Online Appendix: Frequency Dependent Risk

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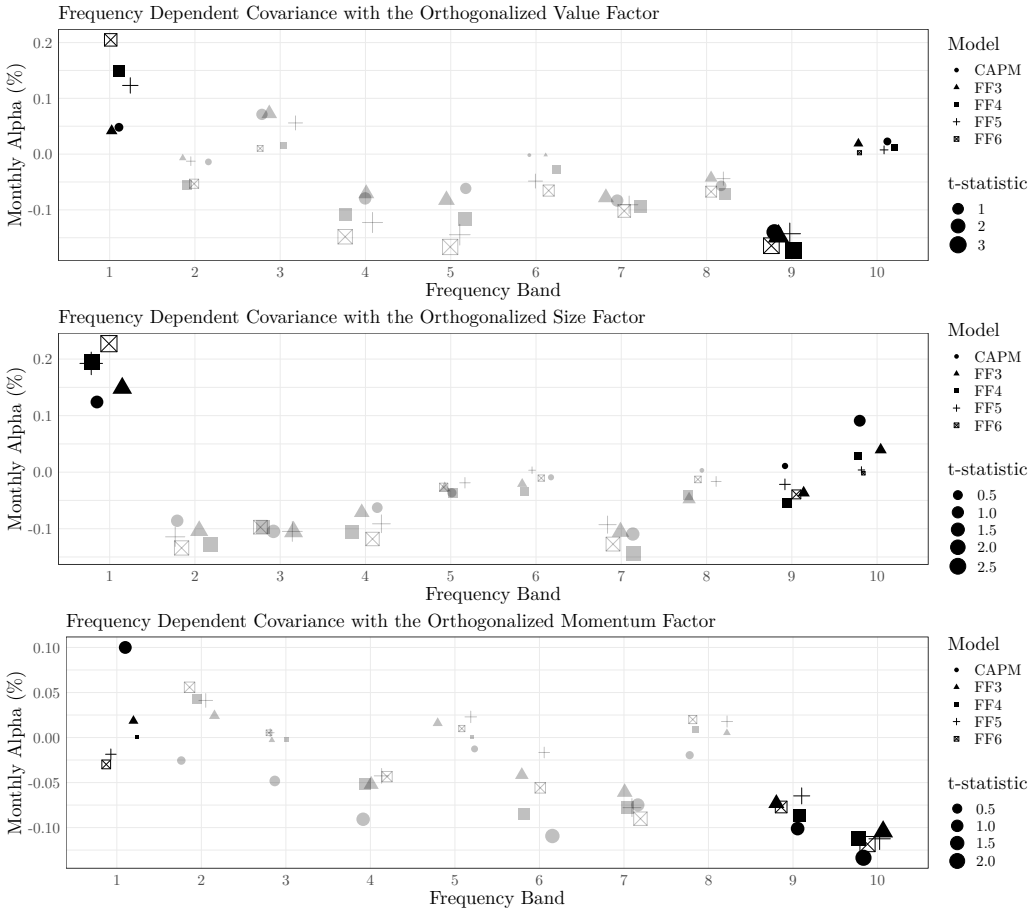
Table A.1: **Estimated Alphas For Different Frequency Band and Orthogonalized Factors**

This table reports monthly alphas (in percentage) against the Fama & French (1993), Carhart (1997) and Fama & French (2015) models. At the beginning of each calendar month, stocks are ranked according to their frequency dependent covariance ratios and then assigned to one of the ten portfolios. Frequency dependent covariance is estimated as detailed in Section 5.1. The portfolio is then long the 10% stocks with highest frequency dependent covariance ratio, in a given frequency bin, and short the 10% stocks with lowest covariance ratio. All stocks are equally weighted within a portfolio. Portfolios are rebalanced every month. t-statistic are calculated using Newey & West (1987) standard errors. The sample period is January 1964 to December 2018.

