Appendix Containing VAR Estimation Results for "Multi-Period Portfolio Choice and the Intertemporal Hedging Demands for Stocks and Bonds: International Evidence"

We report OLS estimation results for the VAR(1) model, equation (3), for each country in Tables A1–A7 below. The VAR model captures the extent of return predictability in each country that provides the basis for the intertemporal hedging demands. Letting $\Phi_0 = \{\phi_i^0\}$ and $\Phi_1 = \{\phi_{i,j}^1\}$, equation (3) can be expressed in more detail as

$$rtbr_{t+1} = \phi_1^0 + \phi_{1,1}^1 rbtr_t + \phi_{1,2}^1 xsr_t + \phi_{1,3}^1 xbr_t + \phi_{1,4}^1 bill_t + \phi_{1,5}^1 div_t + \phi_{1,6}^1 spread_t + v_{1,t+1}, \qquad \text{(A1)}$$

$$xsr_{t+1} = \phi_2^0 + \phi_{2,1}^1 rbtr_t + \phi_{2,2}^1 xsr_t + \phi_{2,3}^1 xbr_t + \phi_{2,4}^1 bill_t + \phi_{2,5}^1 div_t + \phi_{2,6}^1 spread_t + v_{2,t+1}, \qquad \text{(A2)}$$

$$xbr_{t+1} = \phi_3^0 + \phi_{3,1}^1 rbtr_t + \phi_{3,2}^1 xsr_t + \phi_{3,3}^1 xbr_t + \phi_{3,4}^1 bill_t + \phi_{3,5}^1 div_t + \phi_{3,6}^1 spread_t + v_{3,t+1}, \qquad \text{(A3)}$$

$$bill_{t+1} = \phi_4^0 + \phi_{4,1}^1 rbtr_t + \phi_{4,2}^1 xsr_t + \phi_{4,3}^1 xbr_t + \phi_{4,4}^1 bill_t + \phi_{4,5}^1 div_t + \phi_{4,6}^1 spread_t + v_{4,t+1}, \qquad \text{(A4)}$$

$$div_{t+1} = \phi_5^0 + \phi_{5,1}^1 rbtr_t + \phi_{5,2}^1 xsr_t + \phi_{5,3}^1 xbr_t + \phi_{5,4}^1 bill_t + \phi_{5,5}^1 div_t + \phi_{5,6}^1 spread_t + v_{5,t+1}, \qquad \text{(A5)}$$

$$spread_{t+1} = \phi_6^0 + \phi_{6,1}^1 rbtr_t + \phi_{6,2}^1 xsr_t + \phi_{6,3}^1 xbr_t + \phi_{6,4}^1 bill_t + \phi_{6,5}^1 div_t + \phi_{6,6}^1 spread_t + v_{6,t+1}, \qquad \text{(A6)}$$

for $t = 1, \ldots, T-1$. The first three equations of the VAR, equations (A1)-(A3), can be viewed as predictive regression models for real bill, excess stock, and excess bond returns, respectively. It is well-known that there are a number of econometric difficulties associated with estimating predictive regressions for stock and bond returns (Mankiw and Shapiro, 1986; Stambaugh, 1986, 1999; Nelson and Kim, 1993; Kirby, 1997; Bekaert, Hodrick, and Marshall, 1997). Essentially, these difficulties lead to size distortions in tests of the significance of the slope coefficients in predictive regressions.[1] In order to help correct for possible size distortions when assessing the predictive power of the lagged returns and instruments with respect to bill, stock, and bond returns in each country, we report *p*-values corresponding to the *t*-statistics for the

[1] Relatedly, OLS estimates can be subject to small-sample biases (Stambaugh, 1986, 1999). Given that small-sample bias corrections can be very complicated in the system defined by equations (A1)–(A6), we follow CCV and assume that investors treat the OLS estimates of the VAR coefficients as given and known.

