Online Appendix to

Commodity Prices, Convenience Yields and Inflation

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A Appendix: Data Description

Table A.1 lists information about each commodity used in the analysis. It contains the symbol, description, futures exchange where the commodity is traded, contract size, sample price and contract months. The notation for the futures exchanges is CBOT - Chicago Board of Trade, CME - Chicago Mercantile Exchange, NYBOT - New York Board of Trade, NYMEX - New York Mercantile Exchange and WCE - Winnipeg Commodity Exchange and the symbols for futures contract months are F = January, G = February, H = March, J = April, K = May, M = June, N = July, Q = August, U = September, V = October, X = November and Z = December. The data source is Commodity Exchange Bureau.

TABLE A.1. Commodity Description.

	description	exchange	contract size	price	contract month
Foodstuffs					
CC	Cocoa/Ivory Coast	NYBOT	10 metric tons	1216	H,K,N,U,Z
KC	Coffee 'C'/Columbian	NYBOT	37,500 lbs.	78.25	H,K,N,U,Z
JO	Orange Juice, Frozen Concentr.	NYBOT	15,000 lbs.	100.50	F,H,K,N,U,X
SB	Sugar #11/World raw	NYBOT	112,000 lbs.	8.32	H,K,N,V
Grains and Oilseeds					
WC	Canola/No.1	WCE	20 tonnes	326.30	F,H,K,N,X
C-	Corn/No.2 Yellow	CBOT	5,000 bu.	203.50	F,H,K,N,U,X,Z
O-	Oats/No.2 White heavy	CBOT	5,000 bu.	140.75	H,K,N,U,Z
S-	Soybeans/No.1 Yellow	CBOT	5,000 bu.	559.75	F,H,K,N,Q,U,X
BO	Soybean Oil/Crude	CBOT	60,000 lbs.	20.34	F,H,K,N,Q,U,V,Z
W-	Wheat/No.2 Soft Red	CBOT	5,000 bu.	283.50	H,K,N,U,Z
Industrials					
CT	Cotton/1-1/16"	NYBOT	50,000 lbs.	51.60	H,K,N,V,Z
LB	Lumber/Spruce-Pine Fir 2×4	CME	110,000 brd. feet	245	F,H,K,N,U,X
Livestock and Meats					
FC	Cattle, Feeder/Average	CME	50,000 lbs.	90.38	F,H,J,K,Q,U,V,X
LC	Cattle, Live/Choice Average	CME	40,000 lbs.	77.25	G,J,M,Q,V,Z
LH	Hogs, Lean/Average Iowa/S M	CME	40,000 lbs.	41.90	G,J,M,N,Q,V,Z
PB	Pork Bellies, Frozen 12-14 lbs.	CME	40,000 lbs.	30.25	G,H,K,N,Q
Metals					
HG	Copper High Grade/Scrap No.2	NYMEX	25,000 lbs.	81.75	H,K,N,U,Z
GC	Gold	NYMEX	100 troy ounces	334.65	G,J,M,Q,V,Z
PA	Palladium	NYMEX	100 troy ounces	95.75	H,M,U,Z
PL	Platinum	NYMEX	50 troy ounces	362.00	F,J,N,V
SI	Silver	NYMEX	5,000 troy ounces	532.30	H,K,N,U,Z
Energy					
CL	Crude Oil, WTI/Global Spot	NYMEX	1,000 barrels	19.50	F-Z
HO	Heating Oil #2/Fuel Oil	NYMEX	42,000 gallons	.5474	F-Z

Table A.2. Median, Standard Deviation and First-Order Autocorrelations.

	$cy_{jt,n}$				q_{jt}		
	median	std.dev.	AR(1)	$cy_{jt,n} > 0$	median	std.dev.	AR(1)
Cocoa	-0.721	2.206	0.830	0.308	-0.008	0.120	0.860
Coffee	-1.211	3.526	0.936	0.338	-0.013	0.172	0.885
Orange Juice	0.371	2.855	0.882	0.548	-0.006	0.158	0.912
Sugar	0.158	5.165	0.798	0.515	-0.004	0.174	0.871
Canola	-0.517	3.171	0.754	0.361	-0.004	0.110	0.870
Corn	-1.777	3.421	0.832	0.253	-0.012	0.124	0.880
Oats	-1.768	4.718	0.826	0.371	0.000	0.145	0.873
Soybeans	-0.213	1.780	0.758	0.420	-0.022	0.116	0.889
Soybean Oil	-0.259	1.526	0.909	0.344	-0.019	0.126	0.880
Wheat	-1.521	3.839	0.866	0.348	-0.011	0.113	0.860
Cotton	-0.441	5.155	0.723	0.430	-0.005	0.127	0.860
Lumber	-0.798	4.256	0.818	0.426	-0.002	0.126	0.823
Cattle, Feeder	0.966	1.637	0.617	0.787	0.003	0.062	0.856
Cattle, Live	0.882	3.507	0.679	0.590	0.004	0.053	0.743
Hogs	1.050	7.133	0.677	0.531	0.003	0.130	0.841
Pork Bellies	0.604	5.279	0.236	0.718	-0.002	0.172	0.830
Copper	0.612	2.690	0.892	0.692	-0.007	0.116	0.865
Gold	0.075	0.202	0.246	0.649	0.003	0.055	0.828
Palladium	0.765	1.716	0.755	0.784	-0.007	0.155	0.886
Platinum	0.809	1.085	0.770	0.957	-0.001	0.097	0.881
Silver	-0.119	0.323	0.233	0.354	-0.008	0.087	0.791
Crude Oil	0.845	1.972	0.843	0.656	0.003	0.152	0.868
Heating Oil	-0.283	2.758	0.759	0.456	0.001	0.151	0.870

Notes: $cy_{jt,n}$ is convenience yield and q_{jt} is detrended real price of commodity j. The column $cy_{jt,n} > 0$ reports the proportion of positive observations of $cy_{jt,n}$ in the sample.

