8***	174.6***	210.2***	292.5***	427.6***	248.5***
Monthly Returns α	5.1	52.9***	69.0***	123.3***	177.5***	172.4***
Quarterly Returns α	-10.9	34.8**	44.8**	103.0***	154.0***	164.9**
Daily α − Monthly α	169.7***	121.7***	141.3***	169.2***	250.1***	76.1***
Monthly α − Quarterly α	16.0**	18.1***	24.2***	20.2***	23.5**	7.5
Daily α − Quarterly α	185.7***	139.8***	165.5***	189.4***	273.6***	83.6***

Table O-2: Robustness Filters of Fama-French-Carhart α of $5-1$ Portfolio Formed on $\Delta\beta$

This table presents estimates of α (in basis points) for a $5-1$ portfolio that is long a portfolio with the largest differences between quarterly and daily CAPM β ($\Delta\beta$) and short a portfolio with the smallest differences in $\Delta\beta$, where the betas are estimated at the end of the previous year using 60 months of data. Panel A reports the quarterly and daily CAPM α estimates, which represents the average pricing error relative to the Fama-French-Carhart four factor model. We report time series estimates of average pricing errors for each portfolio at the daily, monthly and quarterly return frequency as well as the difference between them. Each column shows the results for a different annual filter of the data used to construct the portfolios: Liquid – every stock must trade every day; Amihud – every stock must be below the cross-sectional median Amihud illiquidity measure; Min. Size – every stock's market capitalization must be at least \$1bn; Min. Price – every stock price must be at least \$5; Liq./Size/Price is the union of the Liquid, Min. Size, and Min. Price filters; Dimson – daily betas are estimated as in Dimson (1979) using two daily lead and lag returns. The sample period is 1969 - 2010. All alphas are compounded to quarterly alphas to facilitate comparison. Standard errors for the differences in alphas across frequency are bootstrapped as described in Appendix A of the paper. ***,** ,* indicate significance at the 1%, 5% and 10% levels.

	Value-weighted 5−1 portfolio						Equal-weighted 5−1 portfolio					
	Liquid	Amihud	Min. Size	Min. Price	Liq./Size/Price	Dimson	Liquid	Amihud	Min. Size	Min. Price	Liq./Size/Price	Dimson
Daily Returns α	117.3***	142.3***	114.2 ***	143.9***	129.7***	N.A.	242.4 ***	150.3	126.9 ***	234.8***	184.1***	N.A.
Monthly Returns α	91.2 **	116.3***	102.2 **	109.1***	122.2***	N.A.	199.3 ***	163.6	126.7 ***	180.2***	184.3***	N.A.
Quarterly Returns α	101.8 *	130.3***	98.1 *	119.0**	104.7**	N.A.	170.6**	170.1	115.5 **	175.8 ***	164.1***	N.A.
Daily α − Monthly α	26.1 **	26.0 **	11.9	34.8***	7.4	N.A.	43.1***	-13.3 *	0.2	54.6 ***	-0.1	N.A.
Monthly α − Quarterly α	-10.6	-14.0	4.2	-9.9	17.6	N.A.	28.7 *	-6.5	11.2	4.5	20.2*	N.A.
Daily α − Quarterly α	15.5	12.0	16.1	24.9	25.0	N.A.	71.8***	-19.9	11.4	59.0 ***	20.0	N.A.

Table O-3: Summary Statistics for Panel Regressions

The table provides descriptive statistics for the two samples used in the panel regressions. Quarterly (daily) betas are estimated at the end of every year using quarterly (daily) returns over the previous 60 months. Managerial discretion is a measure of the amount of managerial discretion at the industry level. Abnormal accrual variance is the five-year rolling variance of the residual from an expected accrual model. Market capitalization is the firm's equity value in millions of dollars. The Amihud illiquidity measure is in absolute return per thousand dollars of daily volume. Illiquidity is the percentage of days with zero trading volume for a given stock within a given year. Turnover is volume per month per share outstanding. The sample period is 1969 - 2010.

Panel A: Managerial Discretion Sample (N = 79,878)

			Percentile				
	Mean	Std. Dev.	1st	25th	Median	75th	99th
Daily β	0.869	0.478	0.019	0.517	0.811	1.157	2.210
Quarterly β	1.305	0.939	-0.511	0.729	1.218	1.830	4.310
$\Delta\beta$ = Quarterly β − Daily β	0.481	0.828	-1.209	-0.043	0.367	0.879	3.193
Managerial Discretion	4.884	1.175	2.080	4.460	5.052	5.727	6.890
Market Capitalization ($ millions)	1,814	11,293	2	36	151	694	29,339
Amihud Illiquidity	0.002	0.015	0.000	0.000	0.000	0.001	0.036
Illiquidity	0.021	0.048	0.000	0.000	0.000	0.012	0.222
Turnover	0.096	0.113	0.005	0.027	0.056	0.118	0.630

Panel B: Abnormal Accrual Variance Sample (N = 88,463)

			Percentile				
	Mean	Std. Dev.	1st	25th	Median	75th	99th
Daily β	0.856	0.463	0.046	0.517	0.800	1.131	2.171
Quarterly β	1.303	0.876	-0.449	0.729	1.189	1.760	4.039
$\Delta\beta$ = Quarterly β − Daily β	0.447	0.765	-1.136	-0.043	0.358	0.828	2.907
Abnormal Accrual Variance	0.009	0.017	0.000	0.001	0.003	0.008	0.091
Market Capitalization ($ millions)	1,749	10,152	4	41	164	720	28,529
Amihud Illiquidity	0.002	0.013	0.000	0.000	0.000	0.002	0.031
Illiquidity	0.022	0.049	0.000	0.000	0.000	0.012	0.222
Turnover	0.091	0.109	0.005	0.025	0.051	0.110	0.624