slope coefficients in equations (A1)-(A3) using a parametric bootstrap procedure similar to the one described in Section 2.2 of the paper, with the exception that we assume real bill, excess stock, and excess bond returns are generated by

$$rtbr_{t+1} = \tilde{\phi}_1^0 + \tilde{v}_{1,t+1}, \quad \text{(A1')}$$

$$xsr_{t+1} = \tilde{\phi}_2^0 + \tilde{v}_{2,t+1}, \quad \text{(A2')}$$

$$xbr_{t+1} = \tilde{\phi}_3^0 + \tilde{v}_{3,t+1}, \quad \text{(A3')}$$

respectively, under the null hypothesis of no return predictability. Using this restricted VAR(1) model as the data-generating process, we can simulate a pseudo-sample of T observations for z_t and calculate the *t*-statistic for each of the slope coefficients in equations (A1)-(A3) for the pseudo-sample.[2] We repeat this process 1,000 times, giving us empirical distributions for the *t*-statistics for each of the slope coefficients in equations (A1)-(A3) under the null hypothesis of no return predictability. In order to generate *p*-values corresponding to one-sided significance tests, if the *t*-statistic for a given slope coefficient for the original sample is positive, then the *p*-value is the proportion of the bootstrapped *t*-statistics that are greater than the *t*-statistic for the original sample; if the *t*-statistic for the original sample is negative, then the *p*-value is the proportion of the bootstrapped *t*-statistics that are less than the *t*-statistic for the original sample. Inoue and Kilian (2004) argue that more powerful one-sided tests should be preferred in predictive regressions, as theory frequently suggests the sign of a coefficient.[3] For each return equation, we also report a bootstrapped *p*-value corresponding to a Wald test of the null hypothesis that the slope coefficients are jointly zero.

References

Bekaert, G., Hodrick, R.J., Marshall, D.A., 1997. On biases in tests of the expectations hypothesis of the term structure of interest rates. Journal of Financial Economics 44, 309-348.

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[2] Like the bootstrap procedure described in Section 2.2 in the paper, we randomize the initial z_t values by including 100 transient start-up observations in each pseudo-sample that we subsequently discard.

[3] While we report *p*-values for one-sided tests, we can simply double the *p*-values to convert them to *p*-values for two-sided tests under the assumptions that the distributions are approximately symmetric.

Inoue, A., Kilian, L., 2004. In-sample or out-of-sample tests of predictability: which one should we use? Econometric Reviews 23, 371-402.

Kirby, C., 1997. Measuring the predictable variation in stock and bond returns. Review of Financial Studies 10, 579-630.

Mankiw, N.G., Shapiro, M.D., 1986. Do we reject too often? Economic Letters 20, 139-145.

Nelson, C.R., Kim, M.J., 1993. Predictable stock returns: the role of small sample bias. Journal of Finance 48, 641-661.

Stambaugh, R.F. 1986. Biases in regressions with lagged stochastic regressors. Working Paper No. 156, University of Chicago, Graduate School of Business.

Stambaugh, R.F., 1999. Predictive regressions. Journal of Financial Economics 54, 375-421.

Table A1: VAR estimation results, United States, 1952:04-2004:05

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dependent Variable	$rtbr_t$	xsr_t	xbr_t	$bill_t$	div_t	$spread_t$	R^2
VAR slope coefficient estimates and goodness-of-fit measures							
$rtbr_{t+1}$	**0.360** (9.610) [0.000]	0.003 (1.169) [0.139]	0.009 (1.287) [0.110]	-0.000 (-0.681) [0.229]	0.000 (0.251) [0.472]	0.000 (0.608) [0.294]	**0.146** [0.000]
xsr_{t+1}	**0.813** (1.381) [0.080]	-0.004 (-0.094) [0.476]	**0.253** (2.294) [0.013]	**-0.004** (-1.874) [0.037]	**0.009** (2.156) [0.072]	0.001 (0.760) [0.269]	**0.042** [0.000]
xbr_{t+1}	**0.651** (2.901) [0.002]	**-0.065** (-4.264) [0.000]	**0.165** (3.913) [0.000]	0.001 (1.072) [0.208]	0.001 (0.317) [0.566]	**0.002** (2.834) [0.001]	**0.070** [0.000]
$bill_{t+1}$	-10.793 (-1.603)	**1.635** (3.551)	**-6.778** (-5.372)	**0.881** (36.718)	-0.022 (-0.448)	**0.048** (2.383)	0.791
div_{t+1}	-0.862 (-1.401)	0.030 (0.706)	**-0.276** (-2.396)	**0.005** (2.285)	**0.992** (223.159)	-0.001 (-0.328)	0.988
$spread_{t+1}$	-0.626 (-0.111)	-0.353 (-0.916)	**3.125** (2.960)	-0.011 (-0.548)	0.000 (0.012)	**0.932** (55.789)	0.885
Cross-correlations of VAR residuals							
	rtbr	*xsr*	*xbr*	*bill*	*div*	*spread*	
rtbr	1.000						
xsr	0.052	1.00					
xbr	-0.010	0.132	1.00				
bill	0.063	-0.046	-0.656	1.00			
div	-0.081	-0.964	-0.126	0.034	1.00		
spread	-0.100	-0.076	0.050	-0.748	0.087	1.00	