B Appendix: Additional Results

B.1 Predictive Power of Individual Convenience Yields

Consider the predictive regression:

$$\Delta p_{t+1} = b + \sum_{k=0}^{1} b_{0k}\Delta p_t + \beta_{j1} cy_{jt,n} + \beta_{j2} q_{jt} + v_{t+1}.$$

We test whether (i) the convenience yield $cy_{jt,n}$ for commodity j has predictive power in the presence of the detrended real price of commodity j, and (ii) the detrended real price of commodity j has predictive power in the presence of the convenience yield for commodity j. Table B.1 presents the t-tests of predictability with 2 lags for the dependent variable.

While the individual convenience yields predict changes in commodity prices (see Table 7 in the paper), these same variables have limited predictive power for the different measures of U.S. inflation. The only commodities for which convenience yield exhibits some predictive power are cocoa, orange juice, soybeans, oats, copper and silver. On the other hand, the real commodity prices of crude and heating oil, platinum and sugar appear to be most useful for predicting inflation. Since the real energy prices are not highly correlated with the first and second principal components of real commodity prices (see Table B.2) and given their importance for predicting various inflation measures, we include the detrended real price of crude oil as a separate variable in the aggregate inflation regressions in the paper.

Table B.1 reveals that the predictive power of convenience yields for inflation comes from six commodities: cocoa, orange juice, soybeans, oats, copper and silver. This period's convenience yields of cocoa, orange juice and copper have a positive effect on next period inflation while the effect of soybeans, oats and silver is negative. These convenience yields remain statistically significant for longer horizons and in the presence of other conditioning variables (see Table B.3). As a result, we group these convenience yields in two separate commodity baskets depending on their sign ($\overline{cy}^{(+)}$ and $\overline{cy}^{(-)}$) by simple averaging and include them in the predictive regression for inflation. We consider three specifications of this predictive regression: the baseline and augmented models in which the principal components $pccy_t^{(1)}$ and $pccy_t^{(2)}$ are replaced by $\overline{cy}_t^{(+)}$ and $\overline{cy}_t^{(-)}$ and the augmented model that contains the principal components $pccy_t^{(1)}$ and $pccy_t^{(2)}$ as well as $\overline{cy}_t^{(+)}$ and $\overline{cy}_t^{(-)}$.

Table B.4 reports the predictive regression results for $h = 1$ and 3 and shows that $\overline{cy}_t^{(+)}$ and $\overline{cy}_t^{(-)}$ are statistically significant at 10% level for all specifications and horizons. The principal components become insignificant in the presence of $\overline{cy}_t^{(+)}$ and $\overline{cy}_t^{(-)}$ which suggests that the additional information that these principal components contain is not useful for predicting inflation. We should note, however, that the principal components are still an objective aggregator of the information in all convenience yields and may be more robust predictors when the predictive power of individual convenience yields change over time. Finally, Table B.5 reports the results for the other inflation measures when the principal components in Table 2 in the paper are replaced by $\overline{cy}_t^{(+)}$ and $\overline{cy}_t^{(-)}$. As in Table B.3, the average convenience yields $\overline{cy}_t^{(+)}$ and $\overline{cy}_t^{(-)}$ have a strong predictive power for all measures of inflation except for energy. Finally, Table B.6 presents the pseudo out-of-sample U.S. inflation forecast results with model CYB using $\overline{cy}_t^{(+)}$ and $\overline{cy}_t^{(-)}$ instead of $pccy_t^{(1)}$ and $pccy_t^{(2)}$ as predictors. These results can be compared directly to those in Table 4 in the paper.

B.2 Variance Decompositions

The results in the paper indicate that the principal components in convenience yields are found significant in single equation models. To see if they still have predictive power in multivariate models, we consider a six-variable VAR with $\Delta^h p_t$ ordered first, followed by pcq_t ($pcq_t^{(1)}$ and $pcq_t^{(2)}$), real oil price, and $pccy_t$ ($pccy_t^{(1)}$ and $pccy_t^{(2)}$). We then perform a variance decomposition of h-period ahead inflation (for all items and less food and energy). The bootstrap standard errors are computed as standard deviations of the variance decomposition estimates over the bootstrap samples.[1]

The results for up to 36 months ahead variance decomposition are presented in Table B.7. For the inflation rate based on CPI all items, the commodity price factors explain collectively between 22% and 33% of the variation in inflation within a 3-year period. While the real oil price explains the largest portion of the inflation variations for monthly (11%) and quarterly (17%) inflation, $pccy_t$ dominates the other determinants for semi-annual and annual inflation. For the core inflation rate (less food and energy), the combined contribution of $pccy_t^{(1)}$ and $pccy_t^{(2)}$ varies between 9% and 20% and often exceeds the combined contribution of $pcq_t^{(1)}$ and $pcq_t^{(2)}$. The contributions of these principal components increase further at quarterly frequency as the inflation rates at lower frequencies are less noisy.

