Internet Appendix:

"Optimal Portfolio Choice with Estimation Risk: No Risk-free Asset Case"

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A. Derivation of the BS Rule

Motivated by a shrinkage consideration and a Bayesian analysis, Jorion (1986, 1991) develops the following estimator of μ,

$$\hat{\mu}_{BS,t} = \frac{\nu_t}{N+2+\nu_t}\hat{\mu}_t + \frac{N+2}{N+2+\nu_t} 1_N \hat{\mu}_{g,t} \tag{IA.1}$$

with

$$\nu_t = (h-N-2)\hat{\psi}_t^2. \tag{IA.2}$$

The empirical Bayes-Stein estimator of the covariance matrix Σ is given by[1]

$$\hat{\Sigma}_{BS,t} = \left(\frac{h+1+\lambda_t}{h+\lambda_t}\right)\frac{h}{h-N-2}\hat{\Sigma}_t + \frac{\lambda_t}{(h-N-2)(h+1+\lambda_t)}\frac{1_N 1_N'}{1_N'\hat{\Sigma}_t^{-1}1_N} \tag{IA.3}$$

with

$$\lambda_t = \frac{h(N+2)}{\nu_t}. \tag{IA.4}$$

Therefore, the empirical Bayes-Stein estimator of the optimal portfolio weights is

$$\hat{w}_{BS,t} = \frac{\hat{\Sigma}_{BS,t}^{-1}1_N}{1_N'\hat{\Sigma}_{BS,t}^{-1}1_N} + \frac{1}{\gamma}\hat{\Sigma}_{BS,t}^{-1}\left(\hat{\mu}_{BS,t} - 1_N\frac{1_N'\hat{\Sigma}_{BS,t}^{-1}\hat{\mu}_{BS,t}}{1_N'\hat{\Sigma}_{BS,t}^{-1}1_N}\right). \tag{IA.5}$$

Using Sherman-Morrison formula, we get

$$\hat{\Sigma}_{BS,t}^{-1} = \frac{(h+\lambda_t)(h-N-2)}{h(h+1+\lambda_t)}\hat{\Sigma}_t^{-1} - \frac{\hat{\Sigma}_t^{-1}1_N 1_N'\hat{\Sigma}_t^{-1}}{1_N'\hat{\Sigma}_t^{-1}1_N}\frac{(h+\lambda_t)^2\lambda_t(h-N-2)}{h(h+1+\lambda_t)[h(h+1+\lambda_t)^2+(h+\lambda_t)\lambda_t]}. \tag{IA.6}$$

Plug the above expression into (IA.5), we can rewrite $\hat{w}_{BS,t}$ as

$$\hat{w}_{BS,t} = \hat{w}_{g,t} + \frac{g_4(\hat{\psi}_t^2)}{\gamma}\hat{w}_{z,t}, \tag{IA.7}$$

where

$$g_4(\hat{\psi}_t^2) = \frac{(h-N-2)^2\hat{\psi}_t^2}{(h+1)(h-N-2)\hat{\psi}_t^2 + h(N+2)}. \tag{IA.8}$$

[1] See Kan and Zhou (2007) for details.

B. Detailed Proof of Proposition 1

Let $P = [\nu,\ \eta,\ P_1]$ be an $N \times N$ orthonormal matrix with its first two columns as

$$\nu = \frac{\Sigma^{-\frac{1}{2}} 1_N}{\left(1_N' \Sigma^{-1} 1_N\right)^{\frac{1}{2}}} = \sigma_g \Sigma^{-\frac{1}{2}} 1_N, \tag{IA.9}$$

$$\eta = \frac{(I_N - \nu\nu')\Sigma^{-\frac{1}{2}}\mu}{\left[\mu'\Sigma^{-\frac{1}{2}}(I_N - \nu\nu')\Sigma^{-\frac{1}{2}}\mu\right]^{\frac{1}{2}}} = \frac{\Sigma^{-\frac{1}{2}}(\mu - 1_N\mu_g)}{\psi}. \tag{IA.10}$$

Define

$$z = \sqrt{h} P' \Sigma^{-\frac{1}{2}} \hat{\mu}_t \sim \mathscr{N}\left(\begin{bmatrix} \sqrt{h}\theta_g \\ \sqrt{h}\psi \\ 0_{N-2} \end{bmatrix}, I_N \right), \tag{IA.11}$$

$$W = h P' \Sigma^{-\frac{1}{2}} \hat{\Sigma}_t \Sigma^{-\frac{1}{2}} P \sim \mathscr{W}_N(h-1, I_N), \tag{IA.12}$$

where $\mathscr{W}_N(h-1, I_N)$ is a Wishart distribution with $h-1$ degrees of freedom and covariance matrix I_N, and z and W are independent of each other. Write $z'z = z_1^2 + z_2^2 + u_0$, where $z_1 \sim \mathscr{N}(\sqrt{h}\theta_g, 1)$, $z_2 \sim \mathscr{N}(\sqrt{h}\psi, 1)$, $u_0 \sim \chi^2_{N-2}$, and they are independent of each other.

With the definition of z and W, we can write

$$\hat{\psi}_t^2 = \hat{\mu}_t' \hat{\Sigma}_t^{-1} \hat{\mu}_t - \frac{(1_N' \hat{\Sigma}_t^{-1} \hat{\mu}_t)^2}{1_N' \hat{\Sigma}_t^{-1} 1_N} = z' W^{-1} z - \frac{(e_1' W^{-1} z)^2}{e_1' W^{-1} e_1}, \tag{IA.13}$$

$$\mu_{z,t} = \hat{w}_{z,t}' \mu = \sqrt{h}\psi \left(e_2' W^{-1} z - \frac{e_1' W^{-1} e_2 e_1' W^{-1} z}{e_1' W^{-1} e_1} \right), \tag{IA.14}$$

$$\mu_{g,t} = \hat{w}_{g,t}' \mu = \mu_g + \sigma_g \psi \frac{e_1' W^{-1} e_2}{e_1' W^{-1} e_1}, \tag{IA.15}$$

$$\sigma_{z,t}^2 = \hat{w}_{z,t}' \Sigma \hat{w}_{z,t} = h z' W^{-2} z + \frac{h (e_1' W^{-1} z)^2 e_1' W^{-2} e_1}{(e_1' W^{-1} e_1)^2} - \frac{2h (e_1' W^{-1} z)(e_1' W^{-2} z)}{e_1' W^{-1} e_1}, \tag{IA.16}$$

$$\sigma_{g,t}^2 = \hat{w}_{g,t}' \Sigma \hat{w}_{g,t} = \frac{\sigma_g^2 e_1' W^{-2} e_1}{(e_1' W^{-1} e_1)^2}, \tag{IA.17}$$

$$\sigma_{gz,t} = \hat{w}_{g,t}' \Sigma \hat{w}_{z,t} = \sqrt{h}\sigma_g \left[\frac{e_1' W^{-2} z}{e_1' W^{-1} e_1} - \frac{e_1' W^{-2} e_1 e_1' W^{-1} z}{(e_1' W^{-1} e_1)^2} \right], \tag{IA.18}$$

where $e_1 = [1,\ 0_{N-1}']'$ and $e_2 = [0,\ 1,\ 0_{N-2}']'$. Therefore, the exact distribution of $r_{t+1}(\tilde{c}) = \hat{w}_t'(\tilde{c})' r_{t+1}$ depends on the following eight terms: $e_1' W^{-1} e_1$, $e_1' W^{-1} z$, $z' W^{-1} z$, $e_2' W^{-1} e_1$, $e_2' W^{-1} z$, $e_1' W^{-2} e_1$, $e_1' W^{-2} z$, and $z' W^{-2} z$.

Define an $N \times N$ orthonormal matrix $Q = [e_1,\ \xi,\ \iota,\ Q_0]$ with its first three columns being e_1,

$$\xi = \frac{(I_N - e_1 e_1')z}{\left[z'(I_N - e_1 e_1')z\right]^{\frac{1}{2}}} = \frac{(I_N - e_1 e_1')z}{\sqrt{z_2^2 + u_0}}, \tag{IA.19}$$

$$\iota = \frac{(I_N - e_1 e_1' - \xi\xi')e_2}{\left[e_2'(I_N - e_1 e_1' - \xi\xi')e_2\right]^{\frac{1}{2}}} = \frac{(I_N - \xi\xi')e_2}{\sqrt{u_0/(z_2^2 + u_0)}} = \frac{\sqrt{z_2^2 + u_0}\,e_2 - z_2\xi}{\sqrt{u_0}}, \tag{IA.20}$$

and denote $Q_1 = [\iota,\ Q_0]$. Let

$$A = (Q'W^{-1}Q)^{-1} = \begin{bmatrix} A_{11} & A_{12} \\ A_{21} & A_{22} \end{bmatrix} \sim \mathscr{W}_N(h-1, I_N), \tag{IA.21}$$

where A_{11} is the upper left 2×2 submatrix of A. Using Theorem 3.2.10 of Muirhead (1982), we have

$$A_{11\cdot 2} \equiv A_{11} - A_{12}A_{22}^{-1}A_{21} \sim \mathscr{W}_2(h-N+1, I_2), \tag{IA.22}$$

$$\mathrm{vec}(y) \equiv \mathrm{vec}(-A_{22}^{-\frac{1}{2}}A_{21}) \sim \mathscr{N}(0_{2N-4}, I_{2N-4}), \tag{IA.23}$$

$$A_{22} \sim \mathscr{W}_{N-2}(h-1, I_{N-2}), \tag{IA.24}$$

and they are independent of each other. Theorem 3.1 and Corollary 3.1 in Dickey (1967) suggest that

$$A_{22}^{-\frac{1}{2}}y = xL^{-1}, \tag{IA.25}$$

where $x \equiv [x_1,\ x_2]$ is an $(N-2) \times 2$ matrix of independent standard normal random variables, L is a lower diagonal matrix such that $LL' \sim \mathscr{W}_2(h-N+3, I_2)$, and x and L are independent of each other.

Note that the first five terms needed, i.e., $e_1'W^{-1}e_1$, $e_1'W^{-1}z$, $z'W^{-1}z$, $e_2'W^{-1}e_1$, $e_2'W^{-1}z$, can be obtained from z together with the elements in the upper left 3×2 submatrix of A^{-1}, i.e., $A_{11\cdot 2}^{-1}$ and

$$[h_1,\ h_2] \equiv \iota'W^{-1}[e_1,\ \xi] = \varepsilon_1'Q_1'W^{-1}[e_1,\ \xi] = \varepsilon_1'xL^{-1}A_{11\cdot 2}^{-1} = [x_{11},\ x_{21}]L^{-1}A_{11\cdot 2}^{-1}, \tag{IA.26}$$

where $\varepsilon_1 = [1,\ 0_{N-3}']'$, and $x_{11} \sim \mathscr{N}(0,1)$ and $x_{21} \sim \mathscr{N}(0,1)$ being the first element of x_1 and x_2, respectively. To obtain the expressions for the remaining three terms that involve W^{-2}, we use the following identity

$$\begin{bmatrix} e_1'W^{-2}e_1 & e_1'W^{-2}\xi \\ e_1'W^{-2}\xi & \xi'W^{-2}\xi \end{bmatrix} = \begin{bmatrix} e_1' \\ \xi' \end{bmatrix} W^{-1}\left([e_1,\ \xi]\begin{bmatrix} e_1' \\ \xi' \end{bmatrix} + Q_1Q_1'\right)W^{-1}[e_1,\ \xi]$$

$$= A_{11\cdot 2}^{-2} + A_{11\cdot 2}^{-1}(y'A_{22}^{-1}y)A_{11\cdot 2}^{-1}$$
$$= A_{11\cdot 2}^{-2} + A_{11\cdot 2}^{-1}(L^{-1})'x'xL^{-1}A_{11\cdot 2}^{-1}. \tag{IA.27}$$

Write

$$x'x = \begin{bmatrix} x_{11}^2 & x_{11}x_{21} \\ x_{11}x_{21} & x_{21}^2 \end{bmatrix} + C, \tag{IA.28}$$

where $C \sim \mathscr{W}_2(N-3, I_2)$. Applying the Bartlett decomposition to $A_{11\cdot 2}$, L, and C, we are able to obtain individual elements in $A_{11\cdot 2}^{-1}$, (IA.26), and (IA.27).

Based on the Bartlett decomposition, we can write

$$A_{11\cdot 2} = \begin{bmatrix} v_1 + a^2 & -a\sqrt{v_2} \\ -a\sqrt{v_2} & v_2 \end{bmatrix}, \tag{IA.29}$$

where $v_1 \sim \chi^2_{h-N}$, $v_2 \sim \chi^2_{h-N+1}$, and $a \sim \mathscr{N}(0,1)$, all of which are independent of each other. Taking the inverse of $A_{11\cdot 2}$ and using the inverse of partitioned matrix formula to (IA.21), we obtain

$$\begin{bmatrix} e_1'W^{-1}e_1 & e_1'W^{-1}\xi \\ e_1'W^{-1}\xi & \xi'W^{-1}\xi \end{bmatrix} = A_{11\cdot 2}^{-1} = \begin{bmatrix} \frac{1}{v_1} & \frac{a}{v_1\sqrt{v_2}} \\ \frac{a}{v_1\sqrt{v_2}} & \frac{1}{v_2} + \frac{a^2}{v_1 v_2} \end{bmatrix}. \tag{IA.30}$$

It follows that

$$e_1'W^{-1}e_1 = \frac{1}{v_1}, \tag{IA.31}$$
$$e_1'W^{-1}\xi = \frac{a}{v_1\sqrt{v_2}}, \tag{IA.32}$$
$$\xi'W^{-1}\xi = \frac{1}{v_2} + \frac{a^2}{v_1 v_2}. \tag{IA.33}$$

Using the definition of ξ, we obtain

$$e_1'W^{-1}\xi = \frac{e_1'W^{-1}z - e_1'W^{-1}e_1 z_1}{\sqrt{z_2^2 + u_0}} = \frac{a}{v_1\sqrt{v_2}}$$
$$\Rightarrow \quad e_1'W^{-1}z = \frac{a\sqrt{z_2^2 + u_0}}{v_1\sqrt{v_2}} + \frac{z_1}{v_1}, \tag{IA.34}$$

and

$$\xi'W^{-1}\xi = \frac{z'(I_N - e_1e_1')W^{-1}(I_N - e_1e_1')z}{z_2^2 + u_0} = \frac{1}{v_2} + \frac{a^2}{v_1 v_2}$$

$$\Rightarrow \quad z'W^{-1}z = \frac{z_2^2+u_0}{v_2} + \frac{1}{v_1}\left(\frac{a\sqrt{z_2^2+u_0}}{\sqrt{v_2}} + z_1\right)^2. \tag{IA.35}$$

Using (IA.31), (IA.34), and (IA.35), we get

$$\hat{\psi}_t^2 = z'W^{-1}z - \frac{(e_1'W^{-1}z)^2}{e_1'W^{-1}e_1} = \frac{z_2^2+u_0}{v_2}. \tag{IA.36}$$

Using again the Bartlett decomposition, we can write

$$L = \begin{bmatrix} \sqrt{w_1} & 0 \\ -b & \sqrt{w_2} \end{bmatrix}, \tag{IA.37}$$

with $w_1 \sim \chi^2_{h-N+3}$, $w_2 \sim \chi^2_{h-N+2}$, and $b \sim \mathcal{N}(0,1)$, and they are independent of each other. Taking the inverse of L, we obtain

$$L^{-1} = \begin{bmatrix} \frac{1}{\sqrt{w_1}} & 0 \\ \frac{b}{\sqrt{w_1 w_2}} & \frac{1}{\sqrt{w_2}} \end{bmatrix}. \tag{IA.38}$$

We can express h_1 and h_2 in (IA.26) as

$$h_1 = \frac{1}{v_1}\left(\frac{x_{11}}{\sqrt{w_1}} + \frac{bx_{21}}{\sqrt{w_1 w_2}} + \frac{ax_{21}}{\sqrt{v_2 w_2}}\right), \tag{IA.39}$$

$$h_2 = \frac{a}{\sqrt{v_2}}h_1 + \frac{x_{21}}{v_2\sqrt{w_2}}. \tag{IA.40}$$

Using the definition of ι, (IA.26), (IA.31), (IA.32), and (IA.33), we have

$$e_2'W^{-1}e_1 = \frac{\sqrt{u_0}}{\sqrt{z_2^2+u_0}}h_1 + \frac{e_1'W^{-1}\xi}{\sqrt{z_2^2+u_0}}z_2 = \frac{\sqrt{u_0}}{\sqrt{z_2^2+u_0}}h_1 + \frac{az_2}{v_1\sqrt{v_2}\sqrt{z_2^2+u_0}}, \tag{IA.41}$$

$$\begin{aligned} e_2'W^{-1}z &= \sqrt{u_0}h_2 + e_2'W^{-1}e_1 z_1 + \xi'W^{-1}\xi z_2 \\ &= \frac{a\sqrt{u_0}}{\sqrt{v_2}}h_1 + \frac{x_{21}\sqrt{u_0}}{v_2\sqrt{w_2}} + e_2'W^{-1}e_1 z_1 + \left(\frac{1}{v_2} + \frac{a^2}{v_1 v_2}\right)z_2. \end{aligned} \tag{IA.42}$$

Substituting these two expressions and (IA.31), (IA.34) in (IA.14) and (IA.15), we obtain

$$\mu_{z,t} = \frac{\sqrt{h}\psi}{v_2}\left(\frac{x_{21}\sqrt{u_0}}{\sqrt{w_2}} + z_2\right), \tag{IA.43}$$

$$\mu_{g,t} = \mu_g + \frac{\sigma_g \psi}{\sqrt{z_2^2+u_0}}\left(y_1\sqrt{u_0} + \frac{az_2}{\sqrt{v_2}}\right), \tag{IA.44}$$

where

$$y_1 = \frac{x_{11}}{\sqrt{w_1}} + \frac{bx_{21}}{\sqrt{w_1 w_2}} + \frac{ax_{21}}{\sqrt{v_2 w_2}}. \tag{IA.45}$$

Next, using the Bartlett decomposition to C in (IA.28), we can write

$$C = \begin{bmatrix} s_1 + c^2 & c\sqrt{s_2} \\ c\sqrt{s_2} & s_2 \end{bmatrix}, \tag{IA.46}$$

where $s_1 \sim \chi^2_{N-4}$, $s_2 \sim \chi^2_{N-3}$, and $c \sim \mathcal{N}(0,1)$, and they are independent of each other.[2] Substituting (IA.28), (IA.30), and (IA.38) in (IA.27) and after simplification, we obtain

$$e_1' W^{-2} e_1 = \frac{1}{v_1^2}\left(y_1^2 + y_2^2 + 1 + \frac{s_1}{w_1} + \frac{a^2}{v_2}\right), \tag{IA.47}$$

$$\xi' W^{-2} \xi = \left(\frac{a y_1}{v_1\sqrt{v_2}} + \frac{x_{21}}{v_2\sqrt{w_2}}\right)^2 + \frac{a^2}{v_1^2 v_2}\left(1 + \frac{s_1}{w_1}\right) + \left(\frac{a y_2}{v_1\sqrt{v_2}} + \frac{\sqrt{s_2}}{v_2\sqrt{w_2}}\right)^2 + \left(\frac{1}{v_2} + \frac{a^2}{v_1 v_2}\right)^2, \tag{IA.48}$$

$$e_1' W^{-2} \xi = \frac{a}{v_1^2\sqrt{v_2}}\left(y_1^2 + y_2^2 + 1 + \frac{s_1}{w_1} + \frac{a^2}{v_2}\right) + \frac{x_{21} y_1}{v_1 v_2 \sqrt{w_2}} + \frac{\sqrt{s_2} y_2}{v_1 v_2 \sqrt{w_2}} + \frac{a}{v_1 v_2^{\frac{3}{2}}}, \tag{IA.49}$$

where

$$y_2 = \frac{c}{\sqrt{w_1}} + \frac{b\sqrt{s_2}}{\sqrt{w_1 w_2}} + \frac{a\sqrt{s_2}}{\sqrt{v_2 w_2}}. \tag{IA.50}$$