Notes: $rtbr_t$ = log real 3-month Treasury bill return; xsr_t = log excess stock return; xbr_t = log excess bond return; $bill_t$ = 3-month Treasury bill yield (deviations from 1-year backward-looking moving average); div_t = log dividend yield; $spread_t$ = 10-year government bond yield – 3-month Treasury bill yield. *t*-statistics are given in parentheses. Bootstrapped *p*-values corresponding to the reported *t*-statistics under the null hypothesis of no predictability are given in brackets for the $rtbr_{t+1}$, xsr_{t+1} and xbr_{t+1} equations; if the *t*-statistic < 0, the reported *p*-value is the proportion of bootstrapped draws that yield a *t*-statistic less than the original statistic; if the *t*-statistic >

0, the reported *p*-value is the proportion of bootstrapped draws that yield a *t*-statistic greater than the original *t*-statistic. A bold coefficient for the $rtbr_{t+1}$, xsr_{t+1} and xbr_{t+1} equations indicates significance at the 10% level according to the bootstrapped *p*-value. A bold coefficient for the $bill_{t+1}$, div_{t+1}, and $spread_{t+1}$ equations indicates significance according to a two-sided test based on the reported *t*-statistic. The bootstrapped *p*-values appearing below the reported R^2 measure for the $rtbr_{t+1}$, xsr_{t+1} and xbr_{t+1} equations correspond to a Wald test of the null hypothesis that the explanatory variables are jointly zero; a bold R^2 indicates that the Wald statistic is significant at the 10% level. 0.000 indicates $\leq$ 0.0005.

Table A2: VAR estimation results, Australia, 1952:04-2004:05

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dependent Variable	$rtbr_t$	xsr_t	xbr_t	$bill_t$	div_t	$spread_t$	R^2
VAR slope coefficient estimates and goodness-of-fit measures							
$rtbr_{t+1}$	**0.323** (8.475) [0.000]	-0.005 (-0.720) [0.230]	0.007 (0.431) [0.325]	**-0.000** (-1.345) [0.077]	**-0.002** (-2.132) [0.007]	**-0.001** (-3.219) [0.000]	**0.164** [0.000]
xsr_{t+1}	-0.095 (-0.377) [0.381]	**0.091** (2.173) [0.015]	**-0.213** (-2.035) [0.029]	-0.002 (-0.836) [0.213]	**0.015** (2.035) [0.073]	0.000 (0.212) [0.461]	**0.020** [0.075]
xbr_{t+1}	0.111 (1.081) [0.123]	0.017 (0.982) [0.151]	0.005 (0.123) [0.423]	**-0.002** (-2.488) [0.005]	0.001 (0.270) [0.503]	0.001 (1.440) [0.112]	**0.027** [0.008]
$bill_{t+1}$	-4.051 (-1.430)	-0.035 (-0.075)	-1.386 (-1.176)	**0.924** (44.702)	**-0.192** (-2.313)	**0.068** (4.389)	0.802
div_{t+1}	-0.220 (-0.946)	**-0.111** (-2.873)	**0.208** (2.152)	**0.005** (2.748)	**0.981** (144.256)	0.002 (1.372)	0.974
$spread_{t+1}$	2.087 (0.774)	0.144 (0.324)	0.792 (0.706)	-0.012 (-0.632)	0.123 (1.554)	**0.940** (63.766)	0.897
Cross-correlations of VAR residuals							
	rtbr	*xsr*	*xbr*	*bill*	*div*	*spread*	
rtbr	1.000						
xsr	0.033	1.000					
xbr	0.063	0.291	1.000				
bill	0.017	-0.212	-0.298	1.000			
div	-0.059	-0.737	-0.250	0.276	1.000		
spread	-0.051	0.068	-0.172	-0.849	-0.119	1.000	

See notes to Table A1.