A similar variance decomposition analysis is performed for commodity prices. In particular, we consider a five-variable VAR with $\Delta^h s_t^{IMF}$ ordered first, followed by the two-dimensional $pccy_t$, $\Delta \overline{x}_t$, and then i_t. The decomposition of variance results for up to 36 months ahead variance decomposition are presented in Table B.8. The component $pccy_t^{(2)}$ appears to be more important at short prediction horizons whereas $pccy_t^{(1)}$ explains a larger portion of commodity price changes at longer horizons. After three years, the vector $pccy_t$ collectively explains from 10% of the variations in the monthly change in commodity prices Δs_t^{IMF}, to 25% of the variations in the six month change in commodity prices, $\Delta^6 s_t^{IMF}$. The exchange rate $\Delta \overline{x}_t$ explains 3-10% of the variance of commodity

[1] To obtain bootstrap samples, we use a larger block size of $m = 18$ since we do not impose the VAR structure in generating the data.

price changes and is dominated by $pccy_t$ at all horizons. The contribution of interest rate increases from 2% for monthly commodity price changes to 5% for annual changes. These findings are in agreement with the results in Hong and Yogo (2009) who document that the aggregate adjusted basis explains a large portion of the variance of expected commodity returns especially after 1986.

Table B.1. Robust t Tests for Predictability:

$$\Delta p_{t+1} = b + \sum_{k=0}^{1} b_{0k}\Delta p_t + \beta_{j1} cy_{jt,n} + \beta_{j2} q_{jt} + v_{t+1}.$$

$j \searrow p$	all items		less f & e		less food		less energy		food		energy	
	$cy_{jt,n}$	q_{jt}	$cy_{jt,n}$	q_{jt}	$cy_{jt,n}$	q_{jt}	$cy_{jt,n}$	q_{jt}	$cy_{jt,n}$	q_{jt}	$cy_{jt,n}$	q_{jt}
Cocoa	**1.78**	-0.79	1.42	-0.92	1.57	-0.72	1.19	-0.62	1.35	-0.42	1.13	-0.35
Coffee	0.29	-0.82	1.48	-1.37	0.22	-0.97	1.22	-0.82	0.73	0.22	-1.27	-0.38
O. J.	**3.56**	-0.30	**5.51**	-1.62	**3.27**	-0.06	**5.87**	**-2.30**	**2.01**	-1.13	0.32	0.41
Sugar	-0.94	0.54	**-2.68**	**2.07**	-0.52	-0.16	**-3.51**	**2.79**	**-1.79**	**2.12**	0.84	**-1.87**
Canola	-1.10	1.43	1.04	-0.74	-0.62	0.70	0.24	0.03	**-2.53**	**2.50**	-1.36	1.01
Corn	-1.01	1.59	**1.93**	-1.31	-0.88	1.06	**1.66**	-0.46	0.03	**1.84**	**-2.63**	**2.34**
Oats	**-2.89**	**3.15**	-1.58	0.39	**-2.66**	**2.58**	**-2.01**	0.87	**-1.78**	1.47	**-1.85**	**1.89**
Soyb.	**-3.35**	**2.17**	-0.66	-0.41	**-2.85**	-1.59	-1.41	0.44	**-2.11**	**2.84**	-1.59	**1.96**
Soy O	0.25	0.91	**2.11**	-1.05	0.81	0.52	1.46	-0.59	**-1.74**	1.63	-1.04	1.18
Wheat	-0.97	1.49	**1.80**	-1.10	-0.99	1.23	**1.77**	-0.54	-0.40	**1.73**	**-2.61**	**2.48**
Cott.	-0.22	0.90	**2.39**	-0.36	-0.49	0.55	**3.15**	0.32	0.78	1.22	**-4.07**	1.03
Lumb.	-0.74	1.17	0.44	0.82	-0.52	1.10	-0.04	0.73	-1.03	0.88	-0.87	1.04
Cat.F.	0.16	0.47	1.21	0.67	0.29	0.54	1.11	0.31	-0.10	0.12	-0.84	0.17
Cat.L.	0.57	1.01	**1.89**	-0.21	0.46	0.79	**2.02**	-0.09	0.29	**1.73**	-0.90	1.10
Hogs	0.12	1.01	1.60	-0.14	0.17	0.81	1.29	0.02	0.22	1.17	-1.08	1.26
Pork	-0.72	0.36	-0.67	0.96	-0.67	0.25	-0.73	0.79	**-1.76**	1.12	0.34	-0.50
Copp.	**3.41**	-0.60	**2.02**	-0.06	**3.05**	-0.57	**2.50**	-0.44	**2.91**	-0.52	0.70	-0.08
Gold	-0.00	0.23	1.54	0.21	0.33	0.26	0.78	0.21	-1.36	0.41	-1.30	0.08
Pallad.	-0.59	1.38	0.98	0.62	-0.68	1.12	0.89	1.44	0.03	**2.30**	**-2.48**	0.38
Plat.	-0.88	**2.11**	**-3.04**	1.31	-0.90	1.55	**-2.44**	**2.28**	-1.28	**3.88**	1.36	0.71
Silver	**-1.95**	0.68	**-2.31**	0.19	**-1.97**	0.70	**-2.02**	0.46	**-1.95**	0.47	0.33	0.37
Oil	-0.30	**2.28**	0.59	0.60	-0.77	**2.96**	0.89	0.09	**2.14**	-1.30	-1.31	**2.82**
Heat O	-0.04	**2.38**	-0.01	0.86	-0.46	**2.88**	0.70	0.60	1.62	-0.35	-0.79	**2.50**

Notes: Based on Newey-West HAC standard errors (with automatic bandwidth selection). Bold font indicates statistical significance at 10% level using asymptotic critical values.