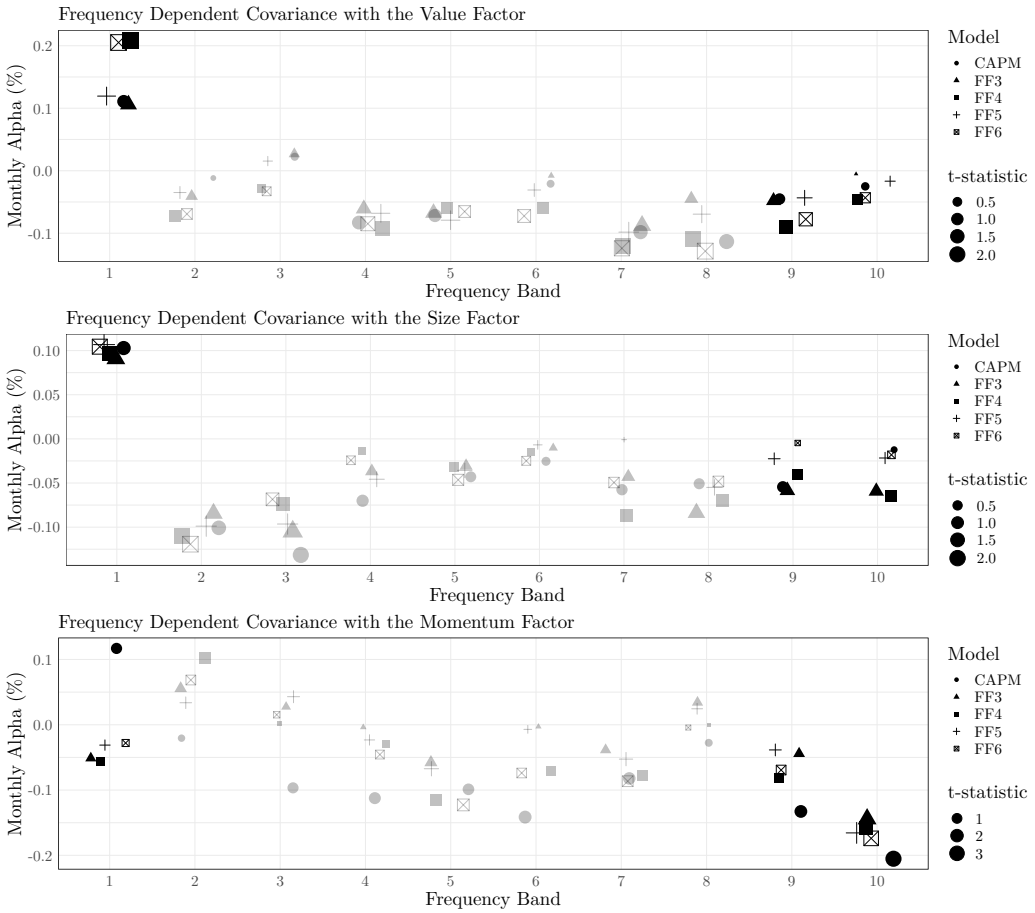
	Frequency Band										
	1	2	3	4	5	6	7	8	9	10	HF
Value Factor$^{\perp}$											
$\hat{\alpha}_{\text{CAPM}}$	0.05	−0.01	0.07	−0.08	−0.06	0.00	−0.08	−0.06	−0.14***	0.02	−0.06
$\hat{\alpha}_{\text{FF3}}$	0.04	−0.01	0.07	−0.07	−0.08	0.00	−0.08	−0.04	−0.15***	0.02	−0.06
$\hat{\alpha}_{\text{FF3 + UMD}}$	0.15	−0.06	0.02	−0.11*	−0.12**	−0.03	−0.09	−0.07	−0.17***	0.01	−0.08
$\hat{\alpha}_{\text{FF5}}$	0.12	−0.01	0.06	−0.12**	−0.14**	−0.05	−0.09	−0.04	−0.14**	0.01	−0.07
$\hat{\alpha}_{\text{FF5 + UMD}}$	0.20	−0.05	0.01	−0.15**	−0.17***	−0.07	−0.10	−0.07	−0.16***	0.00	−0.08
Size Factor$^{\perp}$											
$\hat{\alpha}_{\text{CAPM}}$	0.12	−0.09	−0.10*	−0.06	−0.04	−0.01	−0.11	0.00	0.01	0.09	0.05
$\hat{\alpha}_{\text{FF3}}$	0.15**	−0.10*	−0.11*	−0.07	−0.03	−0.02	−0.11	−0.05	−0.04	0.04	0.00
$\hat{\alpha}_{\text{FF3 + UMD}}$	0.20**	−0.13*	−0.10*	−0.11	−0.04	−0.03	−0.14**	−0.04	−0.05	0.03	−0.01
$\hat{\alpha}_{\text{FF5}}$	0.19**	−0.11*	−0.10*	−0.09	−0.02	0.00	−0.09	−0.02	−0.02	0.00	−0.01
$\hat{\alpha}_{\text{FF5 + UMD}}$	0.23***	−0.13*	−0.10*	−0.12	−0.03	−0.01	−0.13*	−0.01	−0.04	0.00	−0.02
Momentum Factor$^{\perp}$											
$\hat{\alpha}_{\text{CAPM}}$	0.10	−0.03	−0.05	−0.09	−0.01	−0.11*	−0.07	−0.02	−0.10	−0.13**	−0.12**
$\hat{\alpha}_{\text{FF3}}$	0.02	0.02	0.00	−0.05	0.02	−0.04	−0.06	0.01	−0.07	−0.10**	−0.09**
$\hat{\alpha}_{\text{FF3 + UMD}}$	0.00	0.04	0.00	−0.05	0.00	−0.09	−0.08	0.01	−0.09	−0.11**	−0.10*
$\hat{\alpha}_{\text{FF5}}$	−0.02	0.04	0.01	−0.04	0.02	−0.02	−0.08	0.02	−0.06	−0.11**	−0.09*
$\hat{\alpha}_{\text{FF5 + UMD}}$	−0.03	0.06	0.01	−0.04	0.01	−0.06	−0.09	0.02	−0.08	−0.12**	−0.10*