Table A3: VAR estimation results, Canada, 1952:04-2004:05

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dependent Variable	$rtbr_t$	xsr_t	xbr_t	$bill_t$	div_t	$spread_t$	R^2
VAR slope coefficient estimates and goodness-of-fit measures							
$rtbr_{t+1}$	**0.152** (3.814) [0.000]	-0.002 (-0.683) [0.235]	0.006 (0.802) [0.209]	**-0.000** (-1.450) [0.070]	**-0.001** (-2.102) [0.017]	**-0.001** (-5.276) [0.000]	**0.093** [0.000]
xsr_{t+1}	-0.109 (-0.239) [0.413]	**0.064** (1.553) [0.073]	**0.168** (1.876) [0.039]	-0.001 (-0.616) [0.265]	0.008 (1.576) [0.154]	**0.002** (1.442) [0.091]	**0.027** [0.013]
xbr_{t+1}	**0.766** (3.639) [0.000]	**-0.098** (-5.173) [0.000]	**0.134** (3.262) [0.000]	-0.000 (-0.300) [0.282]	0.003 (1.132) [0.269]	**0.003** (3.576) [0.000]	0.085 [0.000]
$bill_{t+1}$	**-12.132** (-2.383)	**1.213** (2.635)	**-6.149** (-6.171)	**0.944** (50.568)	-0.024 (-0.408)	**0.069** (3.974)	0.863
div_{t+1}	-0.194 (-0.413)	-0.038 (-0.898)	**-0.198** (-2.150)	**0.003** (1.813)	**0.990** (183.840)	-0.001 (-0.628)	0.984
$spread_{t+1}$	1.903 (0.427)	0.289 (0.716)	**4.193** (4.801)	**-0.050** (-3.050)	-0.030 (-0.594)	**0.922** (60.929)	0.914
Cross-correlations of VAR residuals							
	rtbr	*xsr*	*xbr*	*bill*	*div*	*spread*	
rtbr	1.000						
xsr	0.018	1.000					
xbr	0.021	0.269	1.000				
bill	0.042	-0.200	-0.449	1.000			
div	-0.068	-0.900	-0.308	0.216	1.000		
spread	-0.051	0.050	-0.167	-0.777	-0.049	1.000	

See notes to Table A1.

Table A4: VAR estimation results, France, 1961:01-2004:05

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dependent Variable	$rtbr_t$	xsr_t	xbr_t	$bill_t$	div_t	$spread_t$	R^2
VAR slope coefficient estimates and goodness-of-fit measures							
$rtbr_{t+1}$	**0.410**	-0.002	0.009	**-0.000**	-0.000	**-0.001**	**0.311**
	(10.111)	(-0.975)	(1.277)	(-2.374)	(-1.103)	(-5.666)	[0.000]
	[0.000]	[0.170]	[0.106]	[0.009]	[0.123]	[0.000]	
xsr_{t+1}	0.014	**0.098**	**0.198**	-0.002	0.005	0.001	**0.026**
	(0.017)	(2.148)	(1.371)	(-1.116)	(0.942)	(0.258)	[0.045]
	[0.489]	[0.014]	[0.085]	[0.159]	[0.386]	[0.422]	
xbr_{t+1}	**1.394**	-0.004	**0.129**	**-0.001**	0.001	**0.002**	**0.103**
	(5.454)	(-0.271)	(2.839)	(-1.791)	(0.670)	(2.583)	[0.000]
	[0.000]	[0.381]	[0.001]	[0.019]	[0.380]	[0.008]	
$bill_{t+1}$	-3.832	-0.469	**-5.695**	**0.947**	-0.040	**0.083**	0.887
	(-0.583)	(-1.279)	(-4.873)	(53.047)	(-0.928)	(4.928)	
div_{t+1}	-0.875	**-0.157**	-0.257	0.003	**0.986**	0.000	0.983
	(-0.968)	(-3.110)	(-1.601)	(1.176)	(168.410)	(0.001)	
$spread_{t+1}$	**-14.085**	0.480	**4.088**	**-0.048**	0.005	**0.918**	0.910
	(-2.200)	(1.344)	(3.592)	(-2.737)	(0.130)	(56.105)	
Cross-correlations of VAR residuals							
	rtbr	*xsr*	*xbr*	*bill*	*div*	*spread*	
rtbr	1.000						
xsr	0.008	1.000					
xbr	-0.031	0.255	1.000				
bill	0.128	-0.151	-0.350	1.000			
div	0.028	-0.778	-0.258	0.068	1.000		
spread	-0.110	0.022	-0.208	-0.798	0.065	1.000	