Table B.2. Regression: $y_{jt} = a_0 + a_1 pcy_t^{(1)} + a_2 pcy_t^{(2)} + e_t$. R^2 (≥ 0.2 in bold).

y_{jt}	cy_{jtn}		q_{jt}	
j pcy_t	$pccy_t^{(1)}$	$pccy_t^{(2)}$	$pcq_t^{(1)}$	$pcq_t^{(2)}$
Cocoa	0.073	**0.208**	0.150	0.019
Coffee	**0.453**	0.072	0.006	0.017
Orange Juice	0.127	0.056	0.193	0.040
Sugar	0.026	0.095	0.043	0.086
Canola	0.153	0.081	**0.651**	0.046
Corn	**0.580**	0.004	**0.527**	0.117
Oats	0.028	0.023	**0.378**	0.001
Soybeans	0.141	**0.271**	**0.317**	**0.341**
Soybean Oil	0.106	0.041	**0.504**	0.137
Wheat	**0.202**	0.137	**0.338**	0.034
Cotton	**0.261**	0.038	0.000	**0.259**
Lumber	0.052	0.001	0.028	0.014
Cattle, Feeder	0.000	0.189	0.174	0.034
Cattle, Live	0.058	0.180	0.052	0.091
Hogs	0.036	0.006	0.137	0.137
Pork Bellies	0.002	0.041	0.065	0.097
Copper	0.037	**0.251**	0.017	0.133
Gold	0.102	0.004	0.000	**0.224**
Palladium	0.155	0.169	0.029	**0.312**
Platinum	0.022	0.093	0.076	**0.497**
Silver	0.000	**0.305**	0.033	**0.241**
Crude Oil	**0.201**	0.092	0.160	0.149
Heating Oil	0.086	**0.200**	0.177	0.148

Table B.3. Estimation Results for U.S. Inflation (CPI All Items):

$$\Delta^h p_{t+h} = b + \sum_{k=0}^{1} \beta_{0k} \Delta p_{t-k} + \sum_{k=1}^{6} \beta_{1k} cy_t\_k + \sum_{k=1}^{2} \beta_{2k} pccy_t^{(k)} + \sum_{k=1}^{2} \beta_{3k} pcq_t^{(k)} + z_t' \beta_4 + v_{t+h}.$$

	$h=1$	$h=3$	$h=6$	$h=12$
cy_t_cocoa	**0.028** **[0.012, 0.058]**	**0.067** **[0.026, 0.116]**	**0.078** **[0.023, 0.151]**	**0.196** **[0.048, 0.384]**
cy_t_orange	**0.028** **[0.000, 0.046]**	**0.166** **[0.124, 0.217]**	**0.296** **[0.223, 0.397]**	**0.515** **[0.352, 0.736]**
cy_t_copper	**0.015** **[0.001, 0.036]**	0.046 [-0.003, 0.108]	**0.107** **[0.018, 0.179]**	**0.192** **[0.017, 0.326]**
cy_t_oats	**-0.028** **[-0.055, -0.015]**	**-0.166** **[-0.132, -0.041]**	-0.054 [-0.137, 0.015]	-0.126 [-0.267, 0.036]
$cy_t\_soybean$	**-0.016** **[-0.032, -0.005]**	**-0.034** **[-0.064, -0.011]**	-0.057 [-0.118, 0.001]	-0.117 [-0.248, 0.021]
cy_t_silver	**-0.026** **[-0.043, -0.006]**	**-0.064** **[-0.104, -0.020]**	**-0.069** **[-0.137, -0.016]**	**-0.141** **[-0.219, -0.057]**
$pcq_t^{(1)}$	-0.007 [-0.056, 0.031]	0.025 [-0.117, 0.167]	0.123 [-0.167, 0.447]	**0.548** **[0.062, 1.359]**
$pcq_t^{(2)}$	0.031 [-0.045, 0.104]	**0.167** **[0.010, 0.344]**	**0.266** **[0.031, 0.613]**	**0.525** **[0.092, 1.221]**
$\triangle p_t$	**0.155** **[0.084, 0.330]**	-0.236 [-0.435, 0.024]	-0.002 [-0.183, 0.246]	**0.560** **[0.258, 0.890]**
$\triangle p_{t-1}$	**-0.169** **[-0.324, -0.049]**	-0.130 [-0.370, 0.069]	0.093 [-0.193, 0.419]	0.083 [-0.362, 0.614]
z_t				
$q_{oil,t}$	**1.122** **[0.804, 1.582]**	**1.488** **[0.773, 2.586]**	0.336 [-0.839, 1.767]	-1.121 [-2.648, 0.188]
$q_{oil,t\text{-}1}$	**-1.041** **[-1.346, -0.761]**	**-1.866** **[-2.855, -1.229]**	**-1.782** **[-3.069, -0.804]**	**-2.516** **[-4.105, -1.165]**
i_t	0.001 [-0.011, 0.008]	-0.018 [-0.052, 0.006]	-0.019 [-0.089, 0.029]	-0.037 [-0.146, 0.043]
$\Delta \overline{x}_t$	**0.010** **[0.001, 0.023]**	0.015 [-0.005, 0.046]	**0.041** **[0.006, 0.088]**	**0.051** **[0.004, 0.108]**
u_t-u^*	-0.006 [-0.044, 0.117]	**-0.166** **[-0.344, -0.015]**	-0.259 [-0.596, 0.078]	-0.215 [-0.736, 0.253]
$\overline{R}^2$	0.324	0.328	0.415	0.552

Notes: The individual convenience yields are standardized. Bold font indicates statistical significance at 10% level using asymptotic critical values.