With these expressions, we can write

$$\begin{aligned} e_1' W^{-2} z &= \sqrt{z_2^2 + u_0}\,(e_1' W^{-2} \xi) + z_1 (e_1' W^{-2} e_1) \\ &= \frac{y_3}{v_1}\left(y_1^2 + y_2^2 + 1 + \frac{s_1}{w_1} + \frac{a^2}{v_2}\right) + \frac{\hat{\psi}_t}{v_1\sqrt{v_2}}\left(\frac{x_{21} y_1 + \sqrt{s_2} y_2}{\sqrt{w_2}} + \frac{a}{\sqrt{v_2}}\right), \end{aligned} \tag{IA.51}$$

$$\begin{aligned} z' W^{-2} z &= (z_2^2 + u_0)(\xi' W^{-2} \xi) + 2 z_1 (e_1' W^{-2} z) - z_1^2 (e_1' W^{-2} e_1) \\ &= \left(1 + \frac{s_1}{w_1}\right) y_3^2 + \left(\frac{a y_3 + \hat{\psi}_t}{\sqrt{v_2}}\right)^2 + \left(y_1 y_3 + \frac{x_{21}\hat{\psi}_t}{\sqrt{v_2 w_2}}\right)^2 + \left(y_2 y_3 + \frac{\sqrt{s_2}\hat{\psi}_t}{\sqrt{v_2 w_2}}\right)^2 \end{aligned} \tag{IA.52}$$

with

$$y_3 = e_1' W^{-1} z = \frac{a\hat{\psi}_t + z_1}{v_1}. \tag{IA.53}$$

We then obtain

$$\sigma_{g,t}^2 = \sigma_g^2\left(y_1^2 + y_2^2 + 1 + \frac{s_1}{w_1} + \frac{a^2}{v_2}\right), \tag{IA.54}$$

[2] Note that when $N = 3$, C is a zero matrix and we set $s_1 = 0$, $s_2 = 0$, and $c = 0$.

$$\sigma_{z,t}^2 = \frac{h\hat{\psi}_t^2}{v_2}\left(1+\frac{x_{21}^2+s_2}{w_2}\right), \quad \text{(IA.55)}$$

$$\sigma_{gz,t} = \frac{\sqrt{h}\sigma_g\hat{\psi}_t}{\sqrt{v_2}}\left(\frac{a}{\sqrt{v_2}}+\frac{x_{21}}{\sqrt{w_2}}y_1+\frac{\sqrt{s_2}}{\sqrt{w_2}}y_2\right). \quad \text{(IA.56)}$$

Using (IA.43), (IA.44), (IA.54), (IA.55), and (IA.56), we obtain

$$\begin{aligned}
\mu_t(\tilde{c}) &= \mu_{g,t}+\frac{\tilde{c}}{\gamma}\mu_{z,t} \\
&= \mu_g+\frac{\sigma_g\psi}{\hat{\psi}_t}\left(\frac{\sqrt{u_0}y_1}{\sqrt{v_2}}+\frac{az_2}{v_2}\right)+\frac{\tilde{c}\sqrt{h}\psi}{\gamma v_2}\left(\frac{x_{21}\sqrt{u_0}}{\sqrt{w_2}}+z_2\right), \quad \text{(IA.57)} \\
\sigma_t^2(\tilde{c}) &= \sigma_{g,t}^2+\frac{\tilde{c}^2}{\gamma^2}\sigma_{z,t}^2+\frac{2\tilde{c}}{\gamma}\sigma_{gz,t} \\
&= \sigma_g^2\left(y_1^2+y_2^2+1+\frac{s_1}{w_1}+\frac{a^2}{v_2}\right)+\frac{\tilde{c}^2h\hat{\psi}_t^2}{\gamma^2v_2}\left(1+\frac{x_{21}^2+s_2}{w_2}\right) \\
&\quad +\frac{2\tilde{c}\sqrt{h}\sigma_g\hat{\psi}_t}{\gamma\sqrt{v_2}}\left(\frac{a}{\sqrt{v_2}}+\frac{x_{21}y_1}{\sqrt{w_2}}+\frac{\sqrt{s_2}y_2}{\sqrt{w_2}}\right). \quad \text{(IA.58)}
\end{aligned}$$

This completes the proof.

C. Expected Out-of-Sample Utility Comparison

Tables IA.1 to IA.3 theoretically assess the portfolios in terms of expected out-of-sample utility, with parameters calibrated using the 10 momentum portfolios over the period of 1927/1–2018/12. Five different estimation windows are examined (i.e., $h = 120$, 240, 360, 480, and 600), and the risk aversion is set to $\gamma = 3$. Different distributional assumptions are made for the three tables. In Table IA.1, the returns of the risky assets are assumed to follow a multivariate normal distribution, and the returns are i.i.d. over time. In Table IA.2, the asset returns are assumed to follow a multivariate t-distribution with five degrees of freedom, and the returns are i.i.d. over time. Under the multivariate t-distribution, the returns of the risky assets have fat tails, which is often what we find in actual data.[3] In Table IA.3, asset returns are generated based on an empirical distribution from actual data using the block bootstrap procedure proposed in Politis and Romano (1994) with the expected length of the block set to 10 months. Note that applying this procedure to stationary data, the resampled data keep the stationary properties. In order to have a proper comparison across

[3]Tu and Zhou (2004), among others, show that t-distribution fits financial data well despite ignoring skewness.

the three distributional assumptions, we set the mean and covariance matrix under the multivariate normal and the multivariate t to be the same as the sample mean and the sample covariance matrix based on the actual data. The expected out-of-sample utilities of the invariant optimal portfolios rules in Table IA.1 are computed based on Lemma 1 and Proposition 2 in the paper. The remaining expected out-of-sample utilities in the three tables are obtained based on 10,000 simulations.

Note that the expected out-of-sample utility of the normalized KZ 3-fund rule ($\hat{w}_{KZ3,t}$) is not reported because it does not exist as shown in Section 3.5.3. In addition, the expected out-of-sample utility of KO_{BT} is not reported because we do not impose any factor structure in the simulations.

D. Additional Empirical Results

Additional empirical results are presented here.

Tables IA.4 to IA.12 report the results assuming no transaction costs for (i) $h = 240$ and $\gamma = 3$, (ii) $h = 120$ and $\gamma = 5$, and (iii) $h = 240$ and $\gamma = 5$. Tables IA.4 to IA.6 present CER results; Tables IA.7 to IA.9 present Sharpe ratio results; and Tables IA.10 to IA.12 present turnover results.

Tables IA.13 to IA.18 report the results assuming transaction costs of 20 bps for (i) $h = 240$ and $\gamma = 3$, (ii) $h = 120$ and $\gamma = 5$, and (iii) $h = 240$ and $\gamma = 5$. Tables IA.13 to IA.15 present CER results; and Tables IA.16 to IA.18 present Sharpe ratio results.

Tables IA.19 to IA.26 report the results assuming transaction costs of 10 bps for (i) $h = 120$ and $\gamma = 3$, (ii) $h = 240$ and $\gamma = 3$, (iii) $h = 120$ and $\gamma = 5$, and (iv) $h = 240$ and $\gamma = 5$. Tables IA.19 to IA.22 present CER results; and Tables IA.23 to IA.26 present Sharpe ratio results.

Tables IA.27 to IA.34 report the results assuming transaction costs of 50 bps for (i) $h = 120$ and $\gamma = 3$, (ii) $h = 240$ and $\gamma = 3$, (iii) $h = 120$ and $\gamma = 5$, and (iv) $h = 240$ and $\gamma = 5$. Tables IA.27 to IA.30 present CER results; and Tables IA.31 to IA.34 present Sharpe ratio results.

Table IA.1: Expected Out-of-Sample Utility – 10 Risky Assets with Normal Distribution

This table reports the expected out-of-sample utilities of the portfolios for different estimation windows (h = 120, 240, 360, 480, 600). The returns of the risky assets are assumed to follow a multivariate normal distribution with parameter values estimated using excess monthly returns of the 10 momentum portfolios over the period of 1927/1–2018/12. The expected out-of-sample utilities of the invariant optimal portfolio rules are computed based on Lemma 1 and Proposition 2. The expected out-of-sample utilities of the remaining portfolios are obtained based on 10,000 simulations. The risk aversion is set to $\gamma = 3$. We set $\eta = 4$ for the timing strategies KO_{VT} and KO_{RT}.

h	120	240	360	480	600
w^*	0.0111	0.0111	0.0111	0.0111	0.0111
Invariant Optimal Portfolio Rules					
$\boxed{\hat{w}_{q,t}}$	0.0063	0.0077	0.0083	0.0088	0.0091
$\hat{w}_{p,t}$	−0.0063	0.0036	0.0063	0.0076	0.0084
$\hat{w}_{u,t}$	−0.0033	0.0043	0.0066	0.0078	0.0085
$\hat{w}_{BS,t}$	0.0054	0.0076	0.0084	0.0089	0.0092
Rules with Shrinkage Covariance Matrix Estimators					
$\boxed{\hat{w}_{q,t}^{LW2004}}$	0.0073	0.0080	0.0085	0.0089	0.0092
$\hat{w}_{p,t}^{LW2004}$	0.0014	0.0056	0.0073	0.0082	0.0087
$\boxed{\hat{w}_{q,t}^{LW2017}}$	0.0068	0.0078	0.0084	0.0088	0.0092
$\hat{w}_{p,t}^{LW2004}$	−0.0030	0.0043	0.0066	0.0078	0.0085
Rules with MacKinlay-Pástor Single Factor Structure					
$\boxed{\hat{w}_{q,t}^{MP}}$	0.0081	0.0081	0.0080	0.0079	0.0078
$\hat{w}_{p,t}^{MP}$	0.0044	0.0056	0.0059	0.0061	0.0063
Rule with No-Short-Sale Constraints					
$\hat{w}_{p,t}^{NS}$	0.0049	0.0053	0.0055	0.0056	0.0057
Other Rules from Portfolio Optimization					
$\hat{w}_{g,t}$	0.0059	0.0061	0.0061	0.0061	0.0061
$\hat{w}_{g,t}^{NS}$	0.0038	0.0038	0.0038	0.0039	0.0039
Non-Optimization Rules					
$1/N$	0.0010	0.0010	0.0010	0.0010	0.0010
KO_{VT}	0.0033	0.0033	0.0033	0.0033	0.0033
KO_{RT}	0.0044	0.0046	0.0046	0.0047	0.0047

Table IA.2: Expected Out-of-Sample Utility – 10 Risky Assets with Multivariate t Distribution

This table reports the expected out-of-sample utilities of the portfolios for different estimation windows ($h = 120$, 240, 360, 480, 600). The returns of the risky assets are assumed to follow a multivariate t distribution with five degrees of freedom. The parameter values are estimated using excess monthly returns of the 10 momentum portfolios over the period of 1927/1–2018/12. The expected out-of-sample utilities of the portfolios are obtained based on 10,000 simulations. The risk aversion is set to $\gamma = 3$. We set $\eta = 4$ for the timing strategies KO_{VT} and KO_{RT}.

h	120	240	360	480	600
w^*	0.0111	0.0111	0.0111	0.0111	0.0111
Invariant Optimal Portfolio Rules					
$\boxed{\hat{w}_{q,t}}$	0.0059	0.0075	0.0082	0.0087	0.0090
$\hat{w}_{p,t}$	−0.0088	0.0027	0.0059	0.0073	0.0081
$\hat{w}_{u,t}$	−0.0053	0.0035	0.0062	0.0075	0.0082
$\hat{w}_{BS,t}$	0.0049	0.0073	0.0083	0.0088	0.0091
Rules with Shrinkage Covariance Matrix Estimators					
$\boxed{\hat{w}_{q,t}^{LW2004}}$	0.0075	0.0082	0.0087	0.0090	0.0093
$\hat{w}_{p,t}^{LW2004}$	0.0035	0.0066	0.0078	0.0085	0.0089
$\boxed{\hat{w}_{q,t}^{LW2017}}$	0.0065	0.0077	0.0083	0.0088	0.0091
$\hat{w}_{p,t}^{LW2017}$	−0.0047	0.0036	0.0062	0.0075	0.0082
Rules with MacKinlay-Pástor Single Factor Structure					
$\boxed{\hat{w}_{q,t}^{MP}}$	0.0084	0.0083	0.0082	0.0081	0.0079
$\hat{w}_{p,t}^{MP}$	0.0042	0.0054	0.0058	0.0061	0.0062
Rule with No-Short-Sale Constraints					
$\hat{w}_{p,t}^{NS}$	0.0049	0.0053	0.0055	0.0056	0.0057
Other Rules from Portfolio Optimization					
$\hat{w}_{g,t}$	0.0057	0.0059	0.0060	0.0060	0.0061
$\hat{w}_{g,t}^{NS}$	0.0037	0.0038	0.0038	0.0038	0.0038
Non-Optimization Rules					
$1/N$	0.0010	0.0010	0.0010	0.0010	0.0010
KO_{VT}	0.0033	0.0033	0.0033	0.0033	0.0033
KO_{RT}	0.0044	0.0046	0.0046	0.0047	0.0047

Table IA.3: Expected Out-of-Sample Utility – 10 Risky Assets with Empirical Distribution

This table reports the expected out-of-sample utilities of the portfolios for different estimation windows ($h = 120$, 240, 360, 480, 600). The returns of the risky assets are resampled from the excess monthly returns of the 10 momentum portfolios over the period of 1927/1–2018/12, using the block bootstrap procedure of Politis and Romano (1994) with the expected length of the block set to 10 months. The expected out-of-sample utilities of the portfolios are obtained based on 10,000 simulations. The risk aversion is set to $\gamma = 3$. We set $\eta = 4$ for the timing strategies KO_{VT} and KO_{RT}.

h	120	240	360	480	600
w^*	0.0111	0.0111	0.0111	0.0111	0.0111
Invariant Optimal Portfolio Rules					
$\boxed{\hat{w}_{q,t}}$	0.0035	0.0064	0.0076	0.0082	0.0087
$\hat{w}_{p,t}$	−0.0189	−0.0006	0.0041	0.0061	0.0072
$\hat{w}_{u,t}$	−0.0131	0.0006	0.0045	0.0063	0.0074
$\hat{w}_{BS,t}$	0.0018	0.0061	0.0076	0.0083	0.0087
Rules with Shrinkage Covariance Matrix Estimators					
$\boxed{\hat{w}_{q,t}^{LW2004}}$	0.0065	0.0077	0.0084	0.0088	0.0091
$\hat{w}_{p,t}^{LW2004}$	−0.0015	0.0050	0.0071	0.0080	0.0086
$\boxed{\hat{w}_{q,t}^{LW2017}}$	0.0046	0.0067	0.0077	0.0083	0.0087
$\hat{w}_{p,t}^{LW2017}$	−0.0134	0.0004	0.0045	0.0063	0.0074
Rules with MacKinlay-Pástor Single Factor Structure					
$\boxed{\hat{w}_{q,t}^{MP}}$	0.0061	0.0068	0.0070	0.0071	0.0071
$\hat{w}_{p,t}^{MP}$	0.0023	0.0039	0.0046	0.0050	0.0053
Rule with No-Short-Sale Constraints					
$\hat{w}_{p,t}^{NS}$	0.0050	0.0054	0.0055	0.0056	0.0057
Other Rules from Portfolio Optimization					
$\hat{w}_{g,t}$	0.0042	0.0049	0.0053	0.0055	0.0056
$\hat{w}_{g,t}^{NS}$	0.0029	0.0033	0.0034	0.0035	0.0036
Non-Optimization Rules					
$1/N$	0.0010	0.0010	0.0010	0.0010	0.0010
KO_{VT}	0.0028	0.0030	0.0031	0.0031	0.0032
KO_{RT}	0.0041	0.0044	0.0045	0.0045	0.0046

Table IA.4: CER Comparison: $h = 240$ and $\gamma = 3$

This table reports the certainty equivalent returns of the portfolios studied in this paper with $h = 240$ and $\gamma = 3$, based on the eight datasets containing excess monthly returns. The four newly obtained optimal combining portfolios, i.e., $\hat{w}_{q,t}$, $\hat{w}_{q,t}^{LW2004}$, $\hat{w}_{q,t}^{LW2017}$, and $\hat{w}_{q,t}^{MP}$, are highlighted with a box around. In the three categories to which the four new portfolios belong, one-sided tests are conducted to assess the value of using the newly derived optimal combining coefficient $\hat{c}_t$, and the p-values are reported in *italics*. For the portfolios in the remaining three categories, one-sided tests are conducted to compare them with the four newly obtained portfolios, and the corresponding p-values are reported in the four rows below the portfolio CER. We set $\eta = 4$ for the timing strategies KO_{VT}, KO_{RT}, and KO_{BT}.