Figure A.1: **Monthly Alphas - Frequency Dependent Covariance Ratios with the Orthogonalized Value, Size and Momentum Factor**



This figure plots monthly alphas (in percentage) against the Fama & French (1993) (FF3), Carhart (1997) (FF4), Fama & French (2015) model (FF5) and the five factor model augmented with the momentum factor (FF6). At the beginning of each month, stocks are ranked according to their frequency dependent covariance ratios and then assigned to one of the ten portfolios. Frequency dependent covariance is estimated as detailed in Section 5.1. The portfolio is then long the 10% stocks with highest frequency dependent covariance ratio, in a given frequency bin, and short the 10% stocks with lowest covariance ratio. All stocks are equally weighted within a portfolio. Portfolios are rebalanced every month. The size of the marker is proportional to the (absolute value) of the t-statistic for alpha using the Newey & West (1987) procedure to estimate standard errors. The sample period is January 1964 to December 2018.

Figure A.2: **Monthly Alphas - Frequency Dependent Covariance Ratios with the Equally Weighted Value, Size and Momentum Factor**

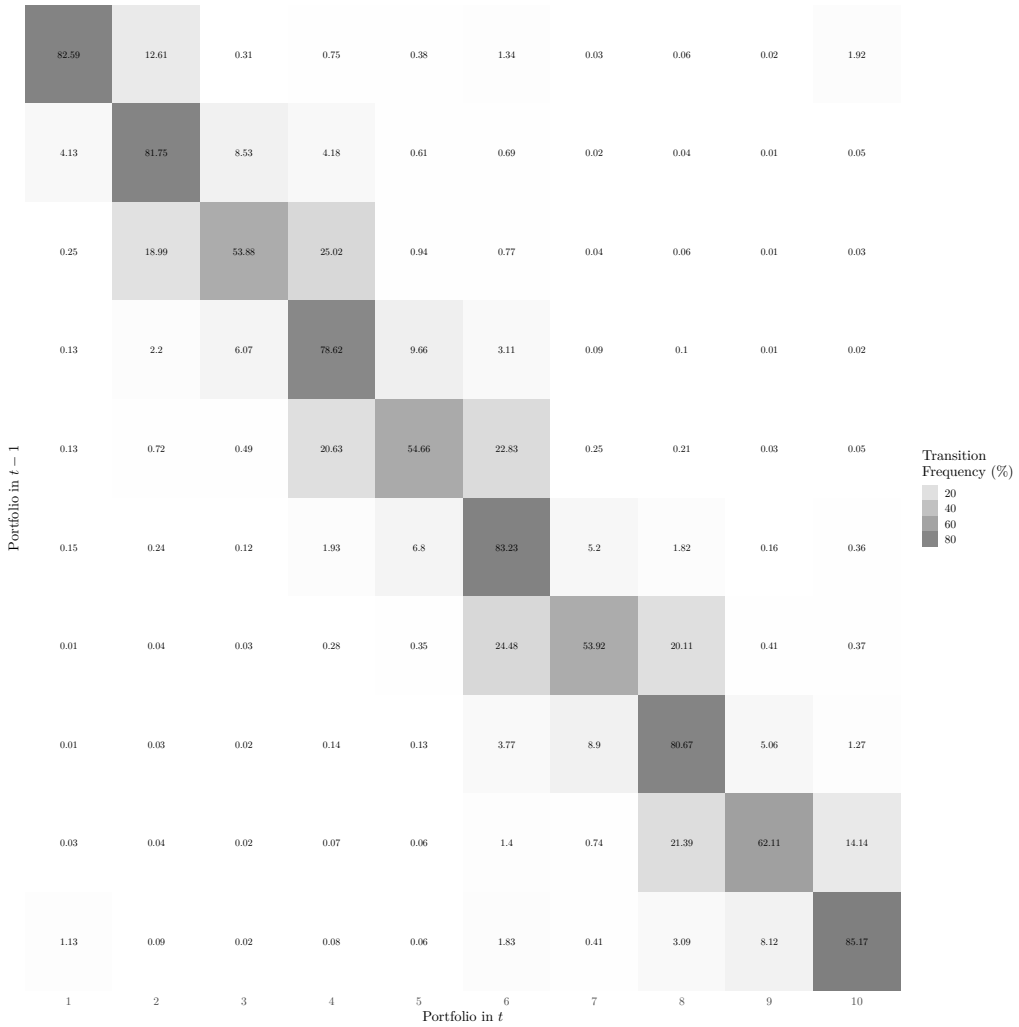


This figure plots monthly alphas (in percentage) against the Fama & French (1993) (FF3), Carhart (1997) (FF4), Fama & French (2015) model (FF5) and the five factor model augmented with the momentum factor (FF6). The assets in the factor portfolios are equally weighted. At the beginning of each month, stocks are ranked according to their frequency dependent covariance ratios and then assigned to one of the ten portfolios. Frequency dependent covariance is estimated as detailed in Section 5.1. The portfolio is then long the 10% stocks with highest frequency dependent covariance ratio, in a given frequency bin, and short the 10% stocks with lowest covariance ratio. All stocks are equally weighted within a portfolio. Portfolios are rebalanced every month. The size of the marker is proportional to the (absolute value) of the t-statistic for alpha using the Newey & West (1987) procedure to estimate standard errors. The sample period is January 1964 to December 2018.

Figure A.3: **Characteristics of the High Frequency Portfolio**