TABLE B.4. Estimation Results for U.S. Inflation (CPI All Items):

$$\Delta^h p_{t+h} = b + \sum_{k=0}^{1} \beta_{0k}\Delta p_{t-k} + \beta_{11}\overline{cy}_t^{(+)} + \beta_{12}\overline{cy}_t^{(-)} + \sum_{k=1}^{2} \beta_{2k} pccy_t^{(k)} + \sum_{k=1}^{2} \beta_{3k} pcq_t^{(k)} + z_t'\beta_4 + v_{t+h}.$$

	$h=1$			$h=3$		
	(1)	(2)	(3)	(1)	(2)	(3)
$\overline{cy}_t^{(+)}$	**0.077** **[0.052, 0.099]**	**0.066** **[0.045, 0.091]**	**0.076** **[0.056, 0.119]**	**0.272** **[0.196, 0.356]**	**0.253** **[0.173, 0.338]**	**0.278** **[0.186, 0.421]**
$\overline{cy}_t^{(-)}$	**-0.052** **[-0.078, -0.026]**	**-0.065** **[-0.097, -0.042]**	**-0.071** **[-0.147, -0.036]**	**-0.154** **[-0.221, -0.093]**	**-0.169** **[-0.236, -0.116]**	**-0.200** **[-0.410, -0.090]**
$pccy_t^{(1)}$	-	-	0.038 [-0.021, 0.121]	-	-	0.044 [-0.199, 0.281]
$pccy_t^{(2)}$	-	-	0.039 [-0.028, 0.218]	-	-	0.113 [-0.125, 0.572]
$pcq_t^{(1)}$	0.016 [-0.027, 0.056]	-0.010 [-0.053, 0.023]	-0.011 [-0.048, 0.036]	-0.002 [-0.165, 0.161]	0.022 [-0.128, 0.183]	0.027 [-0.106, 0.229]
$pcq_t^{(2)}$	**0.064** **[0.026, 0.132]**	0.032 [-0.027, 0.102]	0.040 [-0.012, 0.118]	**0.168** **[0.056, 0.336]**	0.148 [-0.003, 0.339]	**0.164** **[0.019, 0.372]**
$\triangle p_t$	**0.327** **[0.235, 0.535]**	**0.158** **[0.087, 0.331]**	**0.158** **[0.095, 0.336]**	0.020 [-0.165, 0.241]	-0.226 [-0.423, 0.023]	-0.220 [-0.371, 0.009]
$\triangle p_{t-1}$	**-0.269** **[-0.406, -0.156]**	**-0.164** **[-0.324, -0.045]**	**-0.166** **[-0.324, -0.048]**	**-0.351** **[-0.610, -0.161]**	-0.110 [-0.344, 0.105]	-0.105 [-0.337, 0.092]
z_t						
$q_{oil,t}$	-	**1.134** **[0.823, 1.549]**	**1.132** **[0.809, 1.522]**	-	**1.670** **[0.912, 2.842]**	**1.656** **[0.845, 2.836]**
$q_{oil,t\text{-}1}$	-	**-1.058** **[-1.362, -0.770]**	**-1.054** **[-1.346, -0.765]**	-	**-2.049** **[-3.150, -1.349]**	**-2.030** **[-3.118, -1.326]**
i_t	-	0.019 [-0.009, 0.010]	0.005 [-0.008, 0.016]	-	0.000 [-0.038, 0.030]	0.003 [-0.041, 0.035]
$\Delta\overline{x}_t$	-	**0.010** **[0.001, 0.023]**	**0.009** **[0.001, 0.022]**	-	0.015 [-0.009, 0.047]	0.014 [-0.011, 0.046]
u_t-u^*	-	-0.003 [-0.050, 0.105]	0.017 [-0.011, 0.151]	-	-0.084 [-0.305, 0.092]	-0.038 [-0.220, 0.180]
$\overline{R}^2$	0.218	0.330	0.330	0.219	0.308	0.307

Notes: Bold font indicates statistical significance at 10% level. 90% bootstrap confidence intervals are reported in square brackets below the parameter estimates. $\overline{R}^2$ denotes the adjusted R^2. $\overline{cy}_t^{(-)}$ is a simple average of the convenience yields of oats, soybeans and silver and $\overline{cy}_t^{(+)}$ is a simple average of the convenience yields of cocoa, orange juice and copper.

Table B.5. Estimates and Bootstrap Confidence Intervals for U.S. Inflation (Other Measures):

$$\Delta^h p_{t+h} = b + \sum_{k=0}^{1} \beta_{0k} \Delta p_{t-k} + \beta_{11} \overline{cy}_t^{(+)} + \beta_{12} \overline{cy}_t^{(-)} + \sum_{k=1}^{2} \beta_{2k} pccy_t^{(k)} + \sum_{k=1}^{2} \beta_{3k} pcq_t^{(k)} + \sum_{k=0}^{1} \beta_{4k} q_{oi,t-k} + v_{t+h}.$$