	Momentum $N = 10$	Size-B/M $N = 25$	IVOL $N = 10$	OP-Inv $N = 25$	NM-V (LT) $N = 16$	NM-V (All) $N = 46$	Industry $N = 49$	Stocks $N = 100$
w^*	0.0145	0.0223	0.0171	0.0246	0.0262	0.0813	0.0290	0.0392
				Invariant Optimal Portfolio Rules				
$\boxed{\hat{w}_{q,t}}$	0.0110	0.0119	0.0056	0.0107	0.0143	−0.0893	0.0015	0.0014
$\hat{w}_{p,t}$	0.0039	−0.0077	−0.0039	−0.0193	0.0007	−0.5314	−0.1030	−0.2697
	0.00	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*
$\hat{w}_{u,t}$	0.0053	−0.0009	−0.0018	−0.0113	0.0039	−0.2970	−0.0624	−0.0945
	0.00	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*
$\hat{w}_{BS,t}$	0.0107	0.0103	0.0050	0.0065	0.0129	−0.1920	−0.0123	−0.0117
	0.09	*0.06*	*0.03*	*0.01*	*0.08*	*0.00*	*0.00*	*0.00*
				Rules with Shrinkage Covariance Matrix Estimators				
$\boxed{\hat{w}_{q,t}^{LW2004}}$	0.0125	0.0133	0.0086	0.0111	0.0156	0.0076	0.0024	0.0029
$\hat{w}_{p,t}^{LW2004}$	0.0088	0.0082	0.0044	−0.0095	0.0102	−0.1800	−0.0675	−0.1293
	0.01	*0.04*	*0.00*	*0.00*	*0.06*	*0.00*	*0.00*	*0.00*
$\boxed{\hat{w}_{q,t}^{LW2017}}$	0.0117	0.0128	0.0063	0.0111	0.0154	−0.0273	0.0024	0.0037
$\hat{w}_{p,t}^{LW2017}$	0.0053	−0.0015	−0.0021	−0.0130	0.0049	−0.3152	−0.0677	−0.0780
	0.00	*0.00*	*0.00*	*0.00*	*0.01*	*0.00*	*0.00*	*0.00*
				Rules with MacKinlay-Pástor Single Factor Structure				
$\boxed{\hat{w}_{q,t}^{MP}}$	0.0064	0.0050	0.0060	0.0087	0.0066	0.0063	0.0045	0.0049
$\hat{w}_{p,t}^{MP}$	0.0050	0.0030	0.0023	0.0030	0.0036	0.0030	0.0024	0.0015
	0.01	*0.08*	*0.00*	*0.00*	*0.00*	*0.02*	*0.19*	*0.14*
				Rule with No-Short-Sale Constraints				
$\hat{w}_{p,t}^{NS}$	0.0068	0.0054	0.0035	0.0052	0.0050	0.0061	0.0005	0.0028
	0.11	*0.02*	*0.30*	*0.07*	*0.04*	*1.00*	*0.35*	*0.75*
	0.03	*0.00*	*0.05*	*0.03*	*0.01*	*0.47*	*0.20*	*0.49*
	0.07	*0.01*	*0.23*	*0.04*	*0.02*	*0.88*	*0.20*	*0.32*
	0.63	*0.61*	*0.00*	*0.01*	*0.10*	*0.47*	*0.04*	*0.20*

Table IA.4: CER Comparison: $h = 240$ and $\gamma = 3$ (Cont'd)

	Momentum $N = 10$	Size-B/M $N = 25$	IVOL $N = 10$	OP-Inv $N = 25$	NM-V (LT) $N = 16$	NM-V (All) $N = 46$	Industry $N = 49$	Stocks $N = 100$
				Other Rules from Portfolio Optimization				
$\hat{w}_{g,t}$	0.0056	0.0070	0.0029	0.0081	0.0075	0.0084	0.0022	0.0016
	0.07	*0.05*	*0.27*	*0.22*	*0.08*	*1.00*	*0.65*	*0.87*
	0.01	*0.00*	*0.05*	*0.14*	*0.01*	*0.52*	*0.45*	*0.00*
	0.04	*0.02*	*0.21*	*0.16*	*0.04*	*0.90*	*0.45*	*0.00*
	0.16	*0.98*	*0.00*	*0.22*	*0.77*	*0.84*	*0.09*	*0.03*
$\hat{w}_{g,t}^{NS}$	0.0039	0.0046	0.0047	0.0058	0.0042	0.0056	0.0043	0.0042
	0.03	*0.01*	*0.42*	*0.10*	*0.03*	*1.00*	*0.91*	*0.99*
	0.00	*0.00*	*0.11*	*0.05*	*0.00*	*0.46*	*0.86*	*0.92*
	0.02	*0.00*	*0.34*	*0.07*	*0.01*	*0.88*	*0.86*	*0.74*
	0.00	*0.29*	*0.01*	*0.00*	*0.00*	*0.33*	*0.46*	*0.31*
$\hat{w}_{KZ3,t}$	−0.0472	0.0095	−0.7265	0.0108	0.0142	−11.6738	0.0022	0.0012
	0.00	*0.15*	*0.00*	*0.52*	*0.49*	*0.00*	*0.90*	*0.22*
	0.00	*0.01*	*0.00*	*0.41*	*0.30*	*0.00*	*0.35*	*0.00*
	0.00	*0.05*	*0.00*	*0.42*	*0.34*	*0.00*	*0.37*	*0.00*
	0.00	*0.99*	*0.00*	*0.91*	*0.97*	*0.00*	*0.14*	*0.01*
				Non-Optimization Rules				
$1/N$	0.0030	0.0043	0.0027	0.0038	0.0023	0.0019	0.0039	0.0044
	0.02	*0.01*	*0.25*	*0.05*	*0.02*	*0.99*	*0.81*	*0.96*
	0.00	*0.00*	*0.04*	*0.02*	*0.00*	*0.40*	*0.73*	*0.84*
	0.01	*0.00*	*0.20*	*0.03*	*0.01*	*0.85*	*0.73*	*0.70*
	0.00	*0.25*	*0.00*	*0.00*	*0.00*	*0.07*	*0.41*	*0.41*
KO_{VT}	0.0040	0.0047	0.0047	0.0051	0.0039	0.0049	0.0045	0.0044
	0.03	*0.02*	*0.41*	*0.08*	*0.03*	*1.00*	*0.90*	*0.99*
	0.00	*0.00*	*0.11*	*0.04*	*0.00*	*0.45*	*0.86*	*0.92*
	0.02	*0.00*	*0.34*	*0.05*	*0.01*	*0.87*	*0.86*	*0.80*
	0.00	*0.34*	*0.01*	*0.00*	*0.00*	*0.22*	*0.50*	*0.36*
KO_{RT}	0.0053	0.0051	0.0043	0.0055	0.0051	0.0063	0.0039	0.0036
	0.05	*0.02*	*0.37*	*0.08*	*0.04*	*1.00*	*0.86*	*0.92*
	0.01	*0.00*	*0.08*	*0.04*	*0.01*	*0.48*	*0.80*	*0.70*
	0.03	*0.01*	*0.30*	*0.05*	*0.02*	*0.89*	*0.79*	*0.48*
	0.05	*0.55*	*0.01*	*0.00*	*0.04*	*0.51*	*0.36*	*0.23*
KO_{BT}	0.0056	0.0053	0.0034	0.0046	0.0045	0.0060	0.0036	0.0036
	0.06	*0.02*	*0.31*	*0.06*	*0.04*	*1.00*	*0.76*	*0.89*
	0.01	*0.00*	*0.06*	*0.03*	*0.01*	*0.47*	*0.68*	*0.67*
	0.04	*0.01*	*0.24*	*0.04*	*0.02*	*0.88*	*0.68*	*0.47*
	0.08	*0.59*	*0.01*	*0.00*	*0.02*	*0.44*	*0.35*	*0.25*

Table IA.5: CER Comparison: $h = 120$ and $\gamma = 5$

This table reports the certainty equivalent returns of the portfolios studied in this paper with $h = 120$ and $\gamma = 5$, based on the eight datasets containing excess monthly returns. The four newly obtained optimal combining portfolios, i.e., $\hat{w}_{q,t}$, $\hat{w}^{LW2004}_{q,t}$, $\hat{w}^{LW2017}_{q,t}$, and $\hat{w}^{MP}_{q,t}$, are highlighted with a box around. In the three categories to which the four new portfolios belong, one-sided tests are conducted to assess the value of using the newly derived optimal combining coefficient $\hat{c}_t$, and the p-values are reported in *italics*. For the portfolios in the remaining three categories, one-sided tests are conducted to compare them with the four newly obtained portfolios, and the corresponding p-values are reported in the four rows below the portfolio CER. We set $\eta = 4$ for the timing strategies KO_{VT}, KO_{RT}, and KO_{BT}.

	Momentum $N = 10$	Size-B/M $N = 25$	IVOL $N = 10$	OP-Inv $N = 25$	NM-V (LT) $N = 16$	NM-V (All) $N = 46$	Industry $N = 49$	Stocks $N = 100$
w^*	0.0084	0.0128	0.0066	0.0156	0.0165	0.0722	0.0133	0.0180
				Invariant Optimal Portfolio Rules				
$\boxed{\hat{w}_{q,t}}$	0.0061	0.0069	0.0037	0.0037	0.0053	0.0165	0.0007	−0.0119
$\hat{w}_{p,t}$	−0.0035	−0.0371	−0.0086	−0.0426	−0.0161	−0.7351	−0.2407	−16.2490
	0.00	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*
$\hat{w}_{u,t}$	−0.0005	−0.0160	−0.0047	−0.0218	−0.0087	−0.1808	−0.0774	−0.4529
	0.00	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*
$\hat{w}_{BS,t}$	0.0055	0.0026	0.0027	−0.0010	0.0032	−0.0827	−0.0133	−0.0791
	0.02	*0.00*	*0.00*	*0.00*	*0.02*	*0.00*	*0.00*	*0.00*
				Rules with Shrinkage Covariance Matrix Estimators				
$\boxed{\hat{w}^{LW2004}_{q,t}}$	0.0076	0.0077	0.0058	0.0057	0.0067	0.0428	0.0029	0.0006
$\hat{w}^{LW2004}_{p,t}$	0.0046	0.0006	0.0025	−0.0126	0.0013	−0.0248	−0.0744	−0.3149
	0.01	*0.00*	*0.00*	*0.00*	*0.02*	*0.00*	*0.00*	*0.00*
$\boxed{\hat{w}^{LW2017}_{q,t}}$	0.0071	0.0083	0.0047	0.0059	0.0062	0.0473	0.0033	0.0018
$\hat{w}^{LW2017}_{p,t}$	−0.0000	−0.0112	−0.0041	−0.0161	−0.0079	−0.1198	−0.0721	−0.1577
	0.00	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*
				Rules with MacKinlay-Pástor Single Factor Structure				
$\boxed{\hat{w}^{MP}_{q,t}}$	0.0024	0.0012	0.0028	0.0051	0.0017	0.0057	0.0028	0.0034
$\hat{w}^{MP}_{p,t}$	0.0023	0.0009	0.0009	0.0016	−0.0008	0.0022	0.0019	0.0001
	0.46	*0.40*	*0.01*	*0.01*	*0.00*	*0.01*	*0.26*	*0.04*
				Rule with No-Short-Sale Constraints				
$\hat{w}^{NS}_{p,t}$	0.0031	0.0026	0.0016	0.0022	0.0016	0.0059	−0.0006	−0.0014
	0.07	*0.02*	*0.20*	*0.26*	*0.09*	*0.21*	*0.29*	*1.00*
	0.00	*0.00*	*0.00*	*0.03*	*0.00*	*0.00*	*0.04*	*0.15*
	0.02	*0.00*	*0.07*	*0.03*	*0.03*	*0.00*	*0.03*	*0.04*
	0.73	*0.83*	*0.11*	*0.04*	*0.47*	*0.53*	*0.09*	*0.02*

Table IA.5: CER Comparison: $h = 120$ and $\gamma = 5$ (Cont'd)

	Momentum $N = 10$	Size-B/M $N = 25$	IVOL $N = 10$	OP-Inv $N = 25$	NM-V (LT) $N = 16$	NM-V (All) $N = 46$	Industry $N = 49$	Stocks $N = 100$
				Other Rules from Portfolio Optimization				
$\hat{w}_{g,t}$	0.0032	0.0043	0.0007	0.0032	0.0034	0.0020	0.0009	−0.0112
	0.07	*0.06*	*0.12*	*0.37*	*0.18*	*0.13*	*0.59*	*0.98*
	0.00	*0.00*	*0.00*	*0.01*	*0.01*	*0.00*	*0.01*	*0.00*
	0.02	*0.00*	*0.04*	*0.01*	*0.07*	*0.00*	*0.01*	*0.00*
	0.85	*1.00*	*0.00*	*0.02*	*0.93*	*0.03*	*0.11*	*0.00*
$\hat{w}^{NS}_{g,t}$	0.0014	0.0023	0.0026	0.0032	0.0005	0.0046	0.0029	0.0015
	0.01	*0.01*	*0.34*	*0.41*	*0.04*	*0.18*	*0.93*	*1.00*
	0.00	*0.00*	*0.02*	*0.07*	*0.00*	*0.00*	*0.53*	*0.80*
	0.00	*0.00*	*0.17*	*0.06*	*0.01*	*0.00*	*0.38*	*0.33*
	0.15	*0.83*	*0.43*	*0.07*	*0.14*	*0.24*	*0.56*	*0.05*
$\hat{w}_{KZ3,t}$	−1.3529	−0.0397	−2.0209	−0.0687	−1.0198	−2.3263	−0.1979	−0.0689
	0.00	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*
	0.00	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*
	0.00	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*
	0.00	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*
				Non-Optimization Rules				
$1/N$	0.0002	0.0006	−0.0008	0.0013	−0.0005	−0.0015	0.0017	0.0006
	0.00	*0.00*	*0.05*	*0.16*	*0.03*	*0.09*	*0.67*	*1.00*
	0.00	*0.00*	*0.00*	*0.01*	*0.00*	*0.00*	*0.25*	*0.48*
	0.00	*0.00*	*0.01*	*0.01*	*0.01*	*0.00*	*0.19*	*0.18*
	0.05	*0.38*	*0.01*	*0.01*	*0.10*	*0.00*	*0.29*	*0.04*
KO_{VT}	0.0015	0.0023	0.0025	0.0027	0.0008	0.0030	0.0036	0.0025
	0.02	*0.01*	*0.32*	*0.33*	*0.05*	*0.15*	*0.96*	*1.00*
	0.00	*0.00*	*0.01*	*0.04*	*0.00*	*0.00*	*0.74*	*0.95*
	0.00	*0.00*	*0.16*	*0.04*	*0.01*	*0.00*	*0.62*	*0.79*
	0.18	*0.81*	*0.37*	*0.04*	*0.24*	*0.07*	*0.73*	*0.19*
KO_{RT}	0.0024	0.0018	0.0010	0.0029	0.0018	0.0042	0.0020	−0.0000
	0.03	*0.01*	*0.15*	*0.36*	*0.10*	*0.17*	*0.76*	*1.00*
	0.00	*0.00*	*0.00*	*0.05*	*0.00*	*0.00*	*0.26*	*0.31*
	0.01	*0.00*	*0.05*	*0.05*	*0.04*	*0.00*	*0.18*	*0.08*
	0.50	*0.66*	*0.07*	*0.07*	*0.53*	*0.22*	*0.33*	*0.02*
KO_{BT}	0.0026	0.0018	−0.0000	0.0027	0.0024	0.0033	0.0021	0.0008
	0.05	*0.01*	*0.09*	*0.33*	*0.15*	*0.16*	*0.73*	*1.00*
	0.00	*0.00*	*0.00*	*0.05*	*0.01*	*0.00*	*0.31*	*0.54*
	0.01	*0.00*	*0.03*	*0.05*	*0.07*	*0.00*	*0.24*	*0.23*
	0.60	*0.65*	*0.02*	*0.05*	*0.66*	*0.12*	*0.35*	*0.05*

Table IA.6: CER Comparison: $h = 240$ and $\gamma = 5$

This table reports the certainty equivalent returns of the portfolios studied in this paper with $h = 240$ and $\gamma = 5$, based on the eight datasets containing excess monthly returns. The four newly obtained optimal combining portfolios, i.e., $\hat{w}_{q,t}$, $\hat{w}_{q,t}^{LW2004}$, $\hat{w}_{q,t}^{LW2017}$, and $\hat{w}_{q,t}^{MP}$, are highlighted with a box around. In the three categories to which the four new portfolios belong, one-sided tests are conducted to assess the value of using the newly derived optimal combining coefficient $\hat{c}_t$, and the p-values are reported in *italics*. For the portfolios in the remaining three categories, one-sided tests are conducted to compare them with the four newly obtained portfolios, and the corresponding p-values are reported in the four rows below the portfolio CER. We set $\eta = 4$ for the timing strategies KO_{VT}, KO_{RT}, and KO_{BT}.

	Momentum $N = 10$	Size-B/M $N = 25$	IVOL $N = 10$	OP-Inv $N = 25$	NM-V (LT) $N = 16$	NM-V (All) $N = 46$	Industry $N = 49$	Stocks $N = 100$
w^*	0.0096	0.0150	0.0108	0.0164	0.0178	0.0518	0.0186	0.0250
				Invariant Optimal Portfolio Rules				
$\boxed{\hat{w}_{q,t}}$	0.0074	0.0087	0.0037	0.0079	0.0104	−0.0518	0.0006	−0.0004
$\hat{w}_{p,t}$	0.0031	−0.0028	−0.0019	−0.0105	0.0024	−0.3173	−0.0614	−0.1599
	0.00	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*
$\hat{w}_{u,t}$	0.0040	0.0012	−0.0007	−0.0056	0.0043	−0.1765	−0.0372	−0.0561
	0.00	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*
$\hat{w}_{BS,t}$	0.0072	0.0078	0.0034	0.0053	0.0096	−0.1135	−0.0075	−0.0076
	0.08	*0.08*	*0.03*	*0.01*	*0.09*	*0.00*	*0.00*	*0.00*
				Rules with Shrinkage Covariance Matrix Estimators				
$\boxed{\hat{w}_{q,t}^{LW2004}}$	0.0083	0.0094	0.0055	0.0083	0.0113	0.0070	0.0016	0.0016
$\hat{w}_{p,t}^{LW2004}$	0.0061	0.0067	0.0029	−0.0044	0.0082	−0.1054	−0.0400	−0.0762
	0.01	*0.06*	*0.00*	*0.00*	*0.06*	*0.00*	*0.00*	*0.00*
$\boxed{\hat{w}_{q,t}^{LW2017}}$	0.0078	0.0093	0.0042	0.0083	0.0111	−0.0142	0.0018	0.0025
$\hat{w}_{p,t}^{LW2017}$	0.0040	0.0009	−0.0008	−0.0066	0.0049	−0.1869	−0.0402	−0.0455
	0.00	*0.00*	*0.00*	*0.00*	*0.01*	*0.00*	*0.00*	*0.00*
				Rules with MacKinlay-Pástor Single Factor Structure				
$\boxed{\hat{w}_{q,t}^{MP}}$	0.0047	0.0026	0.0048	0.0077	0.0063	0.0057	0.0029	0.0031
$\hat{w}_{p,t}^{MP}$	0.0042	0.0030	0.0033	0.0053	0.0047	0.0048	0.0027	0.0031
	0.14	*0.70*	*0.02*	*0.01*	*0.00*	*0.20*	*0.44*	*0.50*
				Rule with No-Short-Sale Constraints				
$\hat{w}_{p,t}^{NS}$	0.0040	0.0030	0.0028	0.0038	0.0031	0.0036	0.0000	0.0015
	0.06	*0.00*	*0.35*	*0.05*	*0.02*	*0.99*	*0.38*	*0.83*
	0.01	*0.00*	*0.07*	*0.02*	*0.00*	*0.40*	*0.17*	*0.49*
	0.04	*0.00*	*0.27*	*0.03*	*0.01*	*0.85*	*0.15*	*0.26*
	0.27	*0.62*	*0.01*	*0.01*	*0.01*	*0.26*	*0.08*	*0.22*

Table IA.6: CER Comparison: $h = 240$ and $\gamma = 5$ (Cont'd)

