Do Combination Forecasts Outperform the Historical Average? Economic and Statistical Evidence

14^{th} IWH-CIREQ Macroeconometric Workshop

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December 3^{rd}, 2013

OUTLINE

OBJECTIVES

1. Predictability of German stock returns using financial and economic variables.
2. Statistical and economic evaluation of stock returns predictability.
3. Examine whether forecast combinations outperform the historical benchmark model.
4. Investigate whether out-of-sample forecasting performance depends on different evaluation periods, as well as near peaks and troughs.

RESULTS

- Only one variable, the term spread, has in-sample and out-of-sample forecasting power and consistently outperform the historical average benchmark model.
- This variable recognises the typical drop in the equity premium near business cycle peaks, as well as the typical increase in the equity premium near business cycle troughs.
- There is no evidence that combinations of forecasts from individual model do deliver any statistical and economic significant out-of-sample gains relative to the historical average on a consistent basis over time.

LITERATURE REVIEW

Predictability of stock returns:

- Dividend yield: Fama and French (1988), Campbell (1991), Cochrane (1992), Ang and Bekaert (2007)
- Price-earnings ratio: Campbell and Shiller (1988), Weigand and Irons (2007)
- Short-term interest rate: Campbell (1987), Gampbell and Hamao (1992), Ang and Bekaert (2002b)
- Term spread: Estrella and Miskin (1996), Rapach *et al.* (2005), Hjalmarsson (2010)
- Inflation rate: Nelson (1976), Fama and Schwert (1977), Campbell and Vuolteenaho (2004)
- Unemployment rate: Boyd *et al.* (2005), Chen and Zhang (2009)
- Oil prices: Driesprong *et al.* (2008), Casassus and Higuera (2011)

LITERATURE REVIEW

- Bates and Granger (1969): combination of individual forecasts
- Newbold and Granger (1974), Clemen (1989), Smith and Wallis (2009): simple rules of combining forecasts outperform more complicated weighting schemes (Stock and Watson, 2004)
- Granger and Jeon (2004): "thick modelling"
- Hendry and Clements (2004): presence of structural breaks (Paye and Timmermann, 2006)
- Timmermann (2006): analogous to a diversification strategy

LITERATURE REVIEW

- Campbell (2008): out-of-sample performance
- Statistical evaluation $\longrightarrow$ mean square prediction error ($MSPE$), squared correlation coefficient ($CORR^2$), out-of-sample R^2 (R^2_{OS}), adjusted-$MSPE$
- Leitch and Turner (1991) and Pesaran and Timmermann (1995): little justification for profit-maximising investors
- Giacomini and White (2006): focus to the forecasting method
- Economic evaluation $\longrightarrow$ utility gain for a mean-variance investor

METHODOLOGY - Predictive Regression Model

- Predictive regression model (univariate prediction model)

$$r_{t+1} = a_i + \beta_i x_{i,t} + \varepsilon_{t+1}, \qquad i = 1, \ldots, N \tag{1}$$

- "Kitchen sink" (multivariate prediction model)

$$r_{t+1} = a_i + \sum_{i=1}^{N} \beta_i x_{i,t} + \varepsilon_{t+1}$$

- Expanding estimation window (Pesaran and Timmermann, 1995; Goyal and Welch, 2003; Ferreira and Santa-Clara, 2011).

- In-sample ($t = 1, \ldots, k$); out-of-sample ($k = s, \ldots, T$).

- Out-of-sample forecasts based on Equation (1)

$$\widehat{r}_{i,t+1} = \widehat{\alpha}_{i,t} + \widehat{\beta}_{i,t} x_{i,t}, \qquad i = 1, \ldots, N$$

Simple Combination Methods

$$\widehat{r}^{c}_{t+1} = \sum_{i=1}^{N} \omega^{c}_{i,t} \widehat{r}_{i,t+1}$$

where $\left\{\omega^{c}_{i,t}\right\}_{i=1}^{N}$ are the combining weights corresponding to each specific scheme ($\sum_{i=1}^{N} \omega^{c}_{i,t} = 1$).

- mean - "naive rule": $\omega^{mean}_{i,t} = 1/N$
- median - median of sequence of individual forecasts: $\left\{\widehat{r}_{i,t+1}\right\}_{i=1}^{N}$
- trimmed-mean: $\omega^{trimmed}_{i,t} = 0$ for the highest and lowest individual forecasts and $\omega^{trimmed}_{i,t} = 1/(N-2)$ for the remaining forecasts

Discounting Method

Sets weights proportional to the inverse of the models *MSPE* value:

$$\omega_{i,t}^{DMSPE} = \frac{DMSPE_{i,t}^{-1}}{\sum_{j=1}^{N} DMSPE_{j,t}^{-1}}$$

and

$$DMSPE_{i,t} = \sum_{l=p}^{t-1} \theta^{t-1-l} (r_{i,l+1} - \widehat{r}_{i,l+1})^2$$

where θ is the discount factor; when $\theta = 0$ no discounting occurs; when $\theta < 1$ greater weight is given to the more recent forecasts.

METHODOLOGY - Forecast Evaluation

Statistical Evaluation

- $CORR^2$ (Pesaran and Timmermann, 1995 and 2000)
- out-of-sample R^2 (Campbell and Thompson, 2008)

$$R^2_{OS} = 1 - \frac{MSPE_m}{MSPE_B}, \quad m = KS, P, c, DMSPE$$

  - $R^2_{OS} > 0$: the competing forecast outperforms the historical average benchmark ($MSPE_m \leq MSPE_B$).
  - $R^2_{OS} \leq 0$: the historical average benchmark is at least as good as the forecasting model ($MSPE_m \geq MSPE_B$).

Statistical Evaluation

- *DMW*-statistic (Diebold and Mariano, 1995; West, 1996): has a non-standard distribution when comparing forecasts from nested linear models, as a result the asymptotic distribution theory does not holds.