This figure shows the normalized rank of nine cross-sectional return characteristics for the long and short leg of the LF portfolio (constructed using market returns). These are the book-to-market ratio, debt-to-price ratio, market equity (size), profitability, investment, operating accruals, the trailing three-year volatility, return one month before portfolio formation (r_{2-1}) and the return from 12 to 2 months before prediction (r_{12-2}). Each month, the characteristics are normalized as in Freyberger et al. (2019), i.e., $\tilde{c}_{it} = \frac{rank(c_{it})}{N_t+1}$, where c_{it} denotes the "raw" characteristic value and N_t denotes the number of firms in month t, $\tilde{c}_{it}$ denotes the rank normalized characteristic, which is always between zero and one. The sample period is January 1964 to December 2018.

Figure A.4: **Transition Frequencies for the Portfolios Sorted on High Frequency Risk**



The figure shows the unconditional transition frequencies between the ten portfolio sorted on LF risk, constructed from market returns, from one month to the next. The sample period is January 1964 to December 2018.

Figure A.5: **Price Path and Yearly Return of the High Frequency Portfolio**

The top panel of the figure shows the logarithmic price path (cumulative returns) of the HF long-short portfolio. At the beginning of each calendar month, stocks are ranked according to their HF covariance ratio and then assigned to one of ten portfolios. The frequency dependent covariance ratios are estimated as described in 5.1. The LF portfolio is, then, long the 10% stocks with highest HF covariance ratio and short the 10% stocks with lowest HF covariance ratio. All stocks are equally weighted within a portfolio. The gray areas depict NBER recessions. The lower panel of the figure shows the yearly returns of the HF portfolio. Portfolios are rebalanced every month. The sample period is January 1964 to December 2018.

Table A.2: **Estimated Alphas For Different Frequency Band and Equally Weighted Factors**

This table reports monthly alphas (in percentage) against the Fama & French (1993), Carhart (1997) and Fama & French (2015) models. At the beginning of each calendar month, stocks are ranked according to their frequency dependent covariance ratios and then assigned to one of the ten portfolios. Frequency dependent covariance is estimated as detailed in Section 5.1. The portfolio is then long the 10% stocks with highest frequency dependent covariance ratio, in a given frequency bin, and short the 10% stocks with lowest covariance ratio. All stocks are equally weighted within a portfolio. Portfolios are rebalanced every month. t-statistic are calculated using Newey & West (1987) standard errors. The sample period is January 1964 to December 2018.