	Momentum $N = 10$	Size-B/M $N = 25$	IVOL $N = 10$	OP-Inv $N = 25$	NM-V (LT) $N = 16$	NM-V (All) $N = 46$	Industry $N = 49$	Stocks $N = 100$
				Other Rules from Portfolio Optimization				
$\hat{w}_{g,t}$	0.0040	0.0057	0.0017	0.0066	0.0061	0.0070	0.0010	−0.0002
	0.06	*0.05*	*0.22*	*0.26*	*0.07*	*1.00*	*0.63*	*0.81*
	0.01	*0.00*	*0.03*	*0.16*	*0.01*	*0.50*	*0.24*	*0.00*
	0.04	*0.02*	*0.16*	*0.18*	*0.04*	*0.90*	*0.22*	*0.00*
	0.16	*1.00*	*0.00*	*0.08*	*0.42*	*0.72*	*0.13*	*0.02*
$\hat{w}^{NS}_{g,t}$	0.0022	0.0030	0.0035	0.0043	0.0023	0.0044	0.0032	0.0031
	0.01	*0.00*	*0.46*	*0.08*	*0.01*	*1.00*	*0.95*	*1.00*
	0.00	*0.00*	*0.15*	*0.04*	*0.00*	*0.42*	*0.88*	*0.95*
	0.01	*0.00*	*0.39*	*0.05*	*0.01*	*0.86*	*0.86*	*0.77*
	0.00	*0.69*	*0.04*	*0.01*	*0.00*	*0.26*	*0.58*	*0.49*
$\hat{w}_{KZ3,t}$	−0.0977	0.0067	−1.2021	0.0083	0.0078	−19.6338	0.0003	−0.0007
	0.00	*0.06*	*0.00*	*0.67*	*0.14*	*0.00*	*0.26*	*0.14*
	0.00	*0.00*	*0.00*	*0.51*	*0.09*	*0.00*	*0.03*	*0.00*
	0.00	*0.02*	*0.00*	*0.50*	*0.08*	*0.00*	*0.03*	*0.00*
	0.00	*0.99*	*0.00*	*0.64*	*0.65*	*0.00*	*0.11*	*0.01*
				Non-Optimization Rules				
$1/N$	0.0010	0.0019	0.0002	0.0019	−0.0002	−0.0010	0.0020	0.0029
	0.01	*0.00*	*0.11*	*0.02*	*0.00*	*0.99*	*0.72*	*0.96*
	0.00	*0.00*	*0.01*	*0.01*	*0.00*	*0.29*	*0.56*	*0.80*
	0.00	*0.00*	*0.07*	*0.01*	*0.00*	*0.77*	*0.54*	*0.60*
	0.00	*0.33*	*0.00*	*0.00*	*0.00*	*0.04*	*0.35*	*0.45*
KO_{VT}	0.0022	0.0029	0.0033	0.0035	0.0018	0.0033	0.0033	0.0033
	0.01	*0.00*	*0.43*	*0.05*	*0.01*	*0.99*	*0.92*	*1.00*
	0.00	*0.00*	*0.13*	*0.02*	*0.00*	*0.39*	*0.85*	*0.95*
	0.01	*0.00*	*0.35*	*0.03*	*0.00*	*0.85*	*0.83*	*0.82*
	0.00	*0.63*	*0.03*	*0.00*	*0.00*	*0.18*	*0.58*	*0.56*
KO_{RT}	0.0033	0.0032	0.0027	0.0038	0.0031	0.0046	0.0026	0.0021
	0.03	*0.01*	*0.34*	*0.06*	*0.02*	*1.00*	*0.87*	*0.93*
	0.00	*0.00*	*0.07*	*0.03*	*0.00*	*0.43*	*0.73*	*0.66*
	0.02	*0.00*	*0.26*	*0.03*	*0.01*	*0.87*	*0.71*	*0.38*
	0.04	*0.67*	*0.01*	*0.00*	*0.00*	*0.35*	*0.42*	*0.28*
KO_{BT}	0.0036	0.0030	0.0012	0.0028	0.0022	0.0040	0.0016	0.0019
	0.05	*0.01*	*0.18*	*0.03*	*0.01*	*0.99*	*0.66*	*0.89*
	0.01	*0.00*	*0.03*	*0.01*	*0.00*	*0.41*	*0.49*	*0.59*
	0.03	*0.00*	*0.13*	*0.02*	*0.01*	*0.86*	*0.47*	*0.34*
	0.09	*0.62*	*0.00*	*0.00*	*0.00*	*0.28*	*0.29*	*0.27*

Table IA.7: Sharpe Ratio Comparison: $h = 240$ and $\gamma = 3$

This table reports the Sharpe ratio of the portfolios studied in this paper with $h = 240$ and $\gamma = 3$, based on the eight datasets containing excess monthly returns. The four newly obtained optimal combining portfolios, i.e., $\hat{w}_{q,t}$, $\hat{w}_{q,t}^{LW2004}$, $\hat{w}_{q,t}^{LW2017}$, and $\hat{w}_{q,t}^{MP}$, are highlighted with a box around. In the three categories to which the four new portfolios belong, one-sided tests are conducted to assess the value of using the newly derived optimal combining coefficient $\hat{c}_t$, and the p-values are reported in *italics*. For the portfolios in the remaining three categories, one-sided tests are conducted to compare them with the four newly obtained portfolios, and the corresponding p-values are reported in the four rows below the portfolio Sharpe ratio. We set $\eta = 4$ for the timing strategies KO_{VT}, KO_{RT}, and KO_{BT}.

	Momentum $N = 10$	Size-B/M $N = 25$	IVOL $N = 10$	OP-Inv $N = 25$	NM-V (LT) $N = 16$	NM-V (All) $N = 46$	Industry $N = 49$	Stocks $N = 100$
w^*	0.2982	0.3691	0.3214	0.3868	0.4005	0.6991	0.4181	0.4856
				Invariant Optimal Portfolio Rules				
$\boxed{\hat{w}_{q,t}}$	0.2638	0.2675	0.2335	0.2533	0.2932	0.4070	0.1033	0.0963
$\hat{w}_{p,t}$	0.2517	0.2461	0.2264	0.1898	0.2578	0.3907	0.0370	−0.0476
	0.03	*0.02*	*0.15*	*0.00*	*0.00*	*0.01*	*0.05*	*0.01*
$\hat{w}_{u,t}$	0.2534	0.2509	0.2275	0.1950	0.2613	0.3938	0.0408	−0.0397
	0.05	*0.05*	*0.19*	*0.00*	*0.00*	*0.02*	*0.06*	*0.01*
$\hat{w}_{BS,t}$	0.2631	0.2637	0.2331	0.2246	0.2835	0.4013	0.0574	−0.0050
	0.34	*0.23*	*0.42*	*0.00*	*0.03*	*0.00*	*0.07*	*0.02*
				Rules with Shrinkage Covariance Matrix Estimators				
$\boxed{\hat{w}_{q,t}^{LW2004}}$	0.2745	0.2935	0.2356	0.2635	0.3178	0.4627	0.1200	0.1337
$\hat{w}_{p,t}^{LW2004}$	0.2647	0.2704	0.2306	0.1969	0.2733	0.4394	0.0297	−0.0439
	0.06	*0.03*	*0.25*	*0.00*	*0.00*	*0.00*	*0.02*	*0.00*
$\boxed{\hat{w}_{q,t}^{LW2017}}$	0.2700	0.2780	0.2342	0.2612	0.3052	0.4464	0.1203	0.1577
$\hat{w}_{p,t}^{LW2017}$	0.2595	0.2575	0.2278	0.1975	0.2674	0.4285	0.0230	−0.0406
	0.05	*0.03*	*0.18*	*0.00*	*0.00*	*0.00*	*0.01*	*0.00*
				Rules with MacKinlay-Pástor Single Factor Structure				
$\boxed{\hat{w}_{q,t}^{MP}}$	0.2107	0.1819	0.2192	0.2884	0.2243	0.2387	0.1757	0.1800
$\hat{w}_{p,t}^{MP}$	0.1744	0.1399	0.1215	0.1339	0.1467	0.1356	0.1216	0.1120
	0.00	*0.05*	*0.00*	*0.00*	*0.00*	*0.01*	*0.17*	*0.14*
				Rule with No-Short-Sale Constraints				
$\hat{w}_{p,t}^{NS}$	0.2066	0.1823	0.1454	0.1824	0.1758	0.1933	0.0833	0.1318
	0.06	*0.02*	*0.01*	*0.10*	*0.04*	*0.01*	*0.35*	*0.78*
	0.03	*0.00*	*0.01*	*0.06*	*0.01*	*0.00*	*0.23*	*0.48*
	0.04	*0.01*	*0.01*	*0.07*	*0.02*	*0.00*	*0.23*	*0.27*
	0.42	*0.51*	*0.00*	*0.00*	*0.05*	*0.22*	*0.04*	*0.18*

Table IA.7: Sharpe Ratio Comparison: $h = 240$ and $\gamma = 3$ (Cont'd)

	Momentum $N = 10$	Size-B/M $N = 25$	IVOL $N = 10$	OP-Inv $N = 25$	NM-V (LT) $N = 16$	NM-V (All) $N = 46$	Industry $N = 49$	Stocks $N = 100$
				Other Rules from Portfolio Optimization				
$\hat{w}_{g,t}$	0.1999	0.2472	0.1352	0.2657	0.2565	0.2809	0.1158	0.1018
	0.05	*0.30*	*0.01*	*0.60*	*0.28*	*0.08*	*0.62*	*0.88*
	0.03	*0.10*	*0.01*	*0.52*	*0.14*	*0.02*	*0.45*	*0.00*
	0.04	*0.21*	*0.01*	*0.54*	*0.21*	*0.03*	*0.45*	*0.00*
	0.29	*1.00*	*0.00*	*0.11*	*0.86*	*0.76*	*0.10*	*0.03*
$\hat{w}_{g,t}^{NS}$	0.1562	0.1762	0.1874	0.2067	0.1624	0.2117	0.1795	0.1756
	0.01	*0.02*	*0.12*	*0.21*	*0.03*	*0.02*	*0.94*	*0.99*
	0.00	*0.00*	*0.10*	*0.15*	*0.01*	*0.00*	*0.91*	*0.95*
	0.00	*0.01*	*0.12*	*0.17*	*0.02*	*0.01*	*0.90*	*0.79*
	0.00	*0.36*	*0.03*	*0.00*	*0.00*	*0.27*	*0.54*	*0.45*
$\hat{w}_{KZ3,t}$	0.1276	0.2586	−0.0191	0.2906	0.2977	0.0943	0.1154	0.0920
	0.00	*0.36*	*0.00*	*0.95*	*0.56*	*0.00*	*0.88*	*0.23*
	0.00	*0.06*	*0.00*	*0.90*	*0.27*	*0.00*	*0.36*	*0.00*
	0.00	*0.21*	*0.00*	*0.89*	*0.41*	*0.00*	*0.38*	*0.00*
	0.03	*0.98*	*0.00*	*0.52*	*0.89*	*0.06*	*0.12*	*0.01*
				Non-Optimization Rules				
$1/N$	0.1352	0.1608	0.1280	0.1527	0.1217	0.1152	0.1552	0.1715
	0.00	*0.01*	*0.01*	*0.05*	*0.01*	*0.00*	*0.80*	*0.96*
	0.00	*0.00*	*0.01*	*0.03*	*0.00*	*0.00*	*0.73*	*0.83*
	0.00	*0.00*	*0.01*	*0.04*	*0.01*	*0.00*	*0.73*	*0.64*
	0.00	*0.19*	*0.00*	*0.00*	*0.00*	*0.03*	*0.36*	*0.43*
KO_{VT}	0.1575	0.1749	0.1810	0.1872	0.1536	0.1823	0.1809	0.1827
	0.01	*0.02*	*0.10*	*0.13*	*0.03*	*0.01*	*0.92*	*0.99*
	0.00	*0.00*	*0.07*	*0.09*	*0.01*	*0.00*	*0.89*	*0.95*
	0.00	*0.01*	*0.09*	*0.10*	*0.02*	*0.00*	*0.88*	*0.83*
	0.00	*0.35*	*0.01*	*0.00*	*0.00*	*0.13*	*0.55*	*0.53*
KO_{RT}	0.1847	0.1823	0.1663	0.1963	0.1815	0.2153	0.1616	0.1517
	0.02	*0.03*	*0.04*	*0.16*	*0.05*	*0.02*	*0.88*	*0.92*
	0.01	*0.00*	*0.03*	*0.11*	*0.02*	*0.00*	*0.82*	*0.69*
	0.02	*0.01*	*0.04*	*0.12*	*0.03*	*0.01*	*0.82*	*0.43*
	0.05	*0.51*	*0.00*	*0.00*	*0.01*	*0.32*	*0.38*	*0.25*
KO_{BT}	0.1919	0.1822	0.1425	0.1730	0.1659	0.2010	0.1473	0.1492
	0.04	*0.03*	*0.02*	*0.09*	*0.04*	*0.02*	*0.76*	*0.89*
	0.02	*0.00*	*0.01*	*0.06*	*0.01*	*0.00*	*0.68*	*0.65*
	0.02	*0.01*	*0.02*	*0.07*	*0.02*	*0.01*	*0.68*	*0.41*
	0.10	*0.51*	*0.00*	*0.00*	*0.01*	*0.24*	*0.30*	*0.26*

Table IA.8: Sharpe Ratio Comparison: $h = 120$ and $\gamma = 5$

This table reports the Sharpe ratio of the portfolios studied in this paper with $h = 120$ and $\gamma = 5$, based on the eight datasets containing excess monthly returns. The four newly obtained optimal combining portfolios, i.e., $\hat{w}_{q,t}$, $\hat{w}_{q,t}^{LW2004}$, $\hat{w}_{q,t}^{LW2017}$, and $\hat{w}_{q,t}^{MP}$, are highlighted with a box around. In the three categories to which the four new portfolios belong, one-sided tests are conducted to assess the value of using the newly derived optimal combining coefficient $\hat{c}_t$, and the p-values are reported in *italics*. For the portfolios in the remaining three categories, one-sided tests are conducted to compare them with the four newly obtained portfolios, and the corresponding p-values are reported in the four rows below the portfolio Sharpe ratio. We set $\eta = 4$ for the timing strategies KO_{VT}, KO_{RT}, and KO_{BT}.

	Momentum $N = 10$	Size-B/M $N = 25$	IVOL $N = 10$	OP-Inv $N = 25$	NM-V (LT) $N = 16$	NM-V (All) $N = 46$	Industry $N = 49$	Stocks $N = 100$
w^*	0.2903	0.3584	0.2581	0.3947	0.4060	0.8500	0.3658	0.4244
				Invariant Optimal Portfolio Rules				
$\boxed{\hat{w}_{q,t}}$	0.2663	0.2667	0.2511	0.2061	0.2392	0.5853	0.1265	0.0289
$\hat{w}_{p,t}$	0.2543	0.2162	0.2459	0.1617	0.2057	0.5649	0.0667	−0.0478
	0.13	*0.00*	*0.29*	*0.05*	*0.07*	*0.06*	*0.10*	*0.08*
$\hat{w}_{u,t}$	0.2575	0.2261	0.2472	0.1705	0.2112	0.5699	0.0764	−0.0399
	0.18	*0.01*	*0.33*	*0.08*	*0.09*	*0.09*	*0.12*	*0.08*
$\hat{w}_{BS,t}$	0.2664	0.2512	0.2517	0.1927	0.2320	0.5776	0.0968	−0.0345
	0.51	*0.04*	*0.58*	*0.19*	*0.23*	*0.11*	*0.18*	*0.06*
				Rules with Shrinkage Covariance Matrix Estimators				
$\boxed{\hat{w}_{q,t}^{LW2004}}$	0.2755	0.2836	0.2467	0.2379	0.2597	0.6964	0.1702	0.1103
$\hat{w}_{p,t}^{LW2004}$	0.2712	0.2606	0.2456	0.1988	0.2321	0.6631	0.0840	−0.0091
	0.35	*0.14*	*0.46*	*0.10*	*0.14*	*0.04*	*0.04*	*0.01*
$\boxed{\hat{w}_{q,t}^{LW2017}}$	0.2748	0.2889	0.2522	0.2438	0.2494	0.6955	0.1804	0.1388
$\hat{w}_{p,t}^{LW2017}$	0.2679	0.2533	0.2505	0.2067	0.2150	0.6680	0.0887	−0.0015
	0.25	*0.03*	*0.43*	*0.10*	*0.07*	*0.04*	*0.03*	*0.00*
				Rules with MacKinlay-Pástor Single Factor Structure				
$\boxed{\hat{w}_{q,t}^{MP}}$	0.1707	0.1429	0.1689	0.2275	0.1458	0.2439	0.1686	0.1849
$\hat{w}_{p,t}^{MP}$	0.1712	0.1360	0.1281	0.1452	0.0976	0.1548	0.1459	0.1204
	0.52	*0.39*	*0.01*	*0.01*	*0.01*	*0.01*	*0.26*	*0.06*
				Rule with No-Short-Sale Constraints				
$\hat{w}_{p,t}^{NS}$	0.1917	0.1756	0.1443	0.1651	0.1631	0.2429	0.1271	0.1101
	0.01	*0.01*	*0.00*	*0.17*	*0.05*	*0.00*	*0.51*	*0.95*
	0.00	*0.00*	*0.00*	*0.03*	*0.00*	*0.00*	*0.13*	*0.50*
	0.00	*0.00*	*0.00*	*0.02*	*0.02*	*0.00*	*0.08*	*0.23*
	0.82	*0.86*	*0.14*	*0.05*	*0.70*	*0.49*	*0.20*	*0.05*

Table IA.8: Sharpe Ratio Comparison: $h = 120$ and $\gamma = 5$ (Cont'd)

	Momentum $N=10$	Size-B/M $N=25$	IVOL $N=10$	OP-Inv $N=25$	NM-V (LT) $N=16$	NM-V (All) $N=46$	Industry $N=49$	Stocks $N=100$
				Other Rules from Portfolio Optimization				
$\hat{w}_{g,t}$	0.1823	0.2085	0.1088	0.1813	0.1843	0.1478	0.1227	0.0369
	0.00	*0.02*	*0.00*	*0.20*	*0.08*	*0.00*	*0.42*	*0.96*
	0.00	*0.00*	*0.00*	*0.01*	*0.01*	*0.00*	*0.01*	*0.01*
	0.00	*0.00*	*0.00*	*0.01*	*0.04*	*0.00*	*0.01*	*0.00*
	0.76	*1.00*	*0.00*	*0.02*	*0.92*	*0.03*	*0.12*	*0.00*
$\hat{w}^{NS}_{g,t}$	0.1450	0.1595	0.1639	0.1816	0.1236	0.2188	0.1717	0.1291
	0.00	*0.00*	*0.00*	*0.28*	*0.01*	*0.00*	*0.89*	*0.99*
	0.00	*0.00*	*0.00*	*0.06*	*0.00*	*0.00*	*0.52*	*0.76*
	0.00	*0.00*	*0.00*	*0.05*	*0.00*	*0.00*	*0.38*	*0.32*
	0.09	*0.74*	*0.40*	*0.07*	*0.18*	*0.26*	*0.54*	*0.03*
$\hat{w}_{KZ3,t}$	0.0640	0.1081	−0.0086	0.0361	−0.0292	−0.1277	0.0075	−0.0191
	0.00	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.01*	*0.11*
	0.00	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*
	0.00	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*
	0.01	*0.20*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*
				Non-Optimization Rules				
$1/N$	0.1276	0.1484	0.1224	0.1426	0.1209	0.1034	0.1527	0.1205
	0.00	*0.00*	*0.00*	*0.09*	*0.01*	*0.00*	*0.70*	*0.97*
	0.00	*0.00*	*0.00*	*0.01*	*0.00*	*0.00*	*0.34*	*0.61*
	0.00	*0.00*	*0.00*	*0.01*	*0.00*	*0.00*	*0.25*	*0.29*
	0.05	*0.56*	*0.06*	*0.01*	*0.24*	*0.01*	*0.36*	*0.05*
KO_{VT}	0.1466	0.1636	0.1619	0.1704	0.1338	0.1751	0.1902	0.1584
	0.00	*0.00*	*0.00*	*0.21*	*0.02*	*0.00*	*0.94*	*1.00*
	0.00	*0.00*	*0.00*	*0.04*	*0.00*	*0.00*	*0.74*	*0.95*
	0.00	*0.00*	*0.00*	*0.04*	*0.01*	*0.00*	*0.62*	*0.79*
	0.12	*0.77*	*0.37*	*0.04*	*0.33*	*0.07*	*0.73*	*0.16*
KO_{RT}	0.1695	0.1651	0.1438	0.1768	0.1665	0.2046	0.1534	0.1078
	0.00	*0.00*	*0.00*	*0.24*	*0.06*	*0.00*	*0.74*	*0.95*
	0.00	*0.00*	*0.00*	*0.05*	*0.01*	*0.00*	*0.31*	*0.47*
	0.00	*0.00*	*0.00*	*0.04*	*0.03*	*0.00*	*0.21*	*0.16*
	0.48	*0.75*	*0.17*	*0.07*	*0.73*	*0.20*	*0.36*	*0.02*
KO_{BT}	0.1747	0.1670	0.1274	0.1713	0.1737	0.1859	0.1585	0.1282
	0.00	*0.00*	*0.00*	*0.22*	*0.09*	*0.00*	*0.75*	*0.97*
	0.00	*0.00*	*0.00*	*0.05*	*0.02*	*0.00*	*0.39*	*0.69*
	0.00	*0.00*	*0.00*	*0.04*	*0.05*	*0.00*	*0.30*	*0.37*
	0.59	*0.76*	*0.07*	*0.06*	*0.80*	*0.12*	*0.41*	*0.06*

Table IA.9: Sharpe Ratio Comparison: $h = 240$ and $\gamma = 5$

This table reports the Sharpe ratio of the portfolios studied in this paper with $h = 240$ and $\gamma = 5$, based on the eight datasets containing excess monthly returns. The four newly obtained optimal combining portfolios, i.e., $\hat{w}_{q,t}$, $\hat{w}_{q,t}^{LW2004}$, $\hat{w}_{q,t}^{LW2017}$, and $\hat{w}_{q,t}^{MP}$, are highlighted with a box around. In the three categories to which the four new portfolios belong, one-sided tests are conducted to assess the value of using the newly derived optimal combining coefficient $\hat{c}_t$, and the p-values are reported in *italics*. For the portfolios in the remaining three categories, one-sided tests are conducted to compare them with the four newly obtained portfolios, and the corresponding p-values are reported in the four rows below the portfolio Sharpe ratio. We set $\eta = 4$ for the timing strategies KO_{VT}, KO_{RT}, and KO_{BT}.