- Clark and West (2007): *adjusted-MSPE* statistic that generates asymptotic confidence intervals that can be calculated by a normal distribution when comparing nested models

$$\widehat{f}_{k+1} = \left(\widehat{u}^{B}_{k+1}\right)^2 - \left[\left(\widehat{u}^{m}_{k+1}\right)^2 - \left(\widehat{r}^{B}_{k+1} - \widehat{r}^{m}_{k+1}\right)^2\right], \quad m = KS, P, c, DMSPE$$

Economic Evaluation

- Classic portfolio choice problem:

$$\max_{\omega_{mt}} \left[E_{mt}\left(y_{p,m,t+1}\right) - \frac{1}{2}\gamma Var_{mt}\left(y_{p,m,t+1}\right) \right], \quad m = KS, P, B, c, DMSPE$$

where

$$y_{p,m,t+1} = (1-\omega_{mt})\, y_{ft} + \omega_{mt} y_{t+1}, \quad m = KS, P, B, c, DMSPE$$

and

$$\omega^{*}_{mt} = \frac{E_{mt}(y_{t+1}) - y_{ft}}{\gamma Var_{mt}\left(y_{t+1}\right)}, \quad m = KS, P, B, c, DMSPE$$

Economic Evaluation

- Impose portfolio constraints

$$\begin{aligned} \omega_{mt} &= 0 \quad \text{if} \quad \omega^*_{mt} < 0 \\ &= \omega^*_{mt} \quad \text{if} \quad 0 \leq \omega^*_{mt} \leq 1.5, \ m = KS, P, B, c, DMSPE \\ &= 1.5 \quad \text{if} \quad \omega^*_{mt} > 1.5 \end{aligned}$$

- Evaluation of the mean-variance analysis: Sharpe (SR) and Sortino (SO) ratio

$$SR_{p,m} = \frac{\overline{y}_{p,m} - \overline{y}_f}{\widehat{\sigma}^{SR}_{p,m}}, \quad m = KS, P, B, c, DMSPE$$

where

$$\widehat{\sigma}^{SR}_{p,m} = \left[\frac{1}{T-s} \sum_{k=s}^{T-1} \left(y_{p,m,t+1} - \overline{y}_{p,m} \right)^2 \right]^{1/2}$$

Economic Evaluation

- Marquering and Verbeek (2004) and Han (2006)

$$\widehat{\sigma}_{p,m}^{SO} = \left[\frac{1}{T-s} \sum_{k=s}^{T-1} \left(y_{p,m,t+1} - \overline{y}_{p,m} \right)^2 I \left(y_{p,m,t+1} \leq y_{ft} \right) \right]^{1/2}$$

  penalises only those returns falling below a minimum acceptable return.

- Utility gain of a particular forecasting method

$$\Delta_m = \overline{U}_m - \overline{U}_B, \quad m = KS, P, c, DMSPE$$

- This utility gain or certainty equivalent return can be viewed as the portfolio management fee that an investor with mean-variance preferences would be willing to pay to access a particular forecasting method.

METHODOLOGY - Forecast Near Peaks and Troughs

- How forecasts from individual and multiple predictor variables behave during peaks and troughs?
- Examine the behaviour of the actual equity premium and forecasts around beginnings and ends of recessions (Neely *et al.* 2012).

$$r_t - \widehat{r}_t^B = a_P + \sum_{l=-2}^{4} b_{P,l} I_{l,t}^P + \varepsilon_{P,t}$$

$$\widehat{r}_t^m - \widehat{r}_t^B = a_P + \sum_{l=-2}^{4} b_{P,l} I_{l,t}^P + \varepsilon_{P,t}, \qquad m = P, i, c.$$

DATA

- monthly data on German stock returns, 1973:01-2012:01 (469 observations).
- all data are obtained from Datastream.
- equity premium: total rate of return on the stock market minus the one-month T-bill rate.
- 9 predictor variables (DY, PER, 3MIR, TMS, INFL, IP, ER, UR, OP).

EMPIRICAL RESULTS

Table 1. In-Sample Analysis Results

Panel A: Individual Variables (1973:02-2012:01)					
Method	Coefficients	Standard Errors	OLS T-Ratios	P-Values	In-sample R-square (%)
DY	0.1430	0.7230	0.1978	0.8433	0.0084
PER	-0.6269	1.0042	-0.6242	0.5328	0.0836
3*MIR*	-0.8506	0.6852	-1.2413	0.2151	0.3303
TMS	0.3383	0.1564	2.1632**	0.0310	0.9964
INFL	-2.1046	0.9152	-2.2294**	0.0219	1.1243
IP	0.0541	0.1425	0.3802	0.7040	0.0311
ER	-0.2143	0.2389	-0.8972	0.3700	0.1728
UR	2.1963	1.7081	1.2858	0.1991	0.3543
OP	-0.0220	0.0241	-0.9144	0.3609	0.1795
Panel B: Multiple Variables (1973:04-2012:01)					
Method	Coefficients	Standard Errors	OLS T-Ratios	P-Values	
DY	-0.1603	1.0737	-0.1493	0.8814	
PER	-1.4532	1.4305	-1.0158	0.3102	
3*MIR*	-0.4107	0.7091	-0.5793	0.5627	
TMS	0.2962	0.1671	1.7723*	0.0770	
INFL	-1.9369	1.0286	-1.8829*	0.0603	
IP	0.0831	0.1443	0.5757	0.5651	
ER	-0.1995	0.2401	-0.8311	0.4063	
UR	2.9308	1.7935	1.6342	0.1029	
OP	-0.0128	0.0245	-0.5226	0.6015	
R^2	0.0301				
$\overline{R}^2$	0.0110				
Diagnostic Tests					
Test Statistics	LM Version		F version		
Serial Correlation	CHSQ(12)=12.9952 (0.3694)		F(12,444)=1.0614 (0.3913)		
Normality	CHSQ(2)=190.1624 (0.0000)		Not applicable		
Heteroscedasticity	CHSQ(9)=9.7587 (0.3704)		F(9,546)=1.0837 (0.3732)		