See notes to Table A1.

Table A5: VAR estimation results, Germany, 1967:02-2004:05

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dependent Variable	$rtbr_t$	xsr_t	xbr_t	$bill_t$	div_t	$spread_t$	R^2
VAR slope coefficient estimates and goodness-of-fit measures							
$rtbr_{t+1}$	**0.224**	-0.002	-0.011	0.000	-0.000	**-0.001**	**0.139**
	(4.768)	(-0.664)	(-1.178)	(0.111)	(-0.101)	(-4.777)	[0.000]
	[0.000]	[0.240]	[0.137]	[0.483]	[0.434]	[0.000]	
xsr_{t+1}	0.343	**0.064**	0.082	**-0.005**	0.010	0.002	0.023
	(0.433)	(1.320)	(0.540)	(-1.965)	(1.144)	(0.849)	[0.138]
	[0.331]	[0.094]	[0.288]	[0.035]	[0.303]	[0.262]	
xbr_{t+1}	**0.745**	**-0.044**	**0.200**	**-0.001**	0.002	0.001	**0.088**
	(2.972)	(-2.877)	(4.200)	(-1.735)	(0.654)	(1.496)	[0.000]
	[0.003]	[0.001]	[0.000]	[0.026]	[0.371]	[0.105]	
$bill_{t+1}$	1.260	0.377	**-7.687**	**0.929**	-0.064	**0.068**	0.892
	(0.248)	(1.218)	(-7.942)	(55.388)	(-1.175)	(4.925)	
div_{t+1}	-0.044	-0.062	-0.156	**0.008**	**0.980**	-0.001	0.962
	(-0.050)	(-1.167)	(-0.934)	(2.609)	(103.836)	(-0.345)	
$spread_{t+1}$	**-11.420**	0.347	**4.664**	**-0.035**	0.014	**0.940**	0.915
	(-2.039)	(1.018)	(4.374)	(-1.874)	(0.237)	(61.636)	
Cross-correlations of VAR residuals							
	rtbr	*xsr*	*xbr*	*bill*	*div*	*spread*	
rtbr	1.000						
xsr	-0.014	1.000					
xbr	0.113	0.152	1.000				
bill	0.017	-0.015	-0.204	1.000			
div	0.018	-0.804	-0.132	0.027	1.000		
spread	-0.082	-0.070	-0.435	-0.774	0.044	1.000	

See notes to Table A1.