	Momentum $N = 10$	Size-B/M $N = 25$	IVOL $N = 10$	OP-Inv $N = 25$	NM-V (LT) $N = 16$	NM-V (All) $N = 46$	Industry $N = 49$	Stocks $N = 100$
w^*	0.3098	0.3897	0.3288	0.4062	0.4252	0.7213	0.4326	0.5011
				Invariant Optimal Portfolio Rules				
$\boxed{\hat{w}_{q,t}}$	0.2825	0.2958	0.2457	0.2810	0.3226	0.4206	0.1149	0.0986
$\hat{w}_{p,t}$	0.2717	0.2704	0.2385	0.2162	0.2853	0.3991	0.0465	−0.0405
	0.07	*0.03*	*0.16*	*0.00*	*0.01*	*0.00*	*0.08*	*0.01*
$\hat{w}_{u,t}$	0.2735	0.2768	0.2397	0.2231	0.2898	0.4040	0.0525	−0.0272
	0.09	*0.06*	*0.19*	*0.00*	*0.01*	*0.01*	*0.09*	*0.01*
$\hat{w}_{BS,t}$	0.2820	0.2927	0.2453	0.2568	0.3140	0.4128	0.0763	0.0247
	0.38	*0.30*	*0.42*	*0.01*	*0.06*	*0.00*	*0.12*	*0.03*
				Rules with Shrinkage Covariance Matrix Estimators				
$\boxed{\hat{w}_{q,t}^{LW2004}}$	0.2905	0.3131	0.2468	0.2883	0.3434	0.4806	0.1364	0.1356
$\hat{w}_{p,t}^{LW2004}$	0.2844	0.2974	0.2432	0.2253	0.3055	0.4506	0.0438	−0.0312
	0.19	*0.15*	*0.31*	*0.00*	*0.02*	*0.00*	*0.03*	*0.00*
$\boxed{\hat{w}_{q,t}^{LW2017}}$	0.2882	0.3045	0.2463	0.2879	0.3345	0.4613	0.1394	0.1593
$\hat{w}_{p,t}^{LW2017}$	0.2793	0.2824	0.2400	0.2248	0.2966	0.4378	0.0378	−0.0225
	0.11	*0.05*	*0.20*	*0.00*	*0.01*	*0.00*	*0.02*	*0.00*
				Rules with MacKinlay-Pástor Single Factor Structure				
$\boxed{\hat{w}_{q,t}^{MP}}$	0.2163	0.1693	0.2217	0.2956	0.2580	0.2451	0.1719	0.1794
$\hat{w}_{p,t}^{MP}$	0.2066	0.1796	0.1833	0.2333	0.2159	0.2286	0.1648	0.1779
	0.14	*0.70*	*0.02*	*0.01*	*0.00*	*0.27*	*0.43*	*0.49*
				Rule with No-Short-Sale Constraints				
$\hat{w}_{p,t}^{NS}$	0.2059	0.1787	0.1670	0.1956	0.1821	0.1967	0.1054	0.1447
	0.01	*0.00*	*0.01*	*0.04*	*0.01*	*0.01*	*0.42*	*0.85*
	0.00	*0.00*	*0.00*	*0.02*	*0.00*	*0.00*	*0.24*	*0.59*
	0.01	*0.00*	*0.01*	*0.02*	*0.01*	*0.00*	*0.21*	*0.35*
	0.32	*0.63*	*0.01*	*0.00*	*0.01*	*0.25*	*0.09*	*0.24*

Table IA.9: Sharpe Ratio Comparison: $h = 240$ and $\gamma = 5$ (Cont'd)

	Momentum $N = 10$	Size-B/M $N = 25$	IVOL $N = 10$	OP-Inv $N = 25$	NM-V (LT) $N = 16$	NM-V (All) $N = 46$	Industry $N = 49$	Stocks $N = 100$
				Other Rules from Portfolio Optimization				
$\hat{w}_{g,t}$	0.1999	0.2472	0.1352	0.2657	0.2565	0.2809	0.1158	0.1018
	0.01	*0.07*	*0.00*	*0.34*	*0.10*	*0.05*	*0.51*	*0.87*
	0.00	*0.01*	*0.00*	*0.25*	*0.03*	*0.01*	*0.22*	*0.00*
	0.00	*0.04*	*0.00*	*0.27*	*0.06*	*0.02*	*0.20*	*0.00*
	0.15	*1.00*	*0.00*	*0.08*	*0.48*	*0.72*	*0.11*	*0.03*
$\hat{w}^{NS}_{g,t}$	0.1562	0.1762	0.1874	0.2067	0.1624	0.2117	0.1795	0.1756
	0.00	*0.00*	*0.05*	*0.07*	*0.01*	*0.01*	*0.93*	*0.99*
	0.00	*0.00*	*0.03*	*0.04*	*0.00*	*0.00*	*0.87*	*0.94*
	0.00	*0.00*	*0.04*	*0.05*	*0.00*	*0.00*	*0.85*	*0.77*
	0.00	*0.62*	*0.05*	*0.01*	*0.00*	*0.28*	*0.57*	*0.46*
$\hat{w}_{KZ3,t}$	0.1276	0.2586	-0.0191	0.2906	0.2977	0.0943	0.1154	0.0920
	0.00	*0.04*	*0.00*	*0.75*	*0.20*	*0.00*	*0.52*	*0.16*
	0.00	*0.00*	*0.00*	*0.57*	*0.08*	*0.00*	*0.09*	*0.00*
	0.00	*0.02*	*0.00*	*0.57*	*0.11*	*0.00*	*0.09*	*0.00*
	0.02	*0.99*	*0.00*	*0.44*	*0.75*	*0.05*	*0.14*	*0.01*
				Non-Optimization Rules				
$1/N$	0.1352	0.1608	0.1280	0.1527	0.1217	0.1152	0.1552	0.1715
	0.00	*0.00*	*0.00*	*0.01*	*0.00*	*0.00*	*0.76*	*0.95*
	0.00	*0.00*	*0.00*	*0.01*	*0.00*	*0.00*	*0.64*	*0.82*
	0.00	*0.00*	*0.00*	*0.01*	*0.00*	*0.00*	*0.62*	*0.63*
	0.00	*0.39*	*0.00*	*0.00*	*0.00*	*0.05*	*0.39*	*0.44*
KO_{VT}	0.1575	0.1749	0.1810	0.1872	0.1536	0.1823	0.1809	0.1827
	0.00	*0.00*	*0.04*	*0.04*	*0.01*	*0.01*	*0.91*	*0.99*
	0.00	*0.00*	*0.02*	*0.02*	*0.00*	*0.00*	*0.84*	*0.94*
	0.00	*0.00*	*0.03*	*0.03*	*0.00*	*0.00*	*0.83*	*0.82*
	0.00	*0.59*	*0.03*	*0.00*	*0.00*	*0.17*	*0.58*	*0.54*
KO_{RT}	0.1847	0.1823	0.1663	0.1963	0.1815	0.2153	0.1616	0.1517
	0.00	*0.00*	*0.01*	*0.04*	*0.01*	*0.02*	*0.84*	*0.91*
	0.00	*0.00*	*0.01*	*0.03*	*0.00*	*0.00*	*0.73*	*0.67*
	0.00	*0.00*	*0.01*	*0.03*	*0.01*	*0.00*	*0.71*	*0.41*
	0.04	*0.68*	*0.01*	*0.00*	*0.00*	*0.33*	*0.41*	*0.26*
KO_{BT}	0.1919	0.1822	0.1425	0.1730	0.1659	0.2010	0.1473	0.1492
	0.01	*0.00*	*0.00*	*0.02*	*0.01*	*0.01*	*0.71*	*0.88*
	0.00	*0.00*	*0.00*	*0.01*	*0.00*	*0.00*	*0.58*	*0.64*
	0.00	*0.00*	*0.00*	*0.01*	*0.00*	*0.00*	*0.56*	*0.39*
	0.09	*0.67*	*0.01*	*0.00*	*0.00*	*0.26*	*0.33*	*0.26*

Table IA.10: Turnover Comparison: $h = 240$ and $\gamma = 3$

This table reports the average turnover of the portfolios studied in this paper for $h = 240$ and $\gamma = 3$, based on the eight datasets containing excess monthly returns. The four newly obtained optimal combining portfolios, i.e., $\hat{w}_{q,t}$, $\hat{w}_{q,t}^{LW2004}$, $\hat{w}_{q,t}^{LW2017}$, and $\hat{w}_{q,t}^{MP}$, are highlighted with a box around. We set $\eta = 4$ for the timing strategies KO_{VT}, KO_{RT}, and KO_{BT}.

	Momentum $N = 10$	Size-B/M $N = 25$	IVOL $N = 10$	OP-Inv $N = 25$	NM-V (LT) $N = 16$	NM-V (All) $N = 46$	Industry $N = 49$	Stocks $N = 100$
w^*	0.5643	2.3389	1.3349	1.7150	2.2983	13.2954	2.7622	5.5998
Invariant Optimal Portfolio Rules								
$\boxed{\hat{w}_{q,t}}$	1.5898	2.5971	2.1918	1.3065	2.3671	60.8614	0.6770	0.7790
$\hat{w}_{p,t}$	2.9732	9.1974	4.3206	5.4093	5.7180	103.6842	11.7600	42.5524
$\hat{w}_{u,t}$	2.7289	12.4310	3.8001	4.4552	5.0331	79.0638	12.5009	11.0304
$\hat{w}_{BS,t}$	1.6935	3.8382	2.3596	2.1463	2.8786	71.9258	2.3339	2.4122
Rules with Shrinkage Covariance Matrix Estimators								
$\boxed{\hat{w}_{q,t}^{LW2004}}$	1.0934	1.4682	1.1609	1.0130	1.2519	16.0434	0.4753	0.4751
$\hat{w}_{p,t}^{LW2004}$	1.9882	4.5987	2.1390	4.0265	2.8388	41.5159	23.0794	13.6581
$\boxed{\hat{w}_{q,t}^{LW2017}}$	1.4956	2.1188	1.9549	1.0724	2.0060	21.2100	0.4467	0.3269
$\hat{w}_{p,t}^{LW2017}$	2.8020	7.5444	6.4697	4.3667	4.7480	83.6182	32.7216	6.6684
Rules with MacKinlay-Pástor Single Factor Structure								
$\boxed{\hat{w}_{q,t}^{MP}}$	0.0939	0.1046	0.0915	0.1262	0.1011	0.1514	0.1302	0.1910
$\hat{w}_{p,t}^{MP}$	0.1163	0.1463	0.1059	0.1399	0.1165	0.1433	0.1009	0.1594
Rule with No-Short-Sale Constraints								
$\hat{w}_{p,t}^{NS}$	0.0546	0.1521	0.1291	0.0992	0.0731	0.0720	0.1582	0.1758
Other Rules from Portfolio Optimization								
$\hat{w}_{g,t}$	0.1642	0.4071	0.1506	0.2569	0.2607	0.7914	0.3669	0.7731
$\hat{w}_{g,t}^{NS}$	0.0520	0.0402	0.0021	0.0497	0.0340	0.0202	0.0484	0.1030
$\hat{w}_{KZ3,t}$	6.4030	1.4097	104.1208	0.6408	2.0696	260.2764	0.6673	0.8318
Non-Optimization Rules								
$1/N$	0.0175	0.0174	0.0167	0.0205	0.0200	0.0259	0.0358	0.0627
KO_{VT}	0.0191	0.0213	0.0129	0.0228	0.0218	0.0261	0.0332	0.0567
KO_{RT}	0.0344	0.0358	0.0347	0.0450	0.0418	0.0381	0.0667	0.0939
KO_{BT}	0.0208	0.0214	0.0237	0.0287	0.0245	0.0298	0.0449	0.0897

Table IA.11: Turnover Comparison: $h = 120$ and $\gamma = 5$

This table reports the average turnover of the portfolios studied in this paper for $h = 120$ and $\gamma = 5$, based on the eight datasets containing excess monthly returns. The four newly obtained optimal combining portfolios, i.e., $\hat{w}_{q,t}$, $\hat{w}^{LW2004}_{q,t}$, $\hat{w}^{LW2017}_{q,t}$, and $\hat{w}^{MP}_{q,t}$, are highlighted with a box around. We set $\eta = 4$ for the timing strategies KO_{VT}, KO_{RT}, and KO_{BT}.

	Momentum $N = 10$	Size-B/M $N = 25$	IVOL $N = 10$	OP-Inv $N = 25$	NM-V (LT) $N = 16$	NM-V (All) $N = 46$	Industry $N = 49$	Stocks $N = 100$
w^*	0.2475	0.8561	0.2984	0.7594	0.9293	8.2565	0.7358	2.1485
				Invariant Optimal Portfolio Rules				
$\boxed{\hat{w}_{q,t}}$	1.0533	2.0343	1.3660	1.1844	1.5640	15.2358	0.9988	3.8203
$\hat{w}_{p,t}$	2.3196	9.3569	3.0018	6.3760	4.9571	231.9536	27.9468	1193.0736
$\hat{w}_{u,t}$	2.0324	6.5593	2.5981	4.4980	3.9968	55.9490	7.8311	158.9246
$\hat{w}_{BS,t}$	1.2118	3.4518	1.5923	2.2009	2.1933	33.9272	2.9245	11.8837
				Rules with Shrinkage Covariance Matrix Estimators				
$\boxed{\hat{w}^{LW2004}_{q,t}}$	0.5486	0.7874	0.5713	0.7039	0.6006	2.5542	0.4356	0.6079
$\hat{w}^{LW2004}_{p,t}$	1.1753	3.1736	1.2498	3.4133	1.7825	18.1305	6.4298	20.9817
$\boxed{\hat{w}^{LW2017}_{q,t}}$	0.8946	1.2664	1.0957	0.7454	1.1631	4.3962	0.4146	0.3826
$\hat{w}^{LW2017}_{p,t}$	1.9522	5.3637	2.3844	3.7441	3.5111	29.2779	5.9121	8.6639
				Rules with MacKinlay-Pástor Single Factor Structure				
$\boxed{\hat{w}^{MP}_{q,t}}$	0.1303	0.1706	0.1202	0.1963	0.1689	0.2093	0.1510	0.2161
$\hat{w}^{MP}_{p,t}$	0.1515	0.1788	0.1415	0.2141	0.1886	0.2093	0.1292	0.1655
				Rule with No-Short-Sale Constraints				
$\hat{w}^{NS}_{p,t}$	0.1069	0.2066	0.1262	0.1786	0.1432	0.0897	0.2106	0.2579
				Other Rules from Portfolio Optimization				
$\hat{w}^{NS}_{g,t}$	0.0817	0.0691	0.0088	0.0774	0.0559	0.0375	0.0733	0.1440
$\hat{w}_{g,t}$	0.2770	0.7665	0.2640	0.5413	0.4911	1.5337	0.8227	3.7827
$\hat{w}_{KZ3,t}$	30.5852	16.5565	55.9217	8.5546	28.0002	181.5043	8.4783	274.6183
				Non-Optimization Rules				
$1/N$	0.0176	0.0182	0.0172	0.0199	0.0197	0.0227	0.0341	0.0648
KO_{VT}	0.0281	0.0309	0.0188	0.0353	0.0347	0.0373	0.0481	0.0706
KO_{RT}	0.0746	0.0767	0.0886	0.1086	0.0959	0.0832	0.1369	0.1591
KO_{BT}	0.0346	0.0319	0.0383	0.0489	0.0373	0.0414	0.0710	0.1358

Table IA.12: Turnover Comparison: $h = 240$ and $\gamma = 5$

This table reports the average turnover of the portfolios studied in this paper for $h = 240$ and $\gamma = 5$, based on the eight datasets containing excess monthly returns. The four newly obtained optimal combining portfolios, i.e., $\hat{w}_{q,t}$, $\hat{w}_{q,t}^{LW2004}$, $\hat{w}_{q,t}^{LW2017}$, and $\hat{w}_{q,t}^{MP}$, are highlighted with a box around. We set $\eta = 4$ for the timing strategies KO_{VT}, KO_{RT}, and KO_{BT}.

	Momentum $N = 10$	Size-B/M $N = 25$	IVOL $N = 10$	OP-Inv $N = 25$	NM-V (LT) $N = 16$	NM-V (All) $N = 46$	Industry $N = 49$	Stocks $N = 100$
w^*	0.2626	1.0338	0.5608	0.6811	0.9543	5.4053	1.1494	2.8261
Invariant Optimal Portfolio Rules								
$\boxed{\hat{w}_{q,t}}$	0.7675	1.3849	0.9509	0.7433	1.1548	15.2409	0.4977	0.7744
$\hat{w}_{p,t}$	1.2916	3.8703	1.6369	2.4311	2.4655	64.0318	7.0337	11.7102
$\hat{w}_{u,t}$	1.2060	3.2709	1.5217	2.0709	2.2037	34.9381	3.1032	4.8430
$\hat{w}_{BS,t}$	0.8096	1.9044	1.0241	1.1219	1.3614	23.6888	1.2103	1.4759
Rules with Shrinkage Covariance Matrix Estimators								
$\boxed{\hat{w}_{q,t}^{LW2004}}$	0.5349	0.8141	0.5420	0.5860	0.6611	5.5489	0.3550	0.4732
$\hat{w}_{p,t}^{LW2004}$	0.8791	2.1245	0.9323	1.8673	1.3271	36.0343	3.1979	5.1253
$\boxed{\hat{w}_{q,t}^{LW2017}}$	0.7194	1.1394	0.8455	0.6144	0.9967	8.3985	0.3346	0.3262
$\hat{w}_{p,t}^{LW2017}$	1.2095	3.1173	1.4557	1.9775	2.0840	27.8413	3.1543	2.9278
Rules with MacKinlay-Pástor Single Factor Structure								
$\boxed{\hat{w}_{q,t}^{MP}}$	0.0897	0.1154	0.0918	0.1423	0.1107	0.1803	0.1352	0.1920
$\hat{w}_{p,t}^{MP}$	0.0840	0.0922	0.0789	0.1106	0.1018	0.1494	0.0860	0.0999
Rule with No-Short-Sale Constraints								
$\hat{w}_{p,t}^{NS}$	0.0573	0.1257	0.0664	0.0993	0.0748	0.0831	0.1468	0.1702
Other Rules from Portfolio Optimization								
$\hat{w}_{g,t}$	0.1642	0.4071	0.1506	0.2569	0.2607	0.7914	0.3669	0.7731
$\hat{w}_{g,t}^{NS}$	0.0520	0.0402	0.0021	0.0497	0.0340	0.0202	0.0484	0.1030
$\hat{w}_{KZ3,t}$	6.4030	1.4097	104.1208	0.6408	2.0696	260.2764	0.6673	0.8318
Non-Optimization Rules								
$1/N$	0.0175	0.0174	0.0167	0.0205	0.0200	0.0259	0.0358	0.0627
KO_{VT}	0.0191	0.0213	0.0129	0.0228	0.0218	0.0261	0.0332	0.0567
KO_{RT}	0.0344	0.0358	0.0347	0.0450	0.0418	0.0381	0.0667	0.0939
KO_{BT}	0.0208	0.0214	0.0237	0.0287	0.0245	0.0298	0.0449	0.0897

Table IA.13: CER Comparison with 20 bps Transaction Costs: $h = 240$ and $\gamma = 3$

This table reports the CER of the portfolios studied in this paper with $h = 240$, $\gamma = 3$, and a transaction cost of 20 bps, based on the eight datasets containing excess monthly returns. The four newly obtained optimal combining portfolios, i.e., $\hat{w}_{q,t}$, $\hat{w}_{q,t}^{LW2004}$, $\hat{w}_{q,t}^{LW2017}$, and $\hat{w}_{q,t}^{MP}$, are highlighted with a box around. In the three categories to which the four new portfolios belong, one-sided tests are conducted to assess the value of using the newly derived optimal combining coefficient $\hat{c}_t$, and the p-values are reported in *italics*. For the portfolios in the remaining three categories, one-sided tests are conducted to compare them with the four newly obtained portfolios, and the corresponding p-values are reported in the four rows below the portfolio CER. We set $\eta = 4$ for the timing strategies KO_{VT}, KO_{RT}, and KO_{BT}.