Table 2. 1-Step Ahead OoS Analysis Results, Statistical Evaluation, Individual Variables

Method	*MSPE*	$CORR^2$	R^2_{OS} (%)	*adjusted-MSPE*
Panel A: January 1985 - January 2012 (325 observations)				
Benchmark	34.0331	0.0152	-	-
DY	34.3586	0.0090	-0.9565	-1.3686
PER	34.2120	0.0068	-0.5258	-0.6529
3MIR	34.1984	0.0051	-0.4785	-0.3771
TMS	33.8167	0.0028	0.6429	1.7799**
INFL	34.2687	0.0023	-0.6850	1.0942
IP	34.3257	0.0042	-0.8597	-0.6904
ER	34.0660	0.0003	-0.0895	0.2352
UR	34.0022	0.0003	0.0978	0.6752
OP	34.1389	0.0022	-0.3038	-0.1219
Panel B: January 1992 - January 2012 (241 observations)				
Benchmark	32.3733	0.0067	-	-
DY	32.5407	0.0117	-0.5169	-1.6532
PER	32.6837	0.0129	-0.9587	-1.1473
3MIR	32.6022	0.0110	-0.7092	-0.8098
TMS	31.9955	0.0152	1.1647	2.5182***
INFL	32.3827	0.0014	-0.0312	0.6301
IP	32.9109	0.0293	-1.6601	-2.3028
ER	32.3509	0.0003	0.0671	0.4717
UR	32.2805	0.0005	0.2844	0.9499
OP	32.4444	0.0002	-0.2219	0.0745
Panel C: January 2007 - January 2012 (61 observations)				
Benchmark	40.8333	0.0181	-	-
DY	41.0756	0.1684	-0.5933	-2.2685
PER	41.5916	0.0595	-1.8571	-1.7311
3MIR	41.6813	0.0921	-2.1064	-1.1605
TMS	39.6941	0.0831	2.7615	2.3124**
INFL	40.5605	0.0126	0.6392	0.5627
IP	41.0898	0.0151	-0.6380	-0.5855
ER	42.7886	0.1573	-4.8189	-2.7137
UR	40.5573	0.0002	0.6469	0.9985
OP	42.4730	0.1090	-4.0457	-1.4795

Table 3. 3-Step Ahead OoS Analysis Results, Statistical Evaluation, Individual Variables

Variance	*MSPE*	$CORR^2$	R^2_{OS} (%)	*adjusted-MSPE*
Panel A: January 1985 - January 2012 (325 observations)				
Benchmark	34.2323	0.0226	-	-
DY	34.5525	0.0104	-0.9355	-1.3535
PER	34.4304	0.0075	-0.5787	-0.6580
3MIR	34.3703	0.0044	-0.3975	-0.2586
TMS	34.0316	0.0016	0.5922	1.6817**
INFL	34.5119	0.0018	-0.8113	0.9863
IP	34.5046	0.0043	-0.7903	-0.6071
ER	34.3030	0.0013	-0.2010	0.0597
UR	34.2083	0.0009	0.0756	0.6147
OP	34.4301	0.0055	-0.5724	-0.4151
Panel B: January 1992 - January 2012 (241 observations)				
Benchmark	32.5230	0.0117	-	-
DY	32.7112	0.0169	-0.5784	-1.7477
PER	32.8416	0.0119	-0.9796	-1.0184
3MIR	32.7480	0.0113	-0.6961	-0.7498
TMS	32.1234	0.0159	1.2243	2.7072***
INFL	32.5630	0.0009	-0.1274	0.5327
IP	33.0276	0.0288	-1.5512	-2.1901
ER	32.5605	1.284×10^{-5}	-0.1197	0.2477
UR	32.4788	0.0001	0.1312	0.6685
OP	32.6533	0.0011	-0.4050	-0.0700
Panel C: January 2007 - January 2012 (61 observations)				
Benchmark	41.6594	0.0304	-	-
DY	41.8481	0.0809	-0.4529	-1.2185
PER	42.4290	0.0461	-1.8472	-1.4716
3MIR	42.4738	0.0630	-1.9913	-1.0126
TMS	40.4358	0.0998	2.9024	2.5044***
INFL	41.4321	0.0119	0.5101	0.4755
IP	41.7932	0.0073	-0.3330	-0.3186
ER	43.8880	0.1727	-5.3872	-2.6999
UR	41.2195	0.0052	1.0205	1.5408*
OP	43.5892	0.1064	-4.6695	-1.3778

Table 4. 6-Step Ahead OoS Analysis Results, Statistical Evaluation, Individual Variables

