Internet Appendix

Procyclicality of the Comovement between Dividend Growth and Consumption Growth

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Table IA1 presents the model selection results of conditional variance models for consumption growth, market returns, dividend growth and the difference between market returns and dividend growth.

Table IA2 presents the parameter estimates of the best conditional variance models.

Table IA3 reports the unconditional correlations.

Table IA4 provides the main Duffee Puzzle decomposition results using Robert Shiller's monthly dividend data.

Figure IA1 depicts the time variation in the conditional volatilities of consumption growth and dividend growth from the empirical model in Section 2.

Figure IA2 reproduces Figure 1 using direct estimates of the valuation covariance.

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Table IA1: Conditional Variance Models.

This table presents the estimation results of 8 univariate conditional variance models with a constant mean (4) or a cyclical long-run mean (4) for consumption growth, market returns, dividend growth, and the difference between market returns and dividend growth. The cyclical long-run mean is denoted by $q_t = \nu SNBER_t$, where $SNBER_t$ is the standardized NBER recession indicator and ν is an unknown parameter. Model details and estimation procedures are described in Section 2 of the paper; the estimations for "GARCH" and "GED-GARCH" use variance targeting. The robust standard errors are shown in parentheses. Parameter estimates in bold (italics) indicate statistical significance at a significant level of 5% (10%). Underlined models are the best models among the eight models, given the Bayesian Information Criteria (BIC). N=665 months (1959/02∼2014/06).

	Loglikelihood	Nparams	AIC	BIC	ν	SE(ν)
Panel A. Consumption Growth						
Unconditional	2884.42	1	-5766.84	-5762.34		
GARCH	2911.44	2	-5816.87	-5803.37		
GED-GARCH	2913.30	3	-5820.59	-5807.10		
BEGE-n_t-GARCH	2919.62	6	-5827.23	-5800.24		
Unconditional, q_t	2885.92	1	-5767.84	-5758.84	**0.1014**	(0.0066)
GARCH, q_t	2913.14	3	-5820.28	-5806.78	**0.0270**	(0.0060)
GED-GARCH, q_t	2917.30	4	-5826.59	<u>-5808.60</u>	**0.0428**	(0.0099)
BEGE-n_t-GARCH, q_t	2924.92	7	-5835.85	-5804.35	**0.1941**	(0.0173)
Panel B. Market returns						
Unconditional	1124.50	1	-2247.01	-2242.51		
GARCH	1145.39	2	-2286.77	-2277.77		
GED-GARCH	1157.51	3	-2309.03	-2295.53		
BEGE-n_t-GARCH	1170.76	6	-2329.53	-2302.53		
Unconditional, q_t	1148.47	1	-2294.95	-2290.45	**0.4691**	(0.0873)
GARCH, q_t	1157.99	3	-2309.98	-2296.48	**0.4445**	(0.0850)
GED-GARCH, q_t	1166.84	4	-2325.69	-2307.69	**0.4391**	(0.0943)
BEGE-n_t-GARCH, q_t	1180.99	7	-2347.99	<u>-2316.49</u>	**0.2425**	(0.0318)
Panel C. Dividend Growth						
Unconditional	2027.55	1	-4053.11	-4048.61		
GARCH	2048.57	2	-4093.14	-4084.15		
GED-GARCH	2069.39	3	-4132.77	<u>-4119.27</u>		
BEGE-n_t-GARCH	2072.16	6	-4132.32	-4105.32		
Unconditional, q_t	2031.39	1	-4060.77	-4056.27	**-0.1358**	(0.0381)
GARCH, q_t	2049.52	3	-4093.03	-4079.53	**-0.0738**	(0.0352)
GED-GARCH, q_t	2069.73	4	-4131.46	-4113.46	-0.0519	(0.0506)
BEGE-n_t-GARCH, q_t	2077.23	7	-4140.45	-4108.95	**-0.2059**	(0.0545)
Panel D. Market Return–Dividend Growth						
Unconditional	1107.80	1	-2213.61	-2209.11		
GARCH	1129.12	2	-2254.25	-2245.25		
GED-GARCH	1142.03	3	-2278.06	-2264.56		
BEGE-n_t-GARCH	1151.83	6	-2291.65	-2264.65		
Unconditional, q_t	1130.38	1	-2258.77	-2254.27	**0.4533**	(0.0869)
GARCH, q_t	1140.87	3	-2275.74	-2262.24	**0.4087**	(0.0814)
GED-GARCH, q_t	1150.68	4	-2293.36	<u>-2275.36</u>	**0.3988**	(0.0879)
BEGE-n_t-GARCH, q_t	1158.98	7	-2303.96	-2272.46	**0.4471**	(0.0250)

Table IA2: Parameter Estimates of Conditional Variance Models.