	less f & e	less food	less energy	food	energy
$h = 1$					
$\overline{cy}_t^{(+)}$	**0.047** **[0.031, 0.061]**	**0.069** **[0.044, 0.089]**	**0.049** **[0.033, 0.065]**	**0.068** **[0.019, 0.103]**	-0.006 [-0.211, 0.153]
$\overline{cy}_t^{(-)}$	**-0.021** **[-0.037, -0.004]**	**-0.070** **[-0.102, -0.046]**	**-0.025** **[-0.040, -0.009]**	**-0.045** **[-0.090, -0.007]**	-0.252 [-0.550, 0.012]
$pcq_t^{(1)}$	**0.029** **[0.004, 0.061]**	-0.013 [-0.069, 0.020]	**0.029** **[0.001, 0.066]**	0.012 [-0.113, 0.118]	**-0.474** **[-1.059, -0.155]**
$pcq_t^{(2)}$	0.009 [-0.020, 0.041]	0.012 [-0.050, 0.067]	**0.027** **[0.001, 0.066]**	**0.152** **[0.098, 0.278]**	0.062 [-0.834, 0.739]
$q_{oil,t}$	-0.085 [-0.199, 0.047]	**1.440** **[1.089, 1.921]**	-0.086 [-0.201, 0.061]	-0.060 [-0.537, 0.359]	**14.214** **[11.050, 18.168]**
$q_{oil,t-1}$	0.085 [-0.025, 0.208]	**-1.278** **[-1.619, -0.959]**	0.045 [-0.063, 0.150]	-0.194 [-0.480, 0.127]	**-12.918** **[-16.164, -9.602]**
$\triangle p_t$	**0.218** **[0.155, 0.308]**	**0.101** **[0.020, 0.248]**	**0.245** **[0.180, 0.342]**	**0.108** **[0.018, 0.246]**	**0.176** **[0.076, 0.332]**
$\triangle p_{t-1}$	**0.213** **[0.119, 0.314]**	**-0.142** **[-0.313, -0.020]**	**0.122** **[0.035, 0.228]**	-0.086 [-0.160, 0.042]	**-0.181** **[-0.345, -0.036]**
$\overline{R}^2$	0.303	0.323	0.306	0.091	0.339
$h = 3$					
$\overline{cy}_t^{(+)}$	**0.131** **[0.089, 0.171]**	**0.254** **[0.180, 0.334]**	**0.154** **[0.106, 0.204]**	**0.255** **[0.142, 0.385]**	0.285 [-0.453, 0.967]
$\overline{cy}_t^{(-)}$	**-0.049** **[-0.082, -0.015]**	**-0.170** **[-0.242, -0.109]**	**-0.065** **[-0.097, -0.030]**	**-0.147** **[-0.258, -0.045]**	-0.581 [-1.395, 0.150]
$pcq_t^{(1)}$	**0.085** **[0.015, 0.189]**	0.021 [-0.163, 0.207]	**0.083** **[0.002, 0.205]**	0.053 [-0.317, 0.491]	-1.064 [-3.364, 0.447]
$pcq_t^{(2)}$	0.038 [-0.041, 0.145]	0.127 [-0.032, 0.326]	0.083 [-0.001, 0.210]	**0.414** **[0.265, 0.765]**	0.723 [-1.674, 2.768]
$q_{oil,t}$	-0.077 [-0.477, 0.276]	**2.087** **[1.189, 3.503]**	-0.164 [-0.540, 0.187]	-0.415 [-1.231, 0.318]	**22.089** **[16.401, 31.887]**
$q_{oil,t-1}$	0.051 [-0.261, 0.428]	**-2.357** **[-3.709, -1.511]**	0.010 [-0.271, 0.331]	-0.562 [-1.178, 0.076]	**-25.350** **[-34.699, -17.224]**
$\triangle p_t$	**0.719** **[0.581, 0.886]**	**-0.255** **[-0.402, -0.079]**	**0.585** **[0.466, 0.758]**	-0.036 [-0.185, 0.150]	**-0.236** **[-0.367, -0.053]**
$\triangle p_{t-1}$	**0.707** **[0.534, 0.897]**	-0.024 [-0.297, 0.222]	**0.529** **[0.383, 0.694]**	-0.188 [-0.388, 0.009]	0.072 [-0.218, 0.362]
$\overline{R}^2$	0.529	0.267	0.507	0.229	0.161

Notes: Bold font indicates statistical significance at 10% level. 90% bootstrap confidence intervals are reported in square brackets below the parameter estimates. $\overline{R}^2$ denotes the adjusted R^2. $\overline{cy}_t^{(-)}$ is a simple average of the convenience yields of oats, soybeans and silver and $\overline{cy}_t^{(+)}$ is a simple average of the convenience yields of cocoa, orange juice and copper.

Table B.6. Recursive Out-of-Sample Forecasts for U.S. Inflation Rate (Relative RMSFEs) .

	all items			less food & energy		
	CYB	OIL	IMA	CYB	OIL	IMA
$h = 1$	0.968	0.951	1.049	1.052	1.076	0.935
$h = 3$	0.920	0.975	1.007	1.017	1.048	0.920
$h = 6$	0.908	1.077	1.037	1.000	1.019	0.916
$h = 12$	0.830	1.125	1.148	0.996	1.019	0.900

Notes: The period for pseudo out-of-sample forecast evaluation starts in January 1998 and continues through July 2008. CYB is a model of $p_{t+h} - p_t$ on $\overline{cy}_t^{(+)}$, $\overline{cy}_t^{(-)}$, Δp_t and their lags; OIL is a model of $p_{t+h} - p_t$ on $pcq_t^{(1)}$, $pcq_t^{(2)}$, $q_{oil,t}$, Δp_t and their lags; the third model is an AR model of $p_{t+h} - p_t$ on Δp_t and its lags; and IMA is an IMA(1,1) model of inflation Δp_{t+1} whose h-period forecast is obtained by aggregating the one-step forecast over h periods. The lags for the first three models are selected using AIC. The reported RMSFEs are relative to the RMSFE of the AR model. $\overline{cy}_t^{(-)}$ is a simple average of the convenience yields of oats, soybeans and silver and $\overline{cy}_t^{(+)}$ is a simple average of the convenience yields of cocoa, orange juice and copper.

TABLE B.7. Variance Decomposition of U.S. Inflation $\Delta^h p_t$.