Variance	*MSPE*	$CORR^2$	R^2_{OS} (%)	*adjusted-MSPE*
Panel A: January 1985 - January 2012 (325 observations)				
Benchmark	34.5069	0.0248	-	-
DY	34.8774	0.0141	-1.0734	-1.7737
PER	34.6975	0.0058	-0.5522	-0.4957
3MIR	34.6420	0.0043	-0.3881	-0.2443
TMS	34.3082	0.0014	0.5792	1.6520**
INFL	34.7636	0.0018	-0.7403	0.9333
IP	34.8165	0.0058	-0.8927	-0.7579
ER	34.6052	0.0021	-0.2814	-0.0645
UR	34.5022	0.0015	0.0171	0.4649
OP	34.6603	0.0040	-0.4411	-0.2593
Panel B: January 1992 - January 2012 (241 observations)				
Benchmark	32.8790	0.0157	-	-
DY	33.0470	0.0150	-0.5109	-1.5365
PER	32.2054	0.0103	-0.9925	-0.9040
3MIR	33.1082	0.0113	-0.7015	-0.7424
TMS	32.4766	0.0161	1.2194	2.7251***
INFL	32.9036	0.0010	-0.0791	0.5810
IP	33.4461	0.0405	-1.7245	-2.5618
ER	32.9622	0.0004	-0.2575	0.0886
UR	32.8488	0.0003	0.0874	0.5813
OP	33.0214	0.0015	-0.4377	-0.1039
Panel C: January 2007 - January 2012 (61 observations)				
Benchmark	43.2031	0.0871	-	-
DY	43.4772	0.1022	-0.6343	-1.1171
PER	44.1290	0.0565	-2.1430	-1.5173
3MIR	44.0406	0.0627	-1.9793	-0.9692
TMS	41.9012	0.1063	2.9745	2.6131***
INFL	42.9303	0.0128	0.5916	0.4999
IP	43.4835	0.0555	-0.6618	-1.0944
ER	45.6796	0.1841	-5.7746	-2.6765
UR	42.7058	0.0019	1.1114	1.6984**
OP	45.2157	0.1097	-4.7004	-1.3685

Table 5. 12-Step Ahead OoS Analysis Results, Statistical Evaluation, Individual Variables

Variance	*MSPE*	$CORR^2$	R^2_{OS} (%)	*adjusted-MSPE*
Panel A: January 1985 - January 2012 (325 observations)				
Benchmark	34.3824	0.0302	-	-
DY	34.9234	0.0316	-1.5733	-2.6852
PER	34.6156	0.0080	-0.6781	-0.6042
3MIR	34.5229	0.0049	-0.4191	-0.2623
TMS	34.2267	0.0004	0.4422	1.3587*
INFL	34.8932	0.0005	-1.4961	0.4614
IP	34.6994	0.0071	-0.9221	-0.8276
ER	34.5218	0.0004	-0.41600	-0.2748
UR	34.3295	0.0008	0.1432	0.7874
OP	34.5380	0.0046	-0.4631	-0.2720
Panel B: January 1992 - January 2012 (241 observations)				
Benchmark	33.1314	0.0206	-	-
DY	33.3563	0.0214	-0.6786	-1.9364
PER	33.5176	0.0102	-1.1656	-0.9398
3MIR	33.3651	0.0115	-0.7015	-0.7113
TMS	32.8122	0.0087	0.9670	2.3306**
INFL	33.0750	0.0015	0.1738	0.8054
IP	33.8204	0.0617	-2.0760	-3.1044
ER	33.2534	0.0013	-0.3644	-0.0370
UR	33.0553	7.225×10^{-7}	0.2332	0.8664
OP	33.2648	0.0015	-0.3988	-0.0594
Panel C: January 2007 - January 2012 (61 observations)				
Benchmark	47.4338	0.0590	-	-
DY	47.6093	0.0132	-0.3700	-0.5300
PER	48.5301	0.0516	-2.3113	-1.4872
3MIR	48.3523	0.0414	-1.9796	-0.9001
TMS	46.0066	0.1376	2.9678	2.7249***
INFL	47.0271	0.0208	0.8153	0.5833
IP	47.7535	0.0745	-0.6878	-1.3516
ER	50.2290	0.1770	-5.9377	-2.6396
UR	46.8612	0.0048	1.1652	1.8087**
OP	49.6864	0.0989	-4.7932	-1.3616

Table 6. 1-Step Ahead OoS Analysis Results, Economic Evaluation, Individual Variables

Variance	*SR*	*SO*	Δ(%), γ=0.5	Δ(%), γ=1	Δ(%), γ=2	Δ(%), γ=5
Panel A: January 1985 - January 2012 (325 observations)						
DY	0.0255	0.0331	-2.1423	-1.6875	-0.8750	-0.3496
PER	0.0347	0.0436	-0.2078	-0.1041	-0.0523	-0.0212
3*MIR*	0.0364	0.0449	-1.3056	-0.9879	-0.4951	-0.1995
TMS	0.0968	0.1246	-1.0533	-0.5242	-0.2597	-0.1009
INFL	0.0933	0.1248	-6.2761	-6.9708	-3.8543	-1.5424
IP	0.0444	0.0585	-1.6445	-1.0607	-0.5319	-0.2146
ER	0.0725	0.0942	-1.2671	-0.8263	-0.4132	-0.1653
UR	0.0664	0.0867	-0.0006	-0.0801	-0.0406	-0.0169
OP	0.0456	0.0560	-1.2344	-1.3344	-0.6670	-0.2666
Panel B: January 1992 - January 2012 (241 observations)						
DY	0.0334	0.0422	-0.9227	-0.4628	-0.2311	-0.0920
PER	0.0079	0.0098	-0.9151	-0.4567	-0.2276	-0.0900
3*MIR*	0.0299	0.0367	-2.0207	-1.2890	-0.6455	-0.2593
TMS	0.1276	0.1696	-0.3252	-0.1607	-0.0785	-0.0292
INFL	0.0854	0.1132	-5.3153	-3.5469	-1.7695	-0.7030
IP	-0.0085	-0.0104	-1.5797	-0.9070	-0.4535	-0.1814
ER	0.0850	0.1108	-1.3094	-0.9157	-0.4586	-0.1843
UR	0.0740	0.0984	0.1011	-0.0576	-0.0300	-0.0135
OP	0.0478	0.0588	-1.4997	-1.7188	-0.8593	-0.3437
Panel C: January 2007 - January 2012 (61 observations)						
DY	-0.0852	-0.1055	-0.6429	-0.3203	-0.1590	-0.0622
PER	-0.1170	-0.1432	-4.2347	-2.1164	-1.0573	-0.4218
3*MIR*	-0.1164	-0.1378	-4.6357	-3.3482	-1.6703	-0.6636
TMS	0.1476	0.2088	0.9571	0.4769	0.2368	0.0928
INFL	0.0216	0.0282	-6.6243	-4.3989	-2.1919	-0.8662
IP	-0.0887	-0.1078	-0.4937	-0.2481	-0.1253	-0.0516
ER	-0.2077	-0.4867	-4.2032	-2.8496	-1.4196	-0.5618
UR	-0.0212	-0.0287	0.2400	0.1199	0.0599	0.0238
OP	-0.1611	-0.1789	-4.6353	-5.8044	-2.8948	-1.1491