	Momentum $N=10$	Size-B/M $N=25$	IVOL $N=10$	OP-Inv $N=25$	NM-V (LT) $N=16$	NM-V (All) $N=46$	Industry $N=49$	Stocks $N=100$
w^*	0.0134	0.0176	0.0144	0.0212	0.0218	0.0539	0.0233	0.0275
				Invariant Optimal Portfolio Rules				
$\boxed{\hat{w}_{q,t}}$	0.0077	0.0069	0.0015	0.0081	0.0096	−1.1287	0.0002	−0.0002
$\hat{w}_{p,t}$	−0.0025	−0.0265	−0.0130	−0.0294	−0.0107	−0.9141	−0.1298	−0.4326
	0.00	*0.00*	*0.00*	*0.00*	*0.00*	*0.95*	*0.00*	*0.00*
$\hat{w}_{u,t}$	−0.0005	−0.1645	−0.0094	−0.0197	−0.0061	−0.6905	−0.1370	−0.1183
	0.00	*0.00*	*0.00*	*0.00*	*0.00*	*1.00*	*0.00*	*0.00*
$\hat{w}_{BS,t}$	0.0072	0.0028	0.0006	0.0024	0.0072	−0.6938	−0.0169	−0.0166
	0.01	*0.00*	*0.00*	*0.00*	*0.01*	*1.00*	*0.00*	*0.00*
				Rules with Shrinkage Covariance Matrix Estimators				
$\boxed{\hat{w}_{q,t}^{LW2004}}$	0.0103	0.0104	0.0063	0.0092	0.0131	−0.0309	0.0015	0.0019
$\hat{w}_{p,t}^{LW2004}$	0.0046	−0.0011	0.0001	−0.0170	0.0047	−0.2557	−0.6562	−0.1626
	0.00	*0.00*	*0.00*	*0.00*	*0.01*	*0.00*	*0.00*	*0.00*
$\boxed{\hat{w}_{q,t}^{LW2017}}$	0.0086	0.0087	0.0026	0.0091	0.0114	−0.0635	0.0015	0.0030
$\hat{w}_{p,t}^{LW2017}$	−0.0007	−0.0177	−0.0626	−0.0210	−0.0046	−0.9302	−1.5734	−0.0930
	0.00	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*
				Rules with MacKinlay-Pástor Single Factor Structure				
$\boxed{\hat{w}_{q,t}^{MP}}$	0.0063	0.0048	0.0059	0.0084	0.0064	0.0060	0.0042	0.0045
$\hat{w}_{p,t}^{MP}$	0.0047	0.0027	0.0021	0.0027	0.0033	0.0027	0.0022	0.0011
	0.01	*0.07*	*0.00*	*0.00*	*0.00*	*0.02*	*0.20*	*0.14*
				Rule with No-Short-Sale Constraints				
$\hat{w}_{p,t}^{NS}$	0.0067	0.0051	0.0032	0.0050	0.0048	0.0059	0.0002	0.0025
	0.38	*0.29*	*0.66*	*0.20*	*0.18*	*1.00*	*0.51*	*0.89*
	0.11	*0.01*	*0.16*	*0.10*	*0.02*	*0.95*	*0.29*	*0.61*
	0.28	*0.11*	*0.56*	*0.11*	*0.09*	*0.99*	*0.28*	*0.38*
	0.65	*0.58*	*0.00*	*0.01*	*0.11*	*0.49*	*0.04*	*0.20*

Table IA.13: CER Comparison with 20 bps Transaction Costs: $h = 240$ and $\gamma = 3$ (Cont'd)

	Momentum $N = 10$	Size-B/M $N = 25$	IVOL $N = 10$	OP-Inv $N = 25$	NM-V (LT) $N = 16$	NM-V (All) $N = 46$	Industry $N = 49$	Stocks $N = 100$
				Other Rules from Portfolio Optimization				
$\hat{w}_{g,t}$	0.0053	0.0062	0.0026	0.0076	0.0069	0.0069	0.0015	0.0000
	0.25	*0.42*	*0.60*	*0.44*	*0.29*	*1.00*	*0.77*	*0.88*
	0.05	*0.03*	*0.13*	*0.29*	*0.05*	*0.95*	*0.51*	*0.00*
	0.17	*0.18*	*0.50*	*0.32*	*0.17*	*1.00*	*0.49*	*0.00*
	0.13	*0.93*	*0.00*	*0.13*	*0.67*	*0.66*	*0.05*	*0.00*
$\hat{w}_{g,t}^{NS}$	0.0038	0.0046	0.0047	0.0057	0.0042	0.0056	0.0042	0.0040
	0.15	*0.24*	*0.78*	*0.26*	*0.16*	*1.00*	*0.97*	*1.00*
	0.02	*0.01*	*0.30*	*0.15*	*0.02*	*0.95*	*0.94*	*0.98*
	0.10	*0.09*	*0.70*	*0.17*	*0.08*	*0.99*	*0.94*	*0.89*
	0.00	*0.36*	*0.02*	*0.01*	*0.00*	*0.39*	*0.50*	*0.36*
$\hat{w}_{KZ3,t}$	−0.1193	0.0066	−6.1266	0.0095	0.0100	−27.3953	0.0009	−0.0005
	0.00	*0.46*	*0.00*	*0.75*	*0.55*	*0.00*	*0.91*	*0.11*
	0.00	*0.01*	*0.00*	*0.58*	*0.11*	*0.00*	*0.14*	*0.00*
	0.00	*0.15*	*0.00*	*0.59*	*0.30*	*0.00*	*0.16*	*0.00*
	0.00	*0.84*	*0.00*	*0.75*	*0.81*	*0.00*	*0.06*	*0.00*
				Non-Optimization Rules				
$1/N$	0.0030	0.0042	0.0026	0.0038	0.0023	0.0018	0.0039	0.0043
	0.11	*0.22*	*0.60*	*0.14*	*0.11*	*1.00*	*0.91*	*0.99*
	0.02	*0.01*	*0.14*	*0.07*	*0.01*	*0.92*	*0.84*	*0.94*
	0.07	*0.08*	*0.50*	*0.08*	*0.05*	*0.99*	*0.83*	*0.82*
	0.00	*0.30*	*0.00*	*0.00*	*0.00*	*0.08*	*0.44*	*0.46*
KO_{VT}	0.0039	0.0047	0.0046	0.0051	0.0038	0.0048	0.0044	0.0043
	0.16	*0.26*	*0.77*	*0.22*	*0.15*	*1.00*	*0.97*	*1.00*
	0.03	*0.01*	*0.30*	*0.11*	*0.02*	*0.94*	*0.94*	*0.99*
	0.10	*0.10*	*0.69*	*0.14*	*0.07*	*0.99*	*0.93*	*0.92*
	0.00	*0.42*	*0.02*	*0.00*	*0.00*	*0.26*	*0.55*	*0.44*
KO_{RT}	0.0052	0.0051	0.0042	0.0054	0.0050	0.0063	0.0037	0.0034
	0.24	*0.30*	*0.74*	*0.23*	*0.20*	*1.00*	*0.95*	*0.99*
	0.05	*0.01*	*0.25*	*0.12*	*0.03*	*0.95*	*0.90*	*0.86*
	0.17	*0.12*	*0.65*	*0.15*	*0.10*	*0.99*	*0.89*	*0.63*
	0.07	*0.61*	*0.01*	*0.00*	*0.05*	*0.56*	*0.39*	*0.26*
KO_{BT}	0.0055	0.0052	0.0033	0.0046	0.0045	0.0059	0.0035	0.0034
	0.27	*0.31*	*0.66*	*0.18*	*0.18*	*1.00*	*0.88*	*0.98*
	0.06	*0.02*	*0.19*	*0.09*	*0.02*	*0.95*	*0.79*	*0.83*
	0.19	*0.13*	*0.57*	*0.11*	*0.09*	*0.99*	*0.78*	*0.61*
	0.12	*0.65*	*0.01*	*0.00*	*0.03*	*0.48*	*0.37*	*0.29*

Table IA.14: CER Comparison with 20bps Transaction Costs: $h = 120$ and $\gamma = 5$

This table reports the CER of the portfolios studied in this paper with $h = 120$, $\gamma = 5$, and a transaction cost of 20 bps, based on the eight datasets containing excess monthly returns. The four newly obtained optimal combining portfolios, i.e., $\hat{w}_{q,t}$, $\hat{w}_{q,t}^{LW2004}$, $\hat{w}_{q,t}^{LW2017}$, and $\hat{w}_{q,t}^{MP}$, are highlighted with a box around. In the three categories to which the four new portfolios belong, one-sided tests are conducted to assess the value of using the newly derived optimal combining coefficient $\hat{c}_t$, and the p-values are reported in *italics*. For the portfolios in the remaining three categories, one-sided tests are conducted to compare them with the four newly obtained portfolios, and the corresponding p-values are reported in the four rows below the portfolio CER. We set $\eta = 4$ for the timing strategies KO_{VT}, KO_{RT}, and KO_{BT}.

	Momentum $N = 10$	Size-B/M $N = 25$	IVOL $N = 10$	OP-Inv $N = 25$	NM-V (LT) $N = 16$	NM-V (All) $N = 46$	Industry $N = 49$	Stocks $N = 100$
w^*	0.0079	0.0111	0.0060	0.0141	0.0146	0.0556	0.0118	0.0138
				Invariant Optimal Portfolio Rules				
$\boxed{\hat{w}_{q,t}}$	0.0041	0.0029	0.0011	0.0013	0.0022	−0.0060	−0.0013	−0.0197
$\hat{w}_{p,t}$	−0.0081	−0.0561	−0.0143	−0.0557	−0.0257	−64.1704	−0.4309	−781.6416
	0.00	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*
$\hat{w}_{u,t}$	−0.0046	−0.0292	−0.0096	−0.0310	−0.0165	−0.5832	−0.0938	−49.9908
	0.00	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*
$\hat{w}_{BS,t}$	0.0031	−0.0042	−0.0003	−0.0054	−0.0011	−0.1359	−0.0191	−0.1068
	0.00	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*
				Rules with Shrinkage Covariance Matrix Estimators				
$\boxed{\hat{w}_{q,t}^{LW2004}}$	0.0065	0.0061	0.0047	0.0042	0.0055	0.0384	0.0020	−0.0006
$\hat{w}_{p,t}^{LW2004}$	0.0023	−0.0058	0.0001	−0.0195	−0.0023	−0.0591	−0.0915	−0.3776
	0.00	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*
$\boxed{\hat{w}_{q,t}^{LW2017}}$	0.0053	0.0058	0.0026	0.0045	0.0038	0.0402	0.0024	0.0010
$\hat{w}_{p,t}^{LW2017}$	−0.0039	−0.0218	−0.0087	−0.0236	−0.0148	−0.1536	−0.0870	−0.1835
	0.00	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*
				Rules with MacKinlay-Pástor Single Factor Structure				
$\boxed{\hat{w}_{q,t}^{MP}}$	0.0021	0.0008	0.0025	0.0047	0.0014	0.0052	0.0025	0.0030
$\hat{w}_{p,t}^{MP}$	0.0020	0.0005	0.0006	0.0012	−0.0012	0.0017	0.0016	−0.0002
	0.42	*0.39*	*0.01*	*0.01*	*0.00*	*0.01*	*0.27*	*0.04*
				Rule with No-Short-Sale Constraints				
$\hat{w}_{p,t}^{NS}$	0.0029	0.0022	0.0013	0.0019	0.0013	0.0057	−0.0010	−0.0019
	0.28	*0.37*	*0.53*	*0.59*	*0.37*	*0.83*	*0.55*	*1.00*
	0.01	*0.00*	*0.01*	*0.09*	*0.01*	*0.00*	*0.06*	*0.25*
	0.10	*0.02*	*0.27*	*0.09*	*0.14*	*0.00*	*0.04*	*0.06*
	0.74	*0.82*	*0.10*	*0.04*	*0.48*	*0.57*	*0.08*	*0.02*

Table IA.14: CER Comparison with 20 bps Transaction Costs: $h = 120$ and $\gamma = 5$ (Cont'd)

	Momentum $N=10$	Size-B/M $N=25$	IVOL $N=10$	OP-Inv $N=25$	NM-V (LT) $N=16$	NM-V (All) $N=46$	Industry $N=49$	Stocks $N=100$
				Other Rules from Portfolio Optimization				
$\hat{w}_{g,t}$	0.0027	0.0028	0.0001	0.0021	0.0024	−0.0011	−0.0007	−0.0189
	0.24	*0.48*	*0.35*	*0.69*	*0.53*	*0.66*	*0.74*	*0.98*
	0.00	*0.00*	*0.00*	*0.03*	*0.01*	*0.00*	*0.00*	*0.00*
	0.08	*0.01*	*0.14*	*0.03*	*0.22*	*0.00*	*0.00*	*0.00*
	0.75	*0.96*	*0.00*	*0.00*	*0.82*	*0.00*	*0.02*	*0.00*
$\hat{w}^{NS}_{g,t}$	0.0013	0.0021	0.0026	0.0031	0.0004	0.0046	0.0028	0.0012
	0.10	*0.35*	*0.73*	*0.79*	*0.25*	*0.81*	*1.00*	*1.00*
	0.00	*0.00*	*0.08*	*0.23*	*0.00*	*0.00*	*0.79*	*0.97*
	0.02	*0.01*	*0.49*	*0.22*	*0.07*	*0.00*	*0.65*	*0.58*
	0.17	*0.87*	*0.54*	*0.10*	*0.19*	*0.32*	*0.61*	*0.06*
$\hat{w}_{KZ3,t}$	−1.2884	−0.2714	−5.8371	−0.2090	−2.3629	−8.5170	−0.2271	−404.1970
	0.00	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*
	0.00	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*
	0.00	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*
	0.00	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*
				Non-Optimization Rules				
$1/N$	0.0002	0.0005	−0.0008	0.0012	−0.0005	−0.0015	0.0016	0.0004
	0.04	*0.16*	*0.24*	*0.48*	*0.18*	*0.64*	*0.90*	*1.00*
	0.00	*0.00*	*0.00*	*0.06*	*0.00*	*0.00*	*0.41*	*0.76*
	0.01	*0.00*	*0.08*	*0.06*	*0.05*	*0.00*	*0.33*	*0.33*
	0.06	*0.44*	*0.01*	*0.02*	*0.14*	*0.01*	*0.34*	*0.06*
KO_{VT}	0.0015	0.0022	0.0024	0.0027	0.0007	0.0029	0.0035	0.0023
	0.11	*0.38*	*0.70*	*0.72*	*0.30*	*0.77*	*1.00*	*1.00*
	0.00	*0.00*	*0.07*	*0.18*	*0.00*	*0.00*	*0.91*	*1.00*
	0.03	*0.02*	*0.46*	*0.17*	*0.10*	*0.00*	*0.83*	*0.94*
	0.25	*0.86*	*0.46*	*0.07*	*0.31*	*0.10*	*0.78*	*0.27*
KO_{RT}	0.0022	0.0017	0.0009	0.0027	0.0016	0.0040	0.0017	−0.0003
	0.19	*0.29*	*0.46*	*0.73*	*0.41*	*0.79*	*0.95*	*1.00*
	0.00	*0.00*	*0.01*	*0.18*	*0.02*	*0.00*	*0.41*	*0.57*
	0.06	*0.01*	*0.21*	*0.17*	*0.18*	*0.00*	*0.30*	*0.14*
	0.55	*0.70*	*0.08*	*0.08*	*0.56*	*0.26*	*0.33*	*0.02*
KO_{BT}	0.0026	0.0018	-0.0001	0.0026	0.0023	0.0032	0.0019	0.0005
	0.23	*0.31*	*0.32*	*0.70*	*0.51*	*0.77*	*0.93*	*1.00*
	0.00	*0.00*	*0.00*	*0.18*	*0.05*	*0.00*	*0.47*	*0.77*
	0.08	*0.02*	*0.13*	*0.17*	*0.27*	*0.00*	*0.38*	*0.36*
	0.67	*0.71*	*0.03*	*0.08*	*0.72*	*0.16*	*0.38*	*0.06*

Table IA.15: CER Comparison with 20 bps Transaction Costs: $h = 240$ and $\gamma = 5$

This table reports the CER of the portfolios studied in this paper with $h = 240$, $\gamma = 5$, and a transaction cost of 20 bps, based on the eight datasets containing excess monthly returns. The four newly obtained optimal combining portfolios, i.e., $\hat{w}_{q,t}$, $\hat{w}_{q,t}^{LW2004}$, $\hat{w}_{q,t}^{LW2017}$, and $\hat{w}_{q,t}^{MP}$, are highlighted with a box around. In the three categories to which the four new portfolios belong, one-sided tests are conducted to assess the value of using the newly derived optimal combining coefficient $\hat{c}_t$, and the p-values are reported in *italics*. For the portfolios in the remaining three categories, one-sided tests are conducted to compare them with the four newly obtained portfolios, and the corresponding p-values are reported in the four rows below the portfolio CER. We set $\eta = 4$ for the timing strategies KO_{VT}, KO_{RT}, and KO_{BT}.