Table O-4: CAPM and the $\Delta\beta$-Factor: Hansen-Jagannathan Distance

This table presents the Hansen-Jagannathan (HJ) distance of the CAPM as a baseline and the percent reduction in the HJ distance from the addition of a second factor, $\Delta\beta$. The $\Delta\beta$-factor is the return difference between value-weighted portfolios of stocks in the top and bottom terciles of stocks sorted on the difference between their quarterly and daily CAPM β (estimated at the end of the previous year using 60 months of data). Panel A uses this $\Delta\beta$-factor directly. Panel B uses as the second factor the $\Delta\beta$-factor orthogonalized to SMB. In both panels, we test these asset pricing models at three different frequencies using daily, monthly and quarterly return data between 1969 and 2010. We also use two different sets of test assets. The first set of test assets is 10 value-weighted portfolios based on the deciles of stocks sorted on the difference between their quarterly and daily CAPM β. The second set of test assets is the 30 value-weighted Fama-French industry portfolios. All returns are in excess of the risk-free rate. The coefficients of the pricing kernel are estimated using one-step GMM with the inverse of the return variance-covariance matrix as the weighting matrix. The HJ distances reject all models as true at the 5% level.

Panel A: HJ Distance for CAPM + $\Delta\beta$-factor

	Baseline HJ Distance			% Improvement by $\Delta\beta$		
Test Assets	Daily	Monthly	Quarterly	Daily	Monthly	Quarterly
10 $\Delta\beta$ Portfolios	0.274	0.301	0.310	9.98%	1.00%	0.66%
30 FF Industries	0.382	0.401	0.424	9.11%	6.09%	2.51%

Panel B: HJ Distance for CAPM + Orthogonalized $\Delta\beta$-factor

	Baseline HJ Distance			% Improvement by Orth. $\Delta\beta$		
Test Assets	Daily	Monthly	Quarterly	Daily	Monthly	Quarterly
10 $\Delta\beta$ Portfolios	0.274	0.301	0.310	9.62%	4.06%	0.81%
30 FF Industries	0.382	0.401	0.424	6.87%	0.12%	0.46%

Table O-5: Fama-French-Carhart Factor Model and the $\Delta\beta$-Factor: Hansen-Jagannathan Distance

This table presents the Hansen-Jagannathan (HJ) distance of the Fama-French-Carhart four factor model as a baseline and the percent reduction in the HJ distance from the addition of a second factor, $\Delta\beta$. The $\Delta\beta$-factor is the return difference between stocks in the top and bottom terciles of stocks sorted on the difference between their quarterly and daily CAPM β (estimated at the end of the previous year using 60 months of data). Panels A and B use this $\Delta\beta$-factor directly. Panels C and D use as the second factor the $\Delta\beta$-factor orthogonalized to SMB. In all panels, we test these asset pricing models at three different frequencies using daily, monthly and quarterly return data between 1969 and 2010. We also use two different sets of test assets. The first set of test assets is 10 portfolios based on the deciles of stocks sorted on the difference between their quarterly and daily CAPM β. The second set of test assets is the 30 Fama-French industry portfolios. Panels A and C use value-weighted test assets and panels B and D use equal-weighted test assets. All returns are in excess of the risk-free rate. The coefficients of the pricing kernel are estimated using one-step GMM with the inverse of the return variance-covariance matrix as the weighting matrix. The HJ distances reject all models as true at the 5% level.

Panel A: HJ Distance for Fama-French-Carhart + $\Delta\beta$-factor (value-weighted)

	Baseline HJ Distance			% Improvement by $\Delta\beta$		
Test Assets	Daily	Monthly	Quarterly	Daily	Monthly	Quarterly
10 VW $\Delta\beta$ Portfolios	0.204	0.222	0.225	26.49%	37.25%	19.91%
30 VW FF Industries	0.313	0.361	0.400	0.00%	0.73%	0.16%

Panel B: HJ Distance for Fama-French-Carhart + $\Delta\beta$-factor (equal-weighted)

	Baseline HJ Distance			% Improvement by $\Delta\beta$		
Test Assets	Daily	Monthly	Quarterly	Daily	Monthly	Quarterly
10 EQ $\Delta\beta$ Portfolios	0.186	0.137	0.120	0.50%	1.45%	0.12%
30 EQ FF Industries	0.619	0.340	0.316	9.46%	3.31%	2.02%

Panel C: HJ Distance for Fama-French-Carhart + Orthogonalized $\Delta\beta$-factor (value-weighted)

	Baseline HJ Distance			% Improvement by Orth. $\Delta\beta$		
Test Assets	Daily	Monthly	Quarterly	Daily	Monthly	Quarterly
10 VW $\Delta\beta$ Portfolios	0.204	0.222	0.225	26.44%	36.91%	18.44%
30 VW FF Industries	0.313	0.361	0.400	0.00%	0.58%	0.00%

Panel D: HJ Distance for Fama-French-Carhart + Orthogonalized $\Delta\beta$-factor (equal-weighted)

	Baseline HJ Distance			% Improvement by Orth. $\Delta\beta$		
Test Assets	Daily	Monthly	Quarterly	Daily	Monthly	Quarterly
10 EQ $\Delta\beta$ Portfolios	0.186	0.137	0.120	63.90%	12.36%	11.30%
30 EQ FF Industries	0.619	0.340	0.316	9.46%	3.31%	2.02%