Table 7. 3-Step Ahead OoS Analysis Results, Economic Evaluation, Individual Variables

Variance	*SR*	*SO*	Δ(%), γ=0.5	Δ(%), γ=1	Δ(%), γ=2	Δ(%), γ=5
Panel A: January 1985 - January 2012 (325 observations)						
DY	0.0216	0.0284	-2.6152	-1.9651	-0.9876	-0.3944
PER	0.0279	0.0353	-0.7573	-0.3787	-0.1894	-0.0755
3MIR	0.0348	0.0431	-1.5118	-1.1395	-0.5708	-0.2297
TMS	0.0904	0.1158	-1.2893	-0.6421	-0.3185	-0.1231
INFL	0.0861	0.1152	-6.7762	-7.5803	-4.2099	-1.6847
IP	0.0422	0.0554	-1.9551	-1.1548	-0.5788	-0.2331
ER	0.0628	0.0808	-1.5246	-0.9687	-0.4845	-0.1939
UR	0.0582	0.0754	-0.2876	-0.1986	-0.1072	-0.0403
OP	0.0288	0.0349	-1.2001	-1.9667	-0.9826	-0.3922
Panel B: January 1992 - January 2012 (241 observations)						
DY	0.0217	0.0272	-1.3369	-0.6689	-0.3338	-0.1328
PER	0.0084	0.0102	-1.5912	-0.7948	-0.3965	-0.1632
3MIR	0.0237	0.0293	-2.2824	-1.5322	-0.7669	-0.3077
TMS	0.1253	0.1661	-0.4633	-0.2302	-0.1136	-0.0419
INFL	0.0762	0.1006	-5.7433	-3.9181	-1.9549	-0.7771
IP	-0.0100	-0.0121	-1.7684	-0.9949	-0.4973	-0.1988
ER	0.0710	0.0914	-1.6126	-1.0871	-0.5442	-0.2185
UR	0.0566	0.0736	-0.0897	-0.0778	-0.0391	-0.0158
OP	0.0332	0.0404	-1.6224	-2.4411	-1.2202	-0.4877
Panel C: January 2007 - January 2012 (61 observations)						
DY	-0.0963	-0.1209	-1.5943	-0.7952	-0.3957	-0.1261
PER	-0.1311	-0.1633	-5.7381	-2.8668	-1.4312	-0.5699
3MIR	-0.1229	-0.1482	-5.1485	-4.0197	-2.0058	-0.7975
TMS	0.1308	0.1871	0.7896	0.3927	0.1942	0.0752
INFL	0.0013	0.0017	-6.9508	-5.2459	-2.6137	-1.0343
IP	-0.0941	-0.1151	-0.7153	-0.3585	-0.1801	-0.0731
ER	-0.2364	-0.2757	-5.0229	-3.4534	-1.7203	-0.6805
UR	-0.0247	-0.0338	-0.1370	-0.0692	-0.0354	-0.0150
OP	-0.1710	-0.1909	-4.7629	-8.4809	-4.2305	-1.6802

Table 8. 6-Step Ahead OoS Analysis Results, Economic Evaluation, Individual Variables

Variance	*SR*	*SO*	Δ(%), γ=0.5	Δ(%), γ=1	Δ(%), γ=2	Δ(%), γ=5
Panel A: January 1985 - January 2012 (325 observations)						
DY	0.0109	0.0143	-2.2803	-1.6562	-0.8271	-0.3296
PER	0.0273	0.0347	-0.9264	-0.4684	-0.2341	-0.0936
3*MIR*	0.0302	0.0375	-1.7299	-1.2499	-0.6260	-0.2516
TMS	0.0850	0.1101	-1.2518	-0.6418	-0.3182	-0.1241
INFL	0.0826	0.1107	-7.0235	-7.7457	-4.2289	-1.6922
IP	0.0346	0.0452	-2.0489	-1.2522	-0.6275	-0.2527
ER	0.0577	0.0741	-1.5300	-0.9985	-0.4998	-0.2000
UR	0.0516	0.0670	-0.3226	-0.2104	-0.1055	-0.0426
OP	0.0305	0.0374	-1.5339	-1.9630	-0.9810	-0.3917
Panel B: January 1992 - January 2012 (241 observations)						
DY	0.0218	0.0275	-1.5419	-0.7702	-0.3844	-0.1529
PER	0.0091	0.0114	-2.1430	-1.0778	-0.5381	-0.2142
3*MIR*	0.0213	0.0263	-2.6385	-1.7312	-0.8663	-0.3474
TMS	0.1194	0.1577	-0.5903	-0.2938	-0.1456	-0.0567
INFL	0.0764	0.1015	-6.0758	-4.1738	-2.0828	-0.8282
IP	-0.0202	-0.0244	-2.1407	-1.1558	-0.5777	-0.2308
ER	0.0645	0.0824	-1.8578	-1.2478	-0.6246	-0.2507
UR	0.0504	0.0654	-0.3251	-0.1942	-0.0972	-0.0390
OP	0.0303	0.0369	-1.7957	-2.5223	-1.2610	-0.5042
Panel C: January 2007 - January 2012 (61 observations)						
DY	-0.1230	-0.1547	-3.1944	-1.5945	-0.7945	-0.3145
PER	-0.1565	-0.1951	-7.4457	-3.7195	-1.8563	-0.7385
3*MIR*	-0.1377	-0.1668	-6.3837	-4.7771	-2.3837	-0.9477
TMS	0.1049	0.1497	0.4566	0.2255	0.1100	0.0406
INFL	-0.0123	-0.0162	-7.7674	-5.9749	-2.9950	-1.1864
IP	-0.1417	-0.1732	-1.5001	-0.7502	-0.3740	-0.1503
ER	-0.2552	-0.2985	-6.2071	-4.2119	-2.0984	-0.8302
UR	-0.0478	-0.0653	-0.7533	-0.3777	-0.1898	-0.0771
OP	-0.1857	-0.2093	-5.6752	-9.2291	-4.6041	-1.8291