	Momentum $N = 10$	Size-B/M $N = 25$	IVOL $N = 10$	OP-Inv $N = 25$	NM-V (LT) $N = 16$	NM-V (All) $N = 46$	Industry $N = 49$	Stocks $N = 100$
w^*	0.0090	0.0129	0.0097	0.0150	0.0160	0.0407	0.0163	0.0191
				Invariant Optimal Portfolio Rules				
$\boxed{\hat{w}_{q,t}}$	0.0058	0.0060	0.0020	0.0064	0.0081	−0.0854	−0.0004	−0.0019
$\hat{w}_{p,t}$	0.0004	−0.0103	−0.0050	−0.0151	−0.0025	−2.1217	−0.0969	−0.1870
	0.00	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*
$\hat{w}_{u,t}$	0.0015	−0.0052	−0.0035	−0.0096	−0.0001	−0.4767	−0.0431	−0.0661
	0.00	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*
$\hat{w}_{BS,t}$	0.0055	0.0041	0.0015	0.0031	0.0069	−0.1917	−0.0098	−0.0106
	0.02	*0.00*	*0.00*	*0.00*	*0.02*	*0.00*	*0.00*	*0.00*
				Rules with Shrinkage Covariance Matrix Estimators				
$\boxed{\hat{w}_{q,t}^{LW2004}}$	0.0072	0.0078	0.0044	0.0071	0.0100	−0.0020	0.0009	0.0006
$\hat{w}_{p,t}^{LW2004}$	0.0043	0.0025	0.0011	−0.0080	0.0056	−0.9684	−0.0463	−0.0870
	0.00	*0.00*	*0.00*	*0.00*	*0.02*	*0.00*	*0.00*	*0.00*
$\boxed{\hat{w}_{q,t}^{LW2017}}$	0.0064	0.0070	0.0026	0.0071	0.0092	−0.0267	0.0011	0.0018
$\hat{w}_{p,t}^{LW2017}$	0.0015	−0.0051	−0.0036	−0.0103	0.0008	−0.3235	−0.0468	−0.0516
	0.00	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*
				Rules with MacKinlay-Pástor Single Factor Structure				
$\boxed{\hat{w}_{q,t}^{MP}}$	0.0045	0.0024	0.0046	0.0074	0.0061	0.0053	0.0027	0.0027
$\hat{w}_{p,t}^{MP}$	0.0041	0.0028	0.0032	0.0050	0.0044	0.0045	0.0025	0.0029
	0.15	*0.71*	*0.02*	*0.01*	*0.00*	*0.22*	*0.46*	*0.54*
				Rule with No-Short-Sale Constraints				
$\hat{w}_{p,t}^{NS}$	0.0039	0.0027	0.0026	0.0036	0.0029	0.0034	−0.0003	0.0012
	0.19	*0.06*	*0.61*	*0.13*	*0.07*	*1.00*	*0.52*	*0.94*
	0.04	*0.00*	*0.16*	*0.06*	*0.01*	*0.66*	*0.24*	*0.63*
	0.13	*0.02*	*0.51*	*0.07*	*0.03*	*0.96*	*0.21*	*0.33*
	0.30	*0.61*	*0.01*	*0.01*	*0.01*	*0.28*	*0.08*	*0.23*

Table IA.15: CER Comparison with 20 bps Transaction Costs: $h = 240$ and $\gamma = 5$ (Cont'd)

	Momentum $N=10$	Size-B/M $N=25$	IVOL $N=10$	OP-Inv $N=25$	NM-V (LT) $N=16$	NM-V (All) $N=46$	Industry $N=49$	Stocks $N=100$
				Other Rules from Portfolio Optimization				
$\hat{w}_{g,t}$	0.0037	0.0049	0.0014	0.0061	0.0056	0.0054	0.0002	−0.0018
	0.16	*0.27*	*0.41*	*0.43*	*0.20*	*1.00*	*0.71*	*0.81*
	0.03	*0.01*	*0.07*	*0.27*	*0.03*	*0.72*	*0.23*	*0.00*
	0.10	*0.10*	*0.31*	*0.29*	*0.10*	*0.98*	*0.20*	*0.00*
	0.11	*0.99*	*0.00*	*0.04*	*0.31*	*0.52*	*0.08*	*0.00*
$\hat{w}_{g,t}^{NS}$	0.0020	0.0030	0.0035	0.0042	0.0023	0.0043	0.0031	0.0029
	0.06	*0.08*	*0.73*	*0.18*	*0.05*	*1.00*	*0.98*	*1.00*
	0.01	*0.00*	*0.31*	*0.09*	*0.00*	*0.69*	*0.95*	*0.99*
	0.03	*0.02*	*0.65*	*0.11*	*0.02*	*0.97*	*0.93*	*0.91*
	0.00	*0.75*	*0.06*	*0.01*	*0.00*	*0.31*	*0.62*	*0.54*
$\hat{w}_{KZ3,t}$	−0.2094	0.0037	−10.0634	0.0070	0.0035	−45.4892	−0.0010	−0.0023
	0.00	*0.04*	*0.00*	*0.74*	*0.03*	*0.00*	*0.11*	*0.07*
	0.00	*0.00*	*0.00*	*0.44*	*0.01*	*0.00*	*0.00*	*0.00*
	0.00	*0.00*	*0.00*	*0.47*	*0.01*	*0.00*	*0.00*	*0.00*
	0.00	*0.76*	*0.00*	*0.39*	*0.26*	*0.00*	*0.05*	*0.00*
				Non-Optimization Rules				
$1/N$	0.0010	0.0019	0.0002	0.0018	−0.0002	−0.0011	0.0019	0.0027
	0.03	*0.04*	*0.26*	*0.06*	*0.02*	*1.00*	*0.83*	*0.99*
	0.00	*0.00*	*0.03*	*0.02*	*0.00*	*0.53*	*0.67*	*0.92*
	0.02	*0.01*	*0.19*	*0.03*	*0.01*	*0.93*	*0.65*	*0.74*
	0.00	*0.38*	*0.00*	*0.00*	*0.00*	*0.05*	*0.38*	*0.50*
KO_{VT}	0.0022	0.0029	0.0032	0.0034	0.0018	0.0032	0.0032	0.0032
	0.06	*0.08*	*0.69*	*0.13*	*0.05*	*1.00*	*0.97*	*1.00*
	0.01	*0.00*	*0.27*	*0.06*	*0.00*	*0.65*	*0.92*	*0.99*
	0.04	*0.02*	*0.61*	*0.08*	*0.02*	*0.96*	*0.91*	*0.93*
	0.00	*0.69*	*0.05*	*0.00*	*0.00*	*0.21*	*0.63*	*0.64*
KO_{RT}	0.0032	0.0031	0.0026	0.0038	0.0030	0.0046	0.0024	0.0019
	0.12	*0.09*	*0.60*	*0.15*	*0.08*	*1.00*	*0.94*	*0.99*
	0.02	*0.00*	*0.17*	*0.07*	*0.01*	*0.69*	*0.84*	*0.83*
	0.08	*0.03*	*0.50*	*0.08*	*0.04*	*0.97*	*0.82*	*0.53*
	0.06	*0.72*	*0.02*	*0.01*	*0.00*	*0.39*	*0.45*	*0.32*
KO_{BT}	0.0036	0.0030	0.0012	0.0028	0.0022	0.0039	0.0015	0.0017
	0.16	*0.09*	*0.39*	*0.09*	*0.06*	*1.00*	*0.78*	*0.98*
	0.03	*0.00*	*0.07*	*0.04*	*0.01*	*0.67*	*0.60*	*0.77*
	0.10	*0.03*	*0.30*	*0.05*	*0.02*	*0.97*	*0.58*	*0.47*
	0.12	*0.67*	*0.01*	*0.00*	*0.00*	*0.31*	*0.32*	*0.31*

Table IA.16: Sharpe Ratio Comparison with 20 bps Transaction Costs: $h = 240$ and $\gamma = 3$

This table reports the Sharpe ratio of the portfolios studied in this paper with $h = 240$, $\gamma = 3$, and a transaction cost of 20 bps, based on the eight datasets containing excess monthly returns. The four newly obtained optimal combining portfolios, i.e., $\hat{w}_{q,t}$, $\hat{w}_{q,t}^{LW2004}$, $\hat{w}_{q,t}^{LW2017}$, and $\hat{w}_{q,t}^{MP}$, are highlighted with a box around. In the three categories to which the four new portfolios belong, one-sided tests are conducted to assess the value of using the newly derived optimal combining coefficient $\hat{c}_t$, and the p-values are reported in *italics*. For the portfolios in the remaining three categories, one-sided tests are conducted to compare them with the four newly obtained portfolios, and the corresponding p-values are reported in the four rows below the portfolio Sharpe ratio. We set $\eta = 4$ for the timing strategies KO_{VT}, KO_{RT}, and KO_{BT}.

	Momentum $N = 10$	Size-B/M $N = 25$	IVOL $N = 10$	OP-Inv $N = 25$	NM-V (LT) $N = 16$	NM-V (All) $N = 46$	Industry $N = 49$	Stocks $N = 100$
w^*	0.2844	0.3253	0.2944	0.3573	0.3619	0.5762	0.3743	0.4092
				Invariant Optimal Portfolio Rules				
$\boxed{\hat{w}_{q,t}}$	0.2337	0.2133	0.2001	0.2211	0.2451	0.0532	0.0748	0.0597
$\hat{w}_{p,t}$	0.2108	0.1493	0.1737	0.1348	0.1903	0.1001	−0.0479	−0.2235
	0.00	*0.00*	*0.00*	*0.00*	*0.00*	*0.77*	*0.00*	*0.00*
$\hat{w}_{u,t}$	0.2144	0.0517	0.1798	0.1445	0.1976	0.1067	−0.0567	−0.1311
	0.00	*0.00*	*0.00*	*0.00*	*0.00*	*0.81*	*0.01*	*0.00*
$\hat{w}_{BS,t}$	0.2320	0.1994	0.1979	0.1866	0.2322	0.0888	0.0157	−0.0605
	0.16	*0.00*	*0.13*	*0.00*	*0.01*	*0.73*	*0.03*	*0.01*
				Rules with Shrinkage Covariance Matrix Estimators				
$\boxed{\hat{w}_{q,t}^{LW2004}}$	0.2512	0.2527	0.2127	0.2356	0.2857	0.3440	0.0975	0.1082
$\hat{w}_{p,t}^{LW2004}$	0.2337	0.2053	0.1981	0.1502	0.2300	0.2830	−0.0617	−0.1382
	0.00	*0.00*	*0.02*	*0.00*	*0.00*	*0.01*	*0.01*	*0.00*
$\boxed{\hat{w}_{q,t}^{LW2017}}$	0.2415	0.2311	0.2029	0.2334	0.2619	0.3308	0.0991	0.1390
$\hat{w}_{p,t}^{LW2017}$	0.2204	0.1704	0.0988	0.1501	0.2074	0.1204	−0.0601	−0.1015
	0.00	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.01*	*0.00*
				Rules with MacKinlay-Pástor Single Factor Structure				
$\boxed{\hat{w}_{q,t}^{MP}}$	0.2064	0.1769	0.2142	0.2816	0.2192	0.2295	0.1689	0.1708
$\hat{w}_{p,t}^{MP}$	0.1697	0.1351	0.1174	0.1280	0.1416	0.1284	0.1170	0.1064
	0.00	*0.05*	*0.00*	*0.00*	*0.00*	*0.01*	*0.18*	*0.15*
				Rule with No-Short-Sale Constraints				
$\hat{w}_{p,t}^{NS}$	0.2046	0.1762	0.1393	0.1780	0.1727	0.1905	0.0767	0.1247
	0.22	*0.19*	*0.06*	*0.22*	*0.14*	*0.94*	*0.51*	*0.92*
	0.10	*0.03*	*0.02*	*0.14*	*0.04*	*0.05*	*0.34*	*0.65*
	0.16	*0.09*	*0.05*	*0.15*	*0.09*	*0.07*	*0.32*	*0.37*
	0.47	*0.49*	*0.00*	*0.00*	*0.05*	*0.25*	*0.04*	*0.19*

Table IA.16: Sharpe Ratio Comparison with 20 bps Transaction Costs: $h = 240$ and $\gamma = 3$ (Cont'd)

	Momentum $N = 10$	Size-B/M $N = 25$	IVOL $N = 10$	OP-Inv $N = 25$	NM-V (LT) $N = 16$	NM-V (All) $N = 46$	Industry $N = 49$	Stocks $N = 100$
				Other Rules from Portfolio Optimization				
$\hat{w}_{g,t}$	0.1917	0.2248	0.1265	0.2526	0.2423	0.2386	0.0951	0.0657
	0.14	*0.62*	*0.05*	*0.75*	*0.48*	*0.98*	*0.69*	*0.90*
	0.06	*0.22*	*0.02*	*0.65*	*0.22*	*0.11*	*0.47*	*0.00*
	0.10	*0.43*	*0.04*	*0.66*	*0.37*	*0.14*	*0.46*	*0.00*
	0.22	*0.98*	*0.00*	*0.06*	*0.79*	*0.56*	*0.05*	*0.00*
$\hat{w}_{g,t}^{NS}$	0.1537	0.1741	0.1873	0.2041	0.1608	0.2106	0.1767	0.1694
	0.03	*0.19*	*0.37*	*0.38*	*0.11*	*0.96*	*0.98*	*1.00*
	0.01	*0.03*	*0.25*	*0.28*	*0.03*	*0.07*	*0.96*	*0.99*
	0.02	*0.10*	*0.34*	*0.30*	*0.07*	*0.10*	*0.96*	*0.91*
	0.00	*0.43*	*0.05*	*0.00*	*0.00*	*0.33*	*0.58*	*0.48*
$\hat{w}_{KZ3,t}$	0.0529	0.2034	−0.1116	0.2653	0.2448	−0.0598	0.0852	0.0533
	0.00	*0.34*	*0.00*	*0.97*	*0.50*	*0.09*	*0.84*	*0.13*
	0.00	*0.01*	*0.00*	*0.92*	*0.10*	*0.00*	*0.17*	*0.00*
	0.00	*0.13*	*0.00*	*0.91*	*0.29*	*0.00*	*0.19*	*0.00*
	0.00	*0.77*	*0.00*	*0.32*	*0.66*	*0.00*	*0.05*	*0.00*
				Non-Optimization Rules				
$1/N$	0.1345	0.1601	0.1274	0.1518	0.1209	0.1142	0.1536	0.1683
	0.01	*0.12*	*0.05*	*0.13*	*0.05*	*0.74*	*0.90*	*0.99*
	0.00	*0.01*	*0.02*	*0.08*	*0.01*	*0.01*	*0.84*	*0.94*
	0.01	*0.06*	*0.04*	*0.09*	*0.03*	*0.02*	*0.83*	*0.78*
	0.00	*0.25*	*0.00*	*0.00*	*0.00*	*0.04*	*0.39*	*0.48*
KO_{VT}	0.1566	0.1739	0.1803	0.1861	0.1526	0.1809	0.1791	0.1794
	0.04	*0.19*	*0.31*	*0.28*	*0.10*	*0.92*	*0.97*	*1.00*
	0.01	*0.03*	*0.19*	*0.19*	*0.03*	*0.05*	*0.95*	*0.99*
	0.02	*0.10*	*0.28*	*0.21*	*0.06*	*0.06*	*0.94*	*0.94*
	0.00	*0.43*	*0.02*	*0.00*	*0.00*	*0.16*	*0.59*	*0.60*
KO_{RT}	0.1832	0.1807	0.1646	0.1940	0.1797	0.2134	0.1579	0.1469
	0.10	*0.23*	*0.18*	*0.32*	*0.17*	*0.96*	*0.95*	*0.99*
	0.04	*0.04*	*0.10*	*0.22*	*0.05*	*0.08*	*0.91*	*0.86*
	0.07	*0.12*	*0.16*	*0.24*	*0.11*	*0.11*	*0.90*	*0.59*
	0.07	*0.57*	*0.01*	*0.00*	*0.02*	*0.37*	*0.41*	*0.29*
KO_{BT}	0.1910	0.1813	0.1415	0.1716	0.1649	0.1997	0.1453	0.1449
	0.14	*0.23*	*0.08*	*0.20*	*0.13*	*0.94*	*0.87*	*0.98*
	0.06	*0.04*	*0.04*	*0.13*	*0.04*	*0.07*	*0.79*	*0.82*
	0.10	*0.13*	*0.07*	*0.15*	*0.08*	*0.09*	*0.78*	*0.56*
	0.14	*0.58*	*0.00*	*0.00*	*0.01*	*0.28*	*0.33*	*0.29*

Table IA.17: Sharpe Ratio Comparison with 20 bps Transaction Costs: $h = 120$ and $\gamma = 5$

This table reports the Sharpe ratio of the portfolios studied in this paper with $h = 120$, $\gamma = 5$, and a transaction cost of 20 bps, based on the eight datasets containing excess monthly returns. The four newly obtained optimal combining portfolios, i.e., $\hat{w}_{q,t}$, $\hat{w}_{q,t}^{LW2004}$, $\hat{w}_{q,t}^{LW2017}$, and $\hat{w}_{q,t}^{MP}$, are highlighted with a box around. In the three categories to which the four new portfolios belong, one-sided tests are conducted to assess the value of using the newly derived optimal combining coefficient $\hat{c}_t$, and the p-values are reported in *italics*. For the portfolios in the remaining three categories, one-sided tests are conducted to compare them with the four newly obtained portfolios, and the corresponding p-values are reported in the four rows below the portfolio Sharpe ratio. We set $\eta = 4$ for the timing strategies KO_{VT}, KO_{RT}, and KO_{BT}.

	Momentum $N = 10$	Size-B/M $N = 25$	IVOL $N = 10$	OP-Inv $N = 25$	NM-V (LT) $N = 16$	NM-V (All) $N = 46$	Industry $N = 49$	Stocks $N = 100$
w^*	0.2817	0.3328	0.2471	0.3757	0.3827	0.7496	0.3442	0.3748
				Invariant Optimal Portfolio Rules				
$\boxed{\hat{w}_{q,t}}$	0.2376	0.2028	0.2196	0.1636	0.1879	0.4521	0.0814	−0.0725
$\hat{w}_{p,t}$	0.2138	0.1074	0.1989	0.0850	0.1307	−0.0172	−0.0861	−0.1420
	0.01	*0.00*	*0.01*	*0.00*	*0.01*	*0.00*	*0.00*	*0.11*
$\hat{w}_{u,t}$	0.2190	0.1305	0.2029	0.1029	0.1419	0.2254	−0.0052	−0.0751
	0.03	*0.00*	*0.03*	*0.01*	*0.01*	*0.00*	*0.02*	*0.48*
$\hat{w}_{BS,t}$	0.2357	0.1739	0.2169	0.1388	0.1743	0.3830	0.0350	−0.1688
	0.25	*0.00*	*0.17*	*0.05*	*0.08*	*0.00*	*0.08*	*0.01*
				Rules with Shrinkage Covariance Matrix Estimators				
$\boxed{\hat{w}_{q,t}^{LW2004}}$	0.2567	0.2485	0.2281	0.2077	0.2335	0.6524	0.1460	0.0775
$\hat{w}_{p,t}^{LW2004}$	0.2443	0.1981	0.2169	0.1423	0.1909	0.5440	0.0160	−0.1239
	0.13	*0.01*	*0.13*	*0.01*	*0.05*	*0.00*	*0.00*	*0.00*
$\boxed{\hat{w}_{q,t}^{LW2017}}$	0.2490	0.2418	0.2246	0.2130	0.2072	0.6369	0.1574	0.1170
$\hat{w}_{p,t}^{LW2017}$	0.2314	0.1739	0.2095	0.1498	0.1534	0.5355	0.0256	−0.0687
	0.05	*0.00*	*0.06*	*0.02*	*0.01*	*0.00*	*0.00*	*0.00*
				Rules with MacKinlay-Pástor Single Factor Structure				
$\boxed{\hat{w}_{q,t}^{MP}}$	0.1653	0.1357	0.1628	0.2175	0.1379	0.2329	0.1609	0.1742
$\hat{w}_{p,t}^{MP}$	0.1651	0.1283	0.1215	0.1352	0.0894	0.1444	0.1392	0.1133
	0.49	*0.38*	*0.01*	*0.01*	*0.01*	*0.01*	*0.26*	*0.07*
				Rule with No-Short-Sale Constraints				
$\hat{w}_{p,t}^{NS}$	0.1876	0.1672	0.1384	0.1574	0.1578	0.2393	0.1195	0.1006
	0.05	*0.16*	*0.01*	*0.44*	*0.26*	*0.00*	*0.80*	*1.00*
	0.00	*0.00*	*0.00*	*0.09*	*0.02*	*0.00*	*0.24*	*0.72*
	0.02	*0.01*	*0.00*	*0.08*	*0.13*	*0.00*	*0.16*	*0.33*
	0.84	*0.85*	*0.14*	*0.05*	*0.73*	*0.55*	*0.20*	*0.06*