This table presents the parameter estimates of the chosen univariate conditional variance models of consumption growth Δc_{t+1} (Panel A), market returns r^m_{t+1} (Panel B), dividend growth Δd_{t+1} (Panel C), and the difference $r^m_{t+1} - \Delta d_{t+1}$ (Panel D). For each variable, the conditional variance model is chosen from 8 models with a constant mean (4) or a cyclical long run mean (4) that is modeled as $q_t = \nu SNBER_t$, where $SNBER_t$ is the standardized NBER recession indicator and ν is a constant parameter. Model details are presented in Section 2; model selection results are shown in the Internet Appendix. All models are estimated using MLE. Robust standard errors are shown in parentheses. Values in bold (italics) are statistically significant at a significant level of 5% (10%). N=665 months (1959/02∼2014/06).

Panel A. Consumption Growth, GED-GARCH-q_t							
	$\sqrt{\bar{h}}$	α	β	τ	ν		
Est.	0.0032	0.0129	**0.9856**	**1.4708**	**0.0428**		
SE	(fix)	(0.0704)	(0.0710)	(0.3442)	(0.0099)		
Panel B. Market Return, BEGE-n_t-GARCH-q_t							
	$\overline{cp}$	σ_{cp}	$\overline{cn}$	σ_{cn}	α_{cn}	β_{cn}	ν
Est.	**0.3934**	**0.0272**	**6.0512**	**0.0197**	**0.0815**	**0.8562**	**0.2425**
SE	(0.0794)	(0.0029)	(0.4482)	(0.0009)	(0.0049)	(0.0095)	(0.0318)
Panel C. Dividend Growth, GED-GARCH							
	$\sqrt{\bar{h}}$	α	β	τ			
Est.	0.0115	**0.1050**	**0.8142**	**1.3075**			
SE	(fix)	(0.0375)	(0.0657)	(0.0897)			
Panel D. Market Return − Dividend Growth, GED-GARCH-q_t							
	$\sqrt{\bar{h}}$	α	β	τ	ν		
Est.	0.0458	**0.0677**	**0.8833**	**1.5082**	**0.3988**		
SE	(fix)	(0.0237)	(0.0365)	(0.0997)	(0.1026)		

Table IA3: Unconditional Correlations between Consumption Growth and Market Return Components.

This table presents the unconditional correlations between consumption growth and other variables. "De-centered innovations" are obtained by regressing the raw data on a business cycle indicator (NBER recession indicator); "De-centered & standardized innovations" are obtained by dividing the zero-mean innovations by the conditional volatility estimates.

	r^m_{t+1}	Δd_{t+1}	$r^m_{t+1} - \Delta d_{t+1}$
Raw data	0.1715	0.0569	0.1533
De-centered innovations	0.1576	0.0242	0.1476
De-centered & standardized innovations	0.1558	0.0121	0.1508

Table IA4: Conditional Correlation Models Using Robert Shiller's Monthly Dividend Data.

This table presents the estimation results of DCC and a cyclical DCC model (DCC-q_t) using the standardized innovations of consumption growth and market return components. This table differs from Table 2 in the paper on the choice of dividend data; the paper uses the 12-month trailing monthly CRSP-implied dividend and return data. This table uses Shiller's monthly dividend data (which uses linear interpolation to obtain non-end-of-quarter dividends) and S&P500 returns; the paper uses the CRSP-implied dividend data and the "NYSE/AMEX/NASDAQ" universe. See other details in Table 2 of the paper. Values in bold (italics) are statistically significant at a significant level of 5% (10%). N=665 months (1959/02∼2014/06).

Series 1:	*Consumption Growth (Δc)*					
Series 2:	*Market Return (r^m)*		*Dividend Growth (Δd)*		*$r^m - \Delta d$*	
	DCC	DCC-q_t	DCC	DCC-q_t	DCC	DCC-q_t
$\overline{Q}_{12}$	0.2022	0.2022	0.2298	0.2298	0.2128	0.2128
	(fix)	(fix)	(fix)	(fix)	(fix)	(fix)
α_{12}	0.0223	0.0227	**0.1431**	**0.1405**	0.0211	0.0210
	(0.1463)	(0.1636)	(0.0637)	(0.0644)	(0.1804)	(0.1823)
β_{12}	**0.9657**	**0.9340**	**0.8300**	**0.8324**	**0.9735**	**0.9740**
	(0.0740)	(0.0830)	(0.0255)	(0.0262)	(0.1147)	(0.0502)
ν_{12}		**-0.1539**		**-0.7999**		**0.0445**
		(0.0645)		(0.0987)		(0.0221)
LL	112.30	116.62	57.62	62.42	17.23	19.08
N(param)	2	3	2	3	2	3
LR test stats. (H0=DCC)	-	8.64	-	9.60	-	3.69
P-value	-	0.0033	-	0.0020	-	0.0546