	Frequency Band										
	1	2	3	4	5	6	7	8	9	10	HF
Market Factor											
$\hat{\alpha}_{\text{CAPM}}$	0.44^{***}	-0.17^{**}	-0.11	-0.21^{***}	-0.14	-0.10	-0.13	-0.23^{***}	-0.22^{***}	-0.09	-0.15^{**}
$\hat{\alpha}_{\text{FF3}}$	0.30^{***}	-0.12	-0.14^{*}	-0.13^{**}	-0.15	-0.03	-0.10	-0.17^{**}	-0.18^{**}	-0.06	-0.12^{*}
$\hat{\alpha}_{\text{FF3 + UMD}}$	0.42^{***}	-0.13	-0.13^{*}	-0.20^{***}	-0.24^{**}	-0.11	-0.22^{**}	-0.27^{***}	-0.27^{***}	-0.12	-0.20^{***}
$\hat{\alpha}_{\text{FF5}}$	0.32^{***}	-0.13	-0.14^{*}	-0.13^{**}	-0.18^{*}	-0.04	-0.14	-0.17^{*}	-0.16^{*}	-0.08	-0.12
$\hat{\alpha}_{\text{FF5 + UMD}}$	0.41^{***}	-0.13	-0.13	-0.20^{***}	-0.23^{**}	-0.11	-0.23^{***}	-0.23^{**}	-0.22^{***}	-0.12	-0.17^{**}
Value Factor											
$\hat{\alpha}_{\text{CAPM}}$	0.11	-0.01	0.02	-0.08	-0.07	-0.02	-0.10^{*}	-0.11^{**}	-0.05	-0.03	-0.04
$\hat{\alpha}_{\text{FF3}}$	0.11	-0.04	0.03	-0.06	-0.07	-0.01	-0.09	-0.04	-0.05	-0.01	-0.03
$\hat{\alpha}_{\text{FF3 + UMD}}$	0.21^{**}	-0.07	-0.03	-0.09^{*}	-0.06	-0.06	-0.12^{**}	-0.11^{**}	-0.09	-0.05	-0.07
$\hat{\alpha}_{\text{FF5}}$	0.12	-0.03	0.02	-0.07	-0.08	-0.03	-0.10^{*}	-0.07	-0.04	-0.02	-0.03
$\hat{\alpha}_{\text{FF5 + UMD}}$	0.21^{**}	-0.07	-0.03	-0.08^{*}	-0.07	-0.07	-0.12^{**}	-0.13^{**}	-0.08	-0.04	-0.06
Size Factor											
$\hat{\alpha}_{\text{CAPM}}$	0.10	-0.10^{*}	-0.13^{**}	-0.07	-0.04	-0.03	-0.06	-0.05	-0.05	-0.01	-0.03
$\hat{\alpha}_{\text{FF3}}$	0.09	-0.08	-0.10^{**}	-0.04	-0.03	-0.01	-0.04	-0.08	-0.06	-0.06	-0.06
$\hat{\alpha}_{\text{FF3 + UMD}}$	0.10^{*}	-0.11^{*}	-0.07	-0.01	-0.03	-0.02	-0.09	-0.07	-0.04	-0.06	-0.05
$\hat{\alpha}_{\text{FF5}}$	0.11^{*}	-0.10^{*}	-0.10^{*}	-0.05	-0.04	-0.01	0.00	-0.05	-0.02	-0.02	-0.02
$\hat{\alpha}_{\text{FF5 + UMD}}$	0.10^{*}	-0.12^{**}	-0.07	-0.02	-0.05	-0.02	-0.05	-0.05	0.00	-0.02	-0.01
Momentum Factor											
$\hat{\alpha}_{\text{CAPM}}$	0.12	-0.02	-0.10	-0.11^{*}	-0.10	-0.14^{**}	-0.08^{**}	-0.03	-0.13^{**}	-0.21^{***}	-0.17^{***}
$\hat{\alpha}_{\text{FF3}}$	-0.05	0.06	0.03	0.00	-0.06	0.00	-0.04	0.03	-0.04	-0.14^{***}	-0.09^{**}
$\hat{\alpha}_{\text{FF3 + UMD}}$	-0.06	0.10	0.00	-0.03	-0.12	-0.07	-0.08	0.00	-0.08	-0.16^{***}	-0.12^{**}
$\hat{\alpha}_{\text{FF5}}$	-0.03	0.03	0.04	-0.02	-0.07	-0.01	-0.05	0.02	-0.04	-0.17^{***}	-0.10^{**}
$\hat{\alpha}_{\text{FF5 + UMD}}$	-0.03	0.07	0.02	-0.05	-0.12^{*}	-0.07	-0.09	0.00	-0.07	-0.17^{***}	-0.12^{**}