	$\triangle p_t$			$\triangle^3 p_t$			$\triangle^6 p_t$			$\triangle^{12} p_t$		
Period	3	18	36	3	18	36	3	18	36	3	18	36
	CPI all items											
$\triangle^h p_t$	85.0	78.6	78.6	80.9	67.6	67.4	89.1	73.4	72.5	93.4	79.7	78.8
	(3.2)	(4.8)	(4.9)	(4.9)	(7.5)	(7.7)	(4.9)	(9.6)	(9.9)	(3.0)	(8.1)	(8.8)
$pcq_t^{(1)}$	0.8	1.8	1.8	0.8	3.0	3.0	0.1	2.8	2.9	0.3	3.6	4.1
	(1.6)	(1.8)	(1.8)	(1.8)	(2.6)	(2.6)	(1.6)	(3.6)	(3.6)	(0.8)	(3.7)	(4.0)
$pcq_t^{(2)}$	2.8	3.7	3.7	4.5	5.4	5.4	3.7	6.4	6.4	3.0	6.0	5.1
	(2.2)	(2.1)	(2.1)	(2.3)	(3.4)	(3.5)	(2.0)	(4.4)	(4.4)	(1.6)	(3.3)	(3.4)
$q_{oil,t}$	10.3	11.4	11.4	13.1	17.3	17.4	5.7	6.8	7.1	2.8	2.7	2.5
	(2.6)	(2.7)	(2.7)	(4.8)	(5.5)	(5.5)	(3.8)	(4.9)	(4.9)	(2.4)	(3.3)	(3.3)
$pccy_t^{(1)}$	0.8	1.3	1.3	0.7	2.9	2.9	1.4	4.1	4.2	0.4	4.0	5.8
	(0.8)	(2.0)	(2.1)	(1.3)	(3.4)	(3.5)	(1.3)	(4.4)	(4.5)	(0.7)	(3.8)	(4.3)
$pccy_t^{(2)}$	0.3	3.1	3.1	0.0	3.9	3.9	0.0	6.5	7.0	0.2	4.1	3.7
	(0.8)	(1.9)	(1.9)	(1.1)	(3.7)	(3.8)	(1.3)	(4.6)	(4.8)	(0.9)	(4.0)	(4.4)
	CPI less food and energy											
$\triangle^h p_t$	95.9	84.7	81.0	99.1	90.1	87.1	98.4	86.4	83.5	97.3	65.0	53.6
	(2.8)	(7.3)	(7.9)	(1.9)	(8.0)	(8.9)	(1.5)	(7.9)	(8.8)	(1.4)	(8.3)	(9.4)
$pcq_t^{(1)}$	1.8	1.6	1.6	0.4	2.0	1.7	0.4	2.9	2.4	0.1	2.9	3.2
	(1.0)	(1.6)	(1.8)	(0.9)	(2.6)	(2.9)	(0.4)	(3.0)	(3.3)	(0.4)	(4.4)	(4.7)
$pcq_t^{(2)}$	0.5	1.0	1.0	0.0	1.8	2.0	0.5	3.8	3.5	2.0	19.4	23.1
	(0.7)	(2.0)	(2.2)	(0.6)	(3.1)	(3.3)	(0.6)	(4.4)	(4.7)	(1.0)	(4.4)	(4.8)
$q_{oil,t}$	0.4	0.5	0.7	0.1	0.3	0.5	0.1	0.3	0.9	0.1	0.2	0.4
	(0.7)	(1.9)	(1.9)	(0.7)	(4.1)	(4.2)	(0.5)	(4.0)	(4.2)	(0.5)	(3.3)	(3.5)
$pccy_t^{(1)}$	0.9	2.4	2.5	0.2	0.6	0.6	0.2	0.3	0.3	0.1	0.4	0.9
	(2.2)	(6.0)	(6.4)	(1.1)	(4.9)	(5.4)	(0.9)	(3.1)	(3.8)	(0.4)	(4.0)	(4.7)
$pccy_t^{(2)}$	0.5	9.9	13.3	0.3	5.3	8.1	0.4	6.3	9.4	0.3	12.1	18.8
	(1.4)	(4.5)	(4.8)	(0.6)	(3.7)	(4.3)	(0.7)	(2.9)	(3.5)	(0.4)	(2.7)	(3.4)

Notes: The results are obtained from a VAR(4) model with a Choleski decomposition using the ordering $(\triangle^h p_t, pcq_t^{(1)}, pcq_t^{(2)}, q_{oil,t}, pccy_t^{(1)}, pccy_t^{(2)})$. Bootstrap standard errors in parentheses.

TABLE B.8. Variance Decomposition of $\Delta^h s_t^{IMF}$.

	$\triangle s_t^{IMF}$			$\triangle^3 s_t^{IMF}$			$\triangle^6 s_t^{IMF}$			$\triangle^{12} s_t^{IMF}$		
Horizon	3	18	36	3	18	36	3	18	36	3	18	36
$\triangle^h s_t^{IMF}$	94.9	86.1	84.8	97.0	77.3	74.0	97.3	64.0	60.3	98.8	81.6	72.9
	(3.0)	(4.0)	(4.0)	(2.2)	(5.9)	(6.0)	(2.1)	(9.2)	(9.4)	(1.4)	(11.3)	(11.4)
$pccy_t^{(1)}$	0.4	5.2	5.2	0.5	10.7	10.7	1.1	14.6	14.8	0.3	7.9	10.7
	(1.7)	(3.3)	(3.3)	(1.6)	(4.6)	(4.6)	(1.5)	(7.1)	(7.0)	(0.7)	(8.8)	(9.0)
$pccy_t^{(2)}$	3.4	4.4	4.8	1.9	5.6	6.9	1.1	9.3	10.6	0.1	2.5	4.7
	(2.1)	(3.5)	(3.5)	(1.6)	(4.7)	(4.7)	(1.4)	(5.9)	(5.8)	(0.7)	(8.1)	(8.0)
$\Delta\overline{x}_t$	0.0	2.9	2.9	0.3	5.6	5.5	0.1	10.5	10.0	0.0	6.6	6.6
	(0.7)	(1.5)	(1.5)	(0.8)	(2.3)	(2.3)	(0.7)	(3.4)	(3.4)	(0.7)	(4.2)	(4.1)
i_t	1.3	1.4	2.3	0.3	0.9	2.9	0.5	1.7	4.3	0.7	1.3	5.2
	(1.4)	(1.8)	(1.8)	(0.8)	(2.2)	(2.4)	(0.6)	(3.4)	(3.8)	(0.6)	(4.3)	(4.8)

Notes: The results are obtained from a VAR(4) model with a Choleski decomposition using the ordering $(\triangle^h s_t^{IMF}, pccy_t^{(1)}, pccy_t^{(2)}, \Delta\overline{x}_t, i_t)$. Bootstrap standard errors are in parentheses.