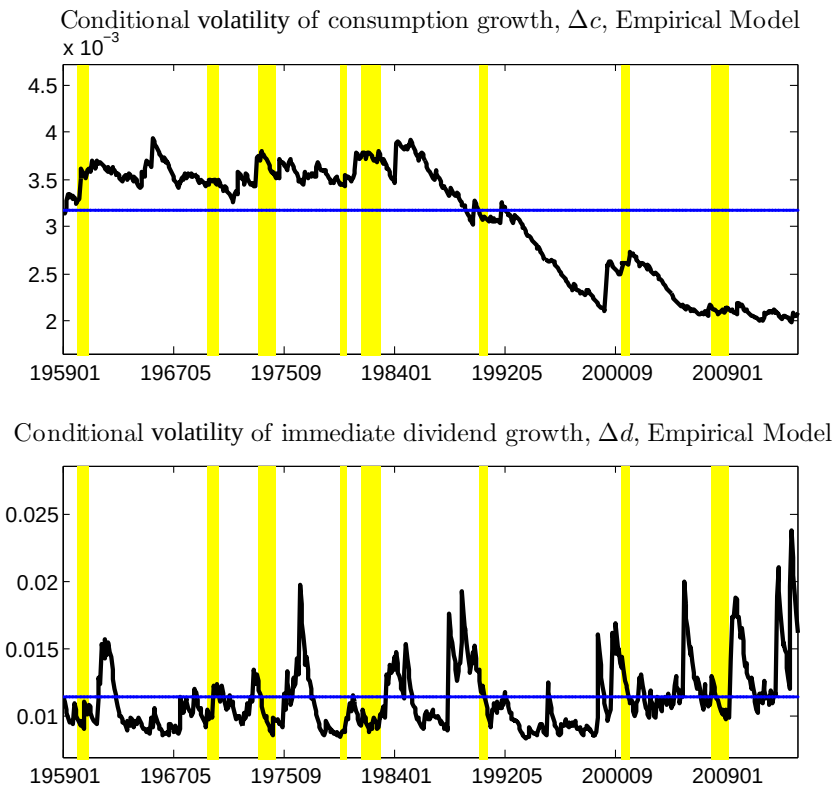

Figure IA1: Conditional volatilities of consumption growth and dividend growth.

The shaded regions are the NBER recession months from the NBER website.

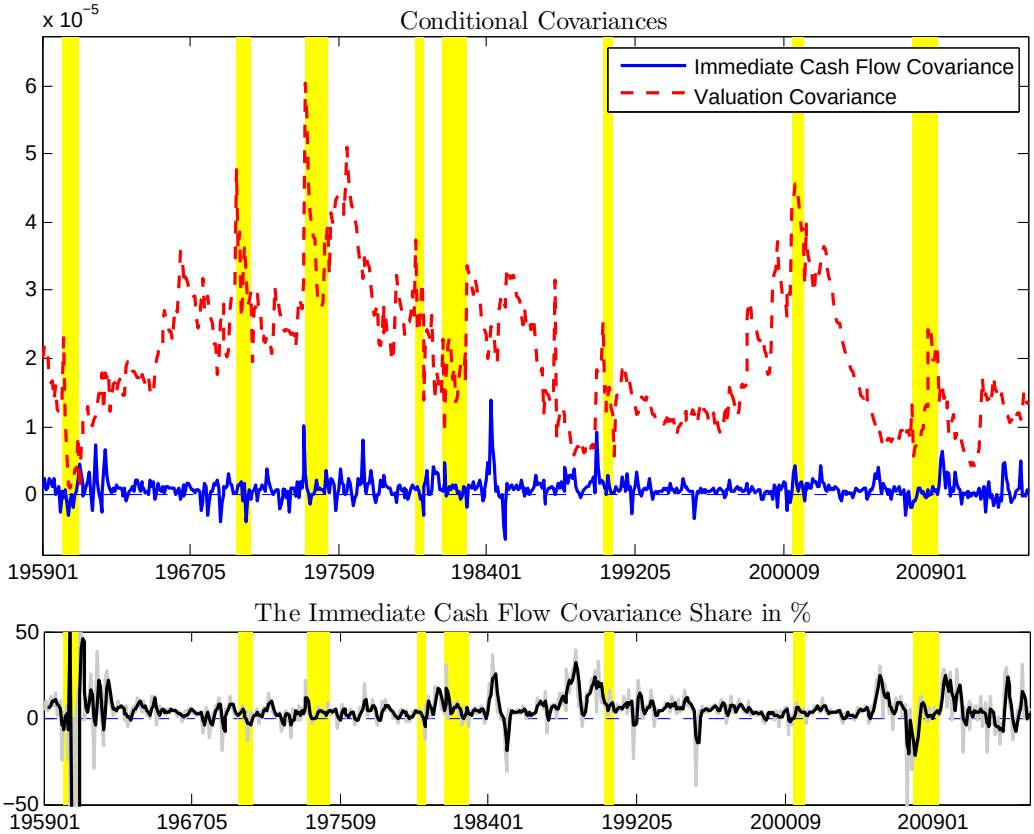

Figure IA2: The Decomposition of the Duffee Puzzle from the Empirical Model

The plot shows the time variation in the immediate cash flow covariance (depicted with a solid blue line) and the valuation covariance (depicted with a dashed red line). Both conditional covariances are separately estimated from a cyclic DCC model. The bottom plot depicts the share of the immediate cash flow covariance in the sum of the two covariances, expressed in percentages; the black line is the 3-month moving average for demonstration purpose. The shaded regions are the NBER recession months from the NBER website. Note: Figure 1 in the paper plots the difference between market return covariance and the cash flow covariance instead of the valuation covariance estimates.