Table 9. 12-Step Ahead OoS Analysis Results, Economic Evaluation, Individual Variables

Variance	*SR*	*SO*	Δ(%), γ=0.5	Δ(%), γ=1	Δ(%), γ=2	Δ(%), γ=5
Panel A: January 1985 - January 2012 (325 observations)						
DY	-0.0267	-0.0323	-2.7346	-1.7900	-0.8935	-0.3557
PER	0.0033	0.0042	-1.5159	-0.8022	-0.4010	-0.1603
3*MIR*	0.0135	0.0166	-1.6985	-1.4327	-0.7171	-0.2877
TMS	0.0627	0.0799	-1.4859	-0.7428	-0.3686	-0.1441
INFL	0.0541	0.0697	-7.0475	-8.1288	-4.3026	-1.7193
IP	0.0151	0.0194	-2.0902	-1.2885	-0.6456	-0.2599
ER	0.0355	0.0450	-1.6606	-1.0809	-0.5404	-0.2161
UR	0.0397	0.0513	-0.3550	-0.2438	-0.1222	-0.0493
OP	0.0151	0.0183	-1.5965	-2.0784	-1.0383	-0.4142
Panel B: January 1992 - January 2012 (241 observations)						
DY	0.0228	0.0289	-1.6640	-0.8305	-0.4138	-0.1637
PER	0.0094	0.0119	-2.6361	-1.3769	-0.6867	-0.2726
3*MIR*	0.0283	0.0349	-2.7983	-2.0011	-1.0008	-0.4007
TMS	0.1156	0.1533	-0.8213	-0.4082	-0.2017	-0.0778
INFL	0.0898	0.1207	-6.2407	-4.5396	-2.2657	-0.9013
IP	-0.0252	-0.0304	-2.6677	-1.3967	-0.6965	-0.2764
ER	0.0663	0.0848	-2.0376	-1.3631	-0.6819	-0.2732
UR	0.0661	0.0865	-0.3592	-0.2149	-0.1077	-0.0434
OP	0.0371	0.0452	-1.8554	-2.6825	-1.3408	-0.5357
Panel C: January 2007 - January 2012 (61 observations)						
DY	-0.1091	-0.1427	-4.6053	-2.2983	-1.1448	-0.4527
PER	-0.1712	-0.2165	-9.3169	-4.6523	-2.3200	-0.9207
3*MIR*	-0.1375	-0.1691	-7.5486	-6.0942	-3.0402	-1.2078
TMS	0.1026	0.1481	0.3352	0.1627	0.0765	0.0248
INFL	-0.0073	-0.0099	-8.9430	-7.4501	-3.7130	-1.4707
IP	-0.1536	-0.1920	-2.1125	-1.0554	-0.5268	-0.2097
ER	-0.2688	-0.3201	-7.5366	-5.1424	-2.5589	-1.0089
UR	-0.0500	-0.0692	-1.2144	-0.6086	-0.3057	-0.1239
OP	-0.1968	-0.2239	-6.5658	-10.6251	-5.2968	-2.0998