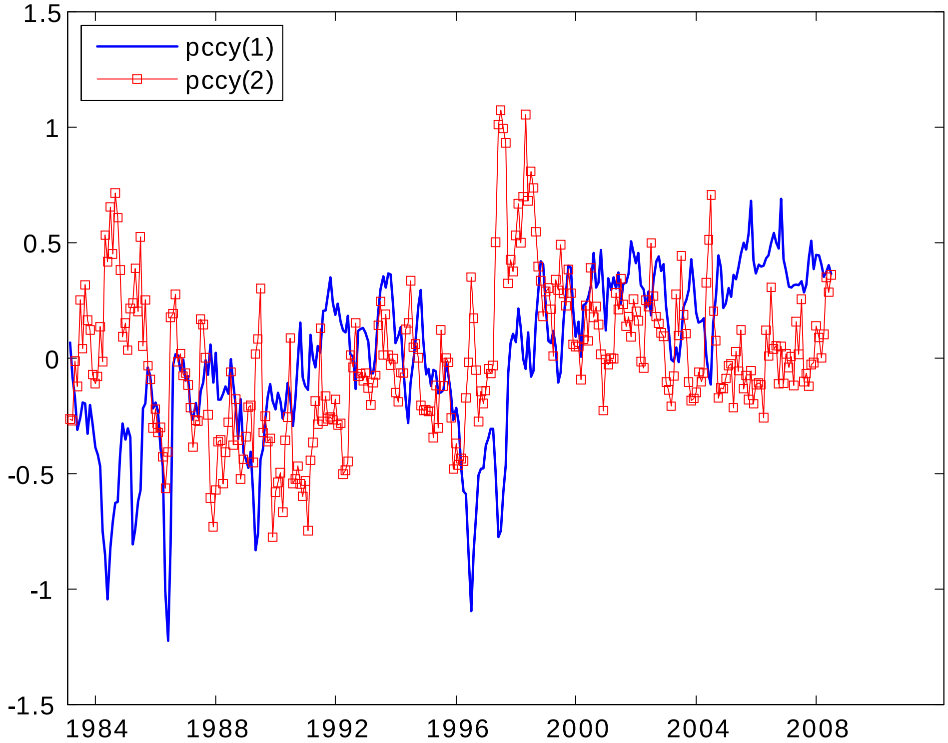

FIGURE 1. First two principal components of 23 commodity convenience yields.

C Monte Carlo Simulation

We use simulations to illustrate the coverage properties of the proposed bootstrap confidence intervals. The data generating process for the Monte Carlo experiment is similar to the one considered by Bai and Ng (2006). More specifically, the simulated data for $i = 1, ..., N$, $t = 1, ..., T$ and $j = 1, 2$ are generated as

$$\begin{aligned} x_{it} &= \lambda_i' F_t + e_{it} \\ F_{jt} &= \rho_j F_{jt-1} + (1 - \rho_j^2)^{1/2} u_{jt} \\ y_t &= 1 + \varepsilon_t, \end{aligned}$$

where λ_i are drawn from the uniform distribution on [0,1], $\rho_j = 0.8^j$ and $u_{jt} \sim iidN(0, 1)$ for $j = 1, 2$, v_t is an $N \times 1$ vector of standard normal variables (uncorrelated with u_{jt}) with variance $\sigma(i)^2$ $(i = 1, ..., N)$ that is uniformly distributed on [0.5, 1.5], $e_t = v_t \Omega(0.5)^{1/2}$ with $\Omega(0.5)^{1/2}$ denoting the Choleski decomposition of the $N \times N$ Toeplitz matrix $\Omega(0.5)$ whose j^{th} main diagonal is 0.5^j for $j \leq 10$ and 0 otherwise, and $\varepsilon_t = 0.5\varepsilon_{t-1} + \xi_t$ with $\xi_t \sim iidN(0, 1)$.

For each simulated sample, we compute two principal components from x_{it}, denoted by $pcx_t^{(1)}$ and $pcx_t^{(2)}$, and estimate the parameters of the regression

$$y_t = \beta_0 + \beta_1 pcx_t^{(1)} + \beta_2 pcx_t^{(2)} + \varepsilon_t,$$

where the true values of β_1 and β_2 are zero. The number of bootstrap replications is 499 and the number of Monte Carlo replications is 5,000. It is important to note that the factor structure of the model from which the data are generated is not imposed in our bootstrap inference procedure. Table C.1 reports the coverage rates of the 90% asymptotic (based on the standard normal critical values) and bootstrap confidence intervals for β_1 and β_2. The results reveal the asymptotic confidence intervals tend to undercover by 3.8% to 8.6% while the coverage rates of the bootstrap confidence intervals are very close to the nominal level even for small sample sizes.

Table C.1. Monte Carlo Coverage Rates of 90% Confidence Intervals.

N	T	asymptotic		bootstrap	
		β_1	β_2	β_1	β_2
20	100	0.814	0.837	0.884	0.902
	300	0.847	0.862	0.893	0.890
	600	0.856	0.862	0.901	0.884
40	100	0.816	0.831	0.895	0.912
	300	0.844	0.855	0.893	0.871
	600	0.859	0.854	0.906	0.870