Table A6: VAR estimation results, Italy, 1952:04-2004:05

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dependent variable	$rtbr_t$	xsr_t	xbr_t	$bill_t$	div_t	$spread_t$	R^2
VAR slope coefficient estimates and goodness-of-fit measures							
$rtbr_{t+1}$	**0.458**	0.000	0.006	**-0.000**	**-0.001**	**-0.000**	**0.262**
	(12.771)	(0.083)	(0.685)	(-1.522)	(-1.494)	(-2.544)	[0.000]
	[0.000]	[0.430]	[0.270]	[0.060]	[0.064]	[0.003]	
xsr_{t+1}	**0.740**	**0.094**	-0.025	-0.001	0.006	0.002	0.016
	(1.319)	(2.298)	(-0.187)	(-0.566)	(0.824)	(0.853)	[0.132]
	[0.092]	[0.006]	[0.422]	[0.283]	[0.359]	[0.218]	
xbr_{t+1}	**0.719**	0.017	**0.238**	**-0.002**	0.000	**0.001**	**0.155**
	(4.273)	(1.367)	(5.919)	(-2.857)	(0.124)	(1.699)	[0.000]
	[0.000]	[0.109]	[0.000]	[0.000]	[0.448]	[0.065]	
$bill_{t+1}$	**-28.046**	-0.562	-2.016	**0.908**	**-0.162**	**0.062**	0.830
	(-5.376)	(-1.484)	(-1.616)	(45.865)	(-2.520)	(3.787)	
div_{t+1}	-0.874	**-0.400**	**0.280**	0.000	**0.971**	0.001	0.969
	(-1.405)	(-8.858)	(1.884)	(0.069)	(126.418)	(0.751)	
$spread_{t+1}$	**16.983**	**0.701**	-0.953	0.002	**0.141**	**0.938**	0.891
	(3.368)	(1.914)	(-0.791)	(0.128)	(2.255)	(59.015)	
Cross-correlations of VAR residuals							
	rtbr	*xsr*	*xbr*	*bill*	*div*	*spread*	
rtbr	1.000						
xsr	-0.017	1.000					
xbr	0.009	0.157	1.000				
bill	0.010	-0.089	-0.244	1.000			
div	0.028	-0.599	-0.118	0.001	1.000		
spread	-0.011	-0.019	-0.179	-0.854	0.084	1.000	

See notes to Table A1.

Table A7: VAR estimation results, United Kingdom, 1952:04-2004:05

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dependent Variable	$rtbr_t$	xsr_t	xbr_t	$bill_t$	div_t	$spread_t$	R^2
VAR slope coefficient estimates and goodness-of-fit measures							
$rtbr_{t+1}$	**0.183**	0.001	-0.003	**-0.001**	**-0.001**	**-0.001**	**0.146**
	(4.624)	(0.324)	(-0.181)	(-3.598)	(-1.468)	(-6.154)	[0.000]
	[0.000]	[0.377]	[0.436]	[0.000]	[0.083]	[0.000]	
xsr_{t+1}	**0.845**	**0.093**	0.210	-0.001	**0.028**	0.001	**0.044**
	(2.240)	(2.224)	(1.269)	(-0.478)	(3.555)	(0.731)	[0.000]
	[0.015]	[0.009]	[0.109]	[0.299]	[0.003]	[0.269]	
xbr_{t+1}	**0.255**	**0.042**	**0.269**	0.000	**0.004**	**0.000**	**0.140**
	(2.732)	(4.018)	(6.572)	(0.284)	(1.918)	(1.553)	[0.000]
	[0.002]	[0.000]	[0.000]	[0.446]	[0.042]	[0.065]	
$bill_{t+1}$	2.671	-0.106	**-7.124**	**0.913**	**-0.251**	**0.054**	0.830
	(0.661)	(-0.236)	(-4.022)	(47.958)	(-3.021)	(4.275)	
div_{t+1}	-0.363	**-0.442**	-0.111	0.002	**0.984**	0.000	0.979
	(-1.213)	(-13.340)	(-0.847)	(1.515)	(160.090)	(0.507)	
$spread_{t+1}$	**-7.353**	**-0.998**	1.851	**-0.031**	**0.149**	**0.950**	0.937
	(-1.961)	(-2.404)	(1.126)	(-1.761)	(1.936)	(80.995)	
Cross-correlations of VAR residuals							
	rtbr	*xsr*	*xbr*	*bill*	*div*	*spread*	
rtbr	1.000						
xsr	-0.111	1.000					
xbr	-0.043	0.279	1.000				
bill	0.097	-0.263	-0.466	1.000			
div	0.082	-0.789	-0.291	0.222	1.000		
spread	-0.098	0.129	0.036	-0.840	-0.083	1.000	

See notes to Table A1.