Figure 1. Out-of-Sample Forecasts Based on Individual Variables

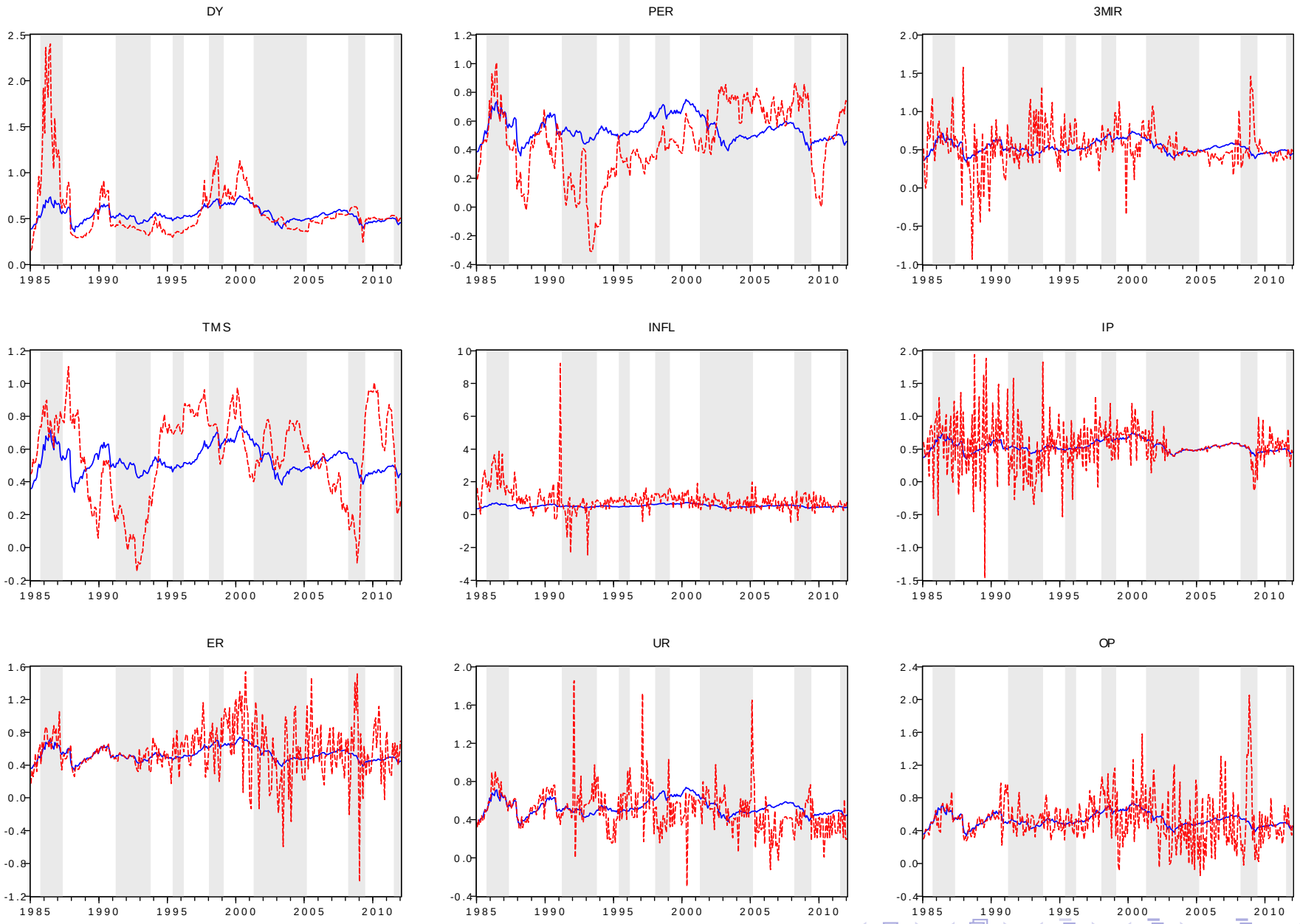


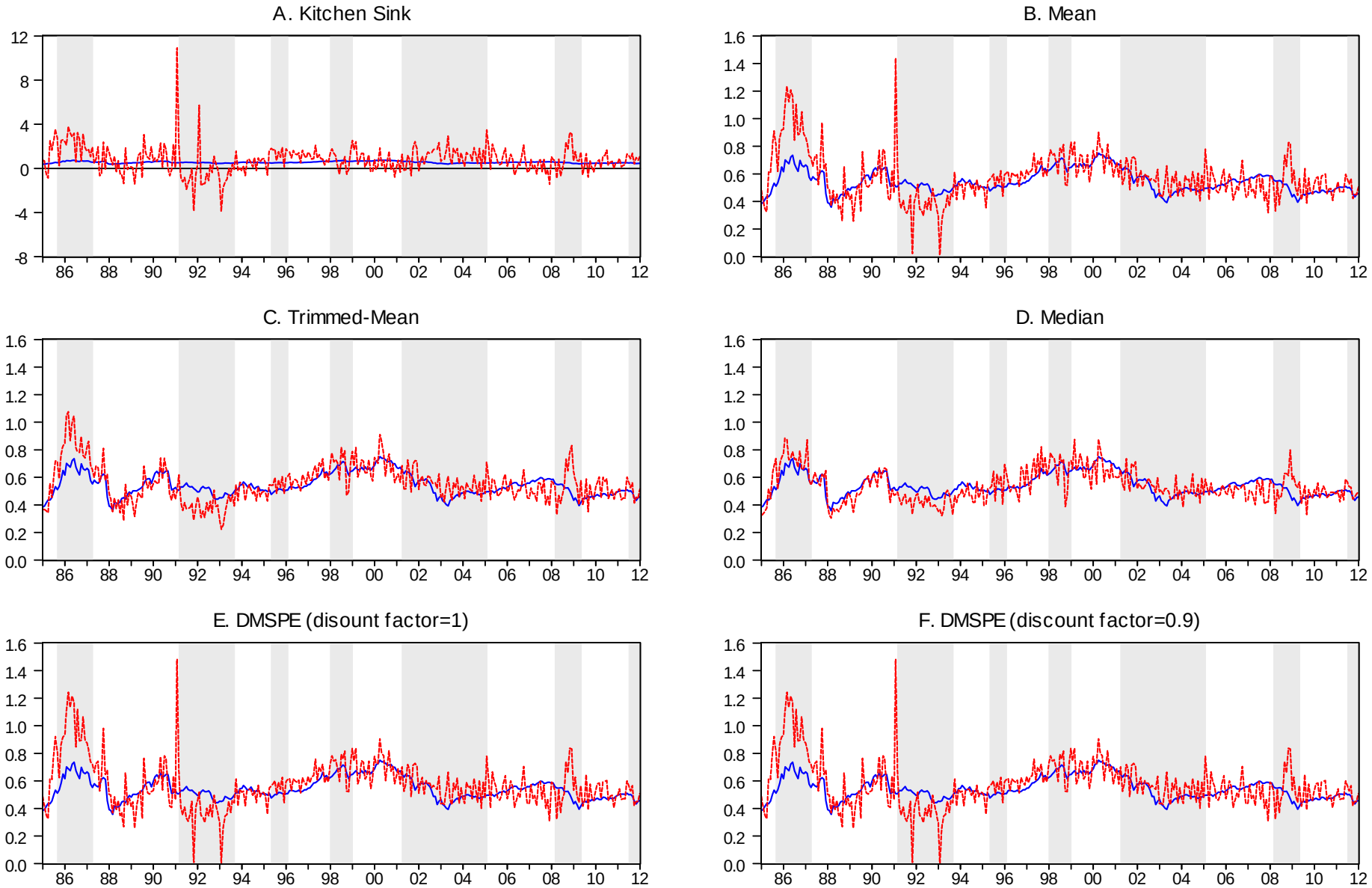
Table 4. Out-of-Sample Analysis Results, Statistical Evaluation, Multiple Variables

Panel A: January 1985 - January 2012 (325 observations)				
Method	*MSPE*	$CORR^2$	R^2_{OS} (%)	*adjusted-MSPE*
Benchmark	34.0331	0.0152	-	-
Kitchen Sink	35.1187	0.0010	-3.1897	0.7063
Mean	34.0226	0.0016	0.0308	0.3303
Trimmed-Mean	34.0502	0.0058	-0.0502	-0.0782
Median	34.1085	0.0188	-0.2217	-1.0210
DMSPE (θ=1.0)	34.0228	0.0017	0.0303	0.3269
DMSPE (θ=0.9)	34.0202	0.0014	0.0379	0.3584
DMSPE (θ=0.75)	34.0188	0.0012	0.0419	0.3771
Panel B: January 1992 - January 2012 (241 observations)				
Method	*MSPE*	$CORR^2$	R^2_{OS} (%)	*adjusted-MSPE*
Benchmark	32.3733	0.0067	-	-
Kitchen Sink	33.5418	0.0003	-3.6093	-0.1587
Mean	32.3904	0.0033	-0.0526	-0.0721
Trimmed-Mean	32.3944	0.0046	-0.0652	-0.1418
Median	32.4353	0.0119	-0.1914	-0.6805
DMSPE (θ=1.0)	32.3904	0.0034	-0.0528	-0.0735
DMSPE (θ=0.9)	32.3877	0.0029	-0.0444	-0.0392
DMSPE (θ=0.75)	32.3872	0.0028	-0.0428	-0.0296
Panel C: January 2007 - January 2012 (61 observations)				
Method	*MSPE*	$CORR^2$	R^2_{OS} (%)	*adjusted-MSPE*
Benchmark	40.8333	0.0181	-	-
Kitchen Sink	45.0403	0.1020	-10.3029	-1.6545
Mean	41.2061	0.1264	-0.9130	-1.3287
Trimmed-Mean	41.1915	0.1303	-0.8771	-1.3175
Median	41.0471	0.1015	-0.5235	-0.9257
DMSPE (θ=1.0)	41.2092	0.1283	-0.9206	-1.3401
DMSPE (θ=0.9)	41.2120	0.1213	-0.9274	-1.3191
DMSPE (θ=0.75)	41.2115	0.1153	-0.9262	-1.2937

Table 5. Out-of-Sample Analysis Results, Economic Evaluation, Multiple Variables

Panel A: January 1985 - January 2012 (325 observations)						
Variance	*SR*	*SO*	$\Delta(\%)$, γ=0.5	$\Delta(\%)$, γ=1	$\Delta(\%)$, γ=2	$\Delta(\%)$, γ=5
Kitchen Sink	0.0722	0.0994	-5.9175	-10.4872	-7.2449	-2.9774
Mean	0.0648	0.0833	-1.3138	-0.6695	-0.3349	-0.1342
Trimmed-Mean	0.0591	0.0753	-0.9626	-0.4812	-0.2405	-0.0960
Median	0.0495	0.0624	-0.6045	-0.3021	-0.1508	-0.0601
DMSPE (θ=1.0)	0.0647	0.0834	-1.3010	-0.6615	-0.3309	-0.1326
DMSPE (θ=0.9)	0.0653	0.0843	-1.3628	-0.6963	-0.3483	-0.1396
DMSPE (θ=0.75)	0.0657	0.0846	-1.4196	-0.7298	-0.3651	-0.1463
Panel B: January 1992 - January 2012 (241 observations)						
Variance	*SR*	*SO*	$\Delta(\%)$, γ=0.5	$\Delta(\%)$, γ=1	$\Delta(\%)$, γ=2	$\Delta(\%)$, γ=5
Kitchen Sink	0.0283	0.0366	-6.8329	-9.6590	-6.5410	-2.7159
Mean	0.0567	0.0715	-0.9452	-0.4721	-0.2355	-0.0936
Trimmed-Mean	0.0558	0.0703	-0.8143	-0.4067	-0.2029	-0.0806
Median	0.0493	0.0619	-0.5319	-0.2656	-0.1324	-0.0526
DMSPE (θ=1.0)	0.0567	0.0715	-0.9396	-0.4693	-0.2341	-0.0930
DMSPE (θ=0.9)	0.0573	0.0723	-0.9802	-0.4896	-0.2442	-0.0970
DMSPE (θ=0.75)	0.0575	0.0726	-1.0173	-0.5081	-0.2535	-0.1007
Panel C: January 2007 - January 2012 (61 observations)						
Variance	*SR*	*SO*	$\Delta(\%)$, γ=0.5	$\Delta(\%)$, γ=1	$\Delta(\%)$, γ=2	$\Delta(\%)$, γ=5
Kitchen Sink	-0.1875	-0.2068	-10.1734	-13.1509	-10.3953	-4.1367
Mean	-0.0909	-0.1110	-2.2491	-1.1219	-0.5583	-0.2201
Trimmed-Mean	-0.0905	-0.1107	-2.1177	-1.0564	-0.5257	-0.2073
Median	-0.0753	-0.0933	-1.5665	-0.7813	-0.3886	-0.1531
DMSPE (θ=1.0)	-0.0914	-0.1115	-2.2484	-1.1215	-0.5581	-0.2200
DMSPE (θ=0.9)	-0.0911	-0.1111	-2.3064	-1.1504	-0.5725	-0.2257
DMSPE (θ=0.75)	-0.0904	-0.1103	-2.3570	-1.1757	-0.5850	-0.2307

Figure 2. Out-of-Sample Forecasts Based on Multiple Variables



CONCLUSION

- Only one variable, the term spread, has in-sample and out-of-sample forecasting power and consistently outperform the historical average benchmark model.
- This variable recognises the typical drop in the equity premium near business cycle peaks, as well as the typical increase in the equity premium near business cycle troughs.
- There is no evidence that combinations of forecasts from individual model do deliver any statistical and economic significant out-of-sample gains relative to the historical average on a consistent basis over time.