Table IA.17: Sharpe Ratio Comparison with 20 bps Transaction Costs: $h = 120$ and $\gamma = 5$ (Cont'd)

	Momentum $N = 10$	Size-B/M $N = 25$	IVOL $N = 10$	OP-Inv $N = 25$	NM-V (LT) $N = 16$	NM-V (All) $N = 46$	Industry $N = 49$	Stocks $N = 100$
				Other Rules from Portfolio Optimization				
$\hat{w}_{g,t}$	0.1696	0.1702	0.0942	0.1554	0.1597	0.0681	0.0816	−0.0641
	0.01	*0.12*	*0.00*	*0.39*	*0.23*	*0.00*	*0.50*	*0.96*
	0.00	*0.00*	*0.00*	*0.01*	*0.01*	*0.00*	*0.00*	*0.00*
	0.00	*0.00*	*0.00*	*0.01*	*0.09*	*0.00*	*0.00*	*0.00*
	0.60	*0.91*	*0.00*	*0.00*	*0.79*	*0.00*	*0.02*	*0.00*
$\hat{w}^{NS}_{g,t}$	0.1414	0.1563	0.1634	0.1778	0.1211	0.2167	0.1675	0.1209
	0.00	*0.10*	*0.04*	*0.63*	*0.08*	*0.00*	*0.99*	*1.00*
	0.00	*0.00*	*0.01*	*0.20*	*0.00*	*0.00*	*0.78*	*0.95*
	0.00	*0.00*	*0.03*	*0.18*	*0.03*	*0.00*	*0.64*	*0.57*
	0.11	*0.79*	*0.51*	*0.10*	*0.24*	*0.34*	*0.58*	*0.04*
$\hat{w}_{KZ3,t}$	−0.0185	−0.0531	−0.0790	−0.0386	−0.0778	−0.2694	−0.0509	−0.0435
	0.00	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.01*	*0.70*
	0.00	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.02*
	0.00	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*
	0.00	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*
				Non-Optimization Rules				
$1/N$	0.1269	0.1477	0.1217	0.1418	0.1202	0.1026	0.1512	0.1175
	0.00	*0.08*	*0.00*	*0.32*	*0.10*	*0.00*	*0.92*	*1.00*
	0.00	*0.00*	*0.00*	*0.06*	*0.00*	*0.00*	*0.55*	*0.87*
	0.00	*0.01*	*0.00*	*0.05*	*0.04*	*0.00*	*0.44*	*0.51*
	0.07	*0.63*	*0.08*	*0.02*	*0.30*	*0.01*	*0.41*	*0.07*
KO_{VT}	0.1453	0.1622	0.1610	0.1687	0.1323	0.1732	0.1875	0.1544
	0.00	*0.14*	*0.04*	*0.55*	*0.13*	*0.00*	*1.00*	*1.00*
	0.00	*0.00*	*0.01*	*0.15*	*0.00*	*0.00*	*0.91*	*1.00*
	0.00	*0.01*	*0.03*	*0.14*	*0.05*	*0.00*	*0.83*	*0.94*
	0.16	*0.83*	*0.47*	*0.07*	*0.42*	*0.10*	*0.77*	*0.23*
KO_{RT}	0.1664	0.1622	0.1402	0.1718	0.1629	0.2008	0.1469	0.1004
	0.01	*0.14*	*0.01*	*0.58*	*0.30*	*0.00*	*0.94*	*1.00*
	0.00	*0.00*	*0.00*	*0.16*	*0.03*	*0.00*	*0.51*	*0.75*
	0.00	*0.01*	*0.01*	*0.14*	*0.16*	*0.00*	*0.38*	*0.29*
	0.52	*0.79*	*0.19*	*0.09*	*0.77*	*0.25*	*0.37*	*0.02*
KO_{BT}	0.1733	0.1658	0.1259	0.1691	0.1723	0.1840	0.1554	0.1221
	0.02	*0.17*	*0.01*	*0.55*	*0.38*	*0.00*	*0.94*	*1.00*
	0.00	*0.00*	*0.00*	*0.16*	*0.06*	*0.00*	*0.59*	*0.89*
	0.01	*0.02*	*0.00*	*0.15*	*0.23*	*0.00*	*0.48*	*0.56*
	0.66	*0.81*	*0.10*	*0.09*	*0.85*	*0.16*	*0.45*	*0.08*

Table IA.18: Sharpe Ratio Comparison with 20 bps Transaction Costs: $h = 240$ and $\gamma = 5$

This table reports the Sharpe ratio of the portfolios studied in this paper with $h = 240$, $\gamma = 5$, and a transaction cost of 20 bps, based on the eight datasets containing excess monthly returns. The four newly obtained optimal combining portfolios, i.e., $\hat{w}_{q,t}$, $\hat{w}_{q,t}^{LW2004}$, $\hat{w}_{q,t}^{LW2017}$, and $\hat{w}_{q,t}^{MP}$, are highlighted with a box around. In the three categories to which the four new portfolios belong, one-sided tests are conducted to assess the value of using the newly derived optimal combining coefficient $\hat{c}_t$, and the p-values are reported in *italics*. For the portfolios in the remaining three categories, one-sided tests are conducted to compare them with the four newly obtained portfolios, and the corresponding p-values are reported in the four rows below the portfolio Sharpe ratio. We set $\eta = 4$ for the timing strategies KO_{VT}, KO_{RT}, and KO_{BT}.

	Momentum $N = 10$	Size-B/M $N = 25$	IVOL $N = 10$	OP-Inv $N = 25$	NM-V (LT) $N = 16$	NM-V (All) $N = 46$	Industry $N = 49$	Stocks $N = 100$
w^*	0.3007	0.3600	0.3116	0.3882	0.4005	0.6389	0.4036	0.4380
				Invariant Optimal Portfolio Rules				
$\boxed{\hat{w}_{q,t}}$	0.2609	0.2528	0.2229	0.2559	0.2873	0.2962	0.0900	0.0623
$\hat{w}_{p,t}$	0.2442	0.2053	0.2075	0.1768	0.2386	0.0531	−0.0332	−0.1344
	0.01	*0.00*	*0.02*	*0.00*	*0.00*	*0.00*	*0.01*	*0.00*
$\hat{w}_{u,t}$	0.2469	0.2157	0.2095	0.1860	0.2451	0.1596	0.0059	−0.0939
	0.02	*0.00*	*0.03*	*0.00*	*0.00*	*0.00*	*0.03*	*0.00*
$\hat{w}_{BS,t}$	0.2598	0.2434	0.2212	0.2273	0.2766	0.2453	0.0428	−0.0241
	0.25	*0.05*	*0.18*	*0.00*	*0.03*	*0.00*	*0.07*	*0.01*
				Rules with Shrinkage Covariance Matrix Estimators				
$\boxed{\hat{w}_{q,t}^{LW2004}}$	0.2739	0.2813	0.2305	0.2667	0.3193	0.4233	0.1171	0.1102
$\hat{w}_{p,t}^{LW2004}$	0.2633	0.2494	0.2209	0.1910	0.2737	0.1080	−0.0034	−0.0917
	0.07	*0.02*	*0.10*	*0.00*	*0.00*	*0.00*	*0.01*	*0.00*
$\boxed{\hat{w}_{q,t}^{LW2017}}$	0.2677	0.2674	0.2250	0.2662	0.3026	0.3894	0.1212	0.1407
$\hat{w}_{p,t}^{LW2017}$	0.2532	0.2262	0.2112	0.1907	0.2546	0.2607	−0.0090	−0.0672
	0.02	*0.00*	*0.03*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*
				Rules with MacKinlay-Pástor Single Factor Structure				
$\boxed{\hat{w}_{q,t}^{MP}}$	0.2122	0.1642	0.2168	0.2883	0.2522	0.2355	0.1649	0.1702
$\hat{w}_{p,t}^{MP}$	0.2027	0.1754	0.1794	0.2274	0.2108	0.2195	0.1600	0.1726
	0.14	*0.71*	*0.02*	*0.01*	*0.00*	*0.28*	*0.45*	*0.52*
				Rule with No-Short-Sale Constraints				
$\hat{w}_{p,t}^{NS}$	0.2036	0.1731	0.1634	0.1910	0.1788	0.1934	0.0985	0.1369
	0.04	*0.02*	*0.04*	*0.09*	*0.04*	*0.13*	*0.57*	*0.96*
	0.01	*0.00*	*0.01*	*0.05*	*0.01*	*0.01*	*0.33*	*0.74*
	0.03	*0.01*	*0.03*	*0.05*	*0.02*	*0.02*	*0.30*	*0.46*
	0.35	*0.62*	*0.01*	*0.00*	*0.01*	*0.28*	*0.09*	*0.25*

Table IA.18: Sharpe Ratio Comparison with 20 bps Transaction Costs: $h = 240$ and $\gamma = 5$ (Cont'd)

	Momentum $N = 10$	Size-B/M $N = 25$	IVOL $N = 10$	OP-Inv $N = 25$	NM-V (LT) $N = 16$	NM-V (All) $N = 46$	Industry $N = 49$	Stocks $N = 100$
				Other Rules from Portfolio Optimization				
$\hat{w}_{g,t}$	0.1917	0.2248	0.1265	0.2526	0.2423	0.2386	0.0951	0.0657
	0.02	*0.19*	*0.01*	*0.46*	*0.19*	*0.25*	*0.57*	*0.89*
	0.01	*0.02*	*0.00*	*0.34*	*0.05*	*0.01*	*0.20*	*0.00*
	0.01	*0.09*	*0.01*	*0.35*	*0.12*	*0.04*	*0.18*	*0.00*
	0.10	*0.99*	*0.00*	*0.04*	*0.36*	*0.52*	*0.07*	*0.00*
$\hat{w}^{NS}_{g,t}$	0.1537	0.1741	0.1873	0.2041	0.1608	0.2106	0.1767	0.1694
	0.00	*0.02*	*0.15*	*0.15*	*0.02*	*0.17*	*0.98*	*1.00*
	0.00	*0.00*	*0.09*	*0.09*	*0.00*	*0.01*	*0.94*	*0.99*
	0.00	*0.01*	*0.14*	*0.10*	*0.01*	*0.02*	*0.93*	*0.90*
	0.00	*0.68*	*0.07*	*0.01*	*0.00*	*0.33*	*0.61*	*0.49*
$\hat{w}_{KZ3,t}$	0.0529	0.2034	−0.1116	0.2653	0.2448	−0.0598	0.0852	0.0533
	0.00	*0.01*	*0.00*	*0.74*	*0.08*	*0.00*	*0.34*	*0.08*
	0.00	*0.00*	*0.00*	*0.46*	*0.01*	*0.00*	*0.02*	*0.00*
	0.00	*0.00*	*0.00*	*0.48*	*0.03*	*0.00*	*0.02*	*0.00*
	0.00	*0.85*	*0.00*	*0.24*	*0.45*	*0.00*	*0.07*	*0.00*
				Non-Optimization Rules				
$1/N$	0.1345	0.1601	0.1274	0.1518	0.1209	0.1142	0.1536	0.1683
	0.00	*0.01*	*0.01*	*0.03*	*0.01*	*0.03*	*0.87*	*0.99*
	0.00	*0.00*	*0.00*	*0.02*	*0.00*	*0.00*	*0.75*	*0.93*
	0.00	*0.00*	*0.01*	*0.02*	*0.00*	*0.00*	*0.73*	*0.77*
	0.00	*0.45*	*0.00*	*0.00*	*0.00*	*0.07*	*0.42*	*0.49*
KO_{VT}	0.1566	0.1739	0.1803	0.1861	0.1526	0.1809	0.1791	0.1794
	0.00	*0.03*	*0.12*	*0.09*	*0.02*	*0.11*	*0.97*	*1.00*
	0.00	*0.00*	*0.06*	*0.05*	*0.00*	*0.01*	*0.92*	*0.99*
	0.00	*0.01*	*0.10*	*0.06*	*0.01*	*0.01*	*0.90*	*0.93*
	0.00	*0.65*	*0.05*	*0.00*	*0.00*	*0.21*	*0.62*	*0.61*
KO_{RT}	0.1832	0.1807	0.1646	0.1940	0.1797	0.2134	0.1579	0.1469
	0.01	*0.03*	*0.05*	*0.11*	*0.04*	*0.19*	*0.93*	*0.98*
	0.00	*0.00*	*0.02*	*0.06*	*0.01*	*0.01*	*0.84*	*0.85*
	0.01	*0.01*	*0.04*	*0.07*	*0.02*	*0.03*	*0.82*	*0.57*
	0.06	*0.72*	*0.02*	*0.01*	*0.00*	*0.37*	*0.44*	*0.29*
KO_{BT}	0.1910	0.1813	0.1415	0.1716	0.1649	0.1997	0.1453	0.1449
	0.02	*0.04*	*0.02*	*0.06*	*0.03*	*0.16*	*0.83*	*0.97*
	0.01	*0.00*	*0.01*	*0.03*	*0.00*	*0.01*	*0.70*	*0.81*
	0.01	*0.01*	*0.02*	*0.04*	*0.01*	*0.02*	*0.67*	*0.55*
	0.12	*0.71*	*0.01*	*0.00*	*0.00*	*0.30*	*0.36*	*0.30*

Table IA.19: CER Comparison with 10 bps Transaction Costs: $h = 120$ and $\gamma = 3$

This table reports the CER of the portfolios studied in this paper with $h = 120$, $\gamma = 3$, and a transaction cost of 10 bps, based on the eight datasets containing excess monthly returns. The four newly obtained optimal combining portfolios, i.e., $\hat{w}_{q,t}$, $\hat{w}_{q,t}^{LW2004}$, $\hat{w}_{q,t}^{LW2017}$, and $\hat{w}_{q,t}^{MP}$, are highlighted with a box around. In the three categories to which the four new portfolios belong, one-sided tests are conducted to assess the value of using the newly derived optimal combining coefficient $\hat{c}_t$, and the p-values are reported in *italics*. For the portfolios in the remaining three categories, one-sided tests are conducted to compare them with the four newly obtained portfolios, and the corresponding p-values are reported in the four rows below the portfolio CER. We set $\eta = 4$ for the timing strategies KO_{VT}, KO_{RT}, and KO_{BT}.

	Momentum $N = 10$	Size-B/M $N = 25$	IVOL $N = 10$	OP-Inv $N = 25$	NM-V (LT) $N = 16$	NM-V (All) $N = 46$	Industry $N = 49$	Stocks $N = 100$
w^*	0.0125	0.0176	0.0101	0.0226	0.0235	0.0944	0.0188	0.0252
				Invariant Optimal Portfolio Rules				
$\boxed{\hat{w}_{q,t}}$	0.0078	0.0067	0.0036	0.0041	0.0053	0.0010	0.0009	−0.0108
$\hat{w}_{p,t}$	−0.0113	−1.4146	−0.0211	−0.0892	−0.0374	−5.6637	−0.7202	−177.9997
	0.00	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*
$\hat{w}_{u,t}$	−0.0056	−0.0434	−0.0150	−0.0462	−0.0228	−1.7916	−0.3289	−2.7185
	0.00	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*
$\hat{w}_{BS,t}$	0.0064	−0.0037	0.0013	−0.0058	0.0007	−0.2307	−0.0265	−0.1632
	0.00	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*
				Rules with Shrinkage Covariance Matrix Estimators				
$\boxed{\hat{w}_{q,t}^{LW2004}}$	0.0110	0.0099	0.0090	0.0072	0.0090	0.0652	0.0036	0.0014
$\hat{w}_{p,t}^{LW2004}$	0.0046	−0.0076	0.0022	−0.0292	−0.0022	−0.1444	−0.1424	−5.0378
	0.00	*0.00*	*0.00*	*0.00*	*0.01*	*0.00*	*0.00*	*0.00*
$\boxed{\hat{w}_{q,t}^{LW2017}}$	0.0096	0.0102	0.0060	0.0076	0.0073	0.0696	0.0040	0.0026
$\hat{w}_{p,t}^{LW2017}$	−0.0048	−0.0327	−0.0120	−0.0357	−0.0207	−0.8689	−0.2050	−0.3251
	0.00	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*
				Rules with MacKinlay-Pástor Single Factor Structure				
$\boxed{\hat{w}_{q,t}^{MP}}$	0.0046	0.0034	0.0034	0.0061	0.0028	0.0064	0.0042	0.0048
$\hat{w}_{p,t}^{MP}$	0.0036	−0.0005	−0.0012	−0.0018	−0.0020	−0.0015	0.0011	−0.0031
	0.13	*0.02*	*0.00*	*0.00*	*0.00*	*0.00*	*0.08*	*0.00*
				Rule with No-Short-Sale Constraints				
$\hat{w}_{p,t}^{NS}$	0.0059	0.0047	0.0026	0.0043	0.0047	0.0090	0.0001	−0.0003
	0.27	*0.25*	*0.40*	*0.53*	*0.43*	*0.65*	*0.37*	*1.00*
	0.01	*0.00*	*0.00*	*0.10*	*0.04*	*0.00*	*0.06*	*0.24*
	0.10	*0.01*	*0.17*	*0.09*	*0.21*	*0.00*	*0.05*	*0.10*
	0.86	*0.81*	*0.21*	*0.14*	*0.86*	*0.87*	*0.07*	*0.03*

Table IA.19: CER Comparison with 10 bps Transactions Costs: $h = 120$ and $\gamma = 3$ (Cont'd)

	Momentum $N = 10$	Size-B/M $N = 25$	IVOL $N = 10$	OP-Inv $N = 25$	NM-V (LT) $N = 16$	NM-V (All) $N = 46$	Industry $N = 49$	Stocks $N = 100$
				Other Rules from Portfolio Optimization				
$\hat{w}_{g,t}$	0.0048	0.0052	0.0017	0.0044	0.0045	0.0019	0.0017	−0.0094
	0.18	*0.28*	*0.33*	*0.56*	*0.40*	*0.52*	*0.70*	*0.99*
	0.00	*0.00*	*0.00*	*0.06*	*0.02*	*0.00*	*0.03*	*0.00*
	0.06	*0.01*	*0.13*	*0.05*	*0.17*	*0.00*	*0.02*	*0.00*
	0.60	*0.96*	*0.03*	*0.03*	*0.92*	*0.01*	*0.05*	*0.00*
$\hat{w}_{g,t}^{NS}$	0.0034	0.0040	0.0040	0.0048	0.0025	0.0059	0.0041	0.0025
	0.10	*0.18*	*0.54*	*0.60*	*0.23*	*0.59*	*0.95*	*1.00*
	0.00	*0.00*	*0.02*	*0.14*	*0.00*	*0.00*	*0.65*	*0.89*
	0.03	*0.00*	*0.30*	*0.13*	*0.07*	*0.00*	*0.53*	*0.45*
	0.09	*0.72*	*0.78*	*0.14*	*0.35*	*0.34*	*0.47*	*0.02*
$\hat{w}_{KZ3,t}$	−0.7290	−0.0535	−1.8834	−0.0765	−0.9672	−2.6787	−0.1287	−60.8810
	0.00	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*
	0.00	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*
	0.00	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*
	0.00	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*
				Non-Optimization Rules				
$1/N$	0.0026	0.0036	0.0022	0.0034	0.0022	0.0013	0.0038	0.0023
	0.07	*0.16*	*0.37*	*0.42*	*0.22*	*0.50*	*0.88*	*1.00*
	0.00	*0.00*	*0.01*	*0.06*	*0.01*	*0.00*	*0.54*	*0.75*
	0.02	*0.01*	*0.16*	*0.06*	*0.08*	*0.00*	*0.46*	*0.41*
	0.06	*0.55*	*0.18*	*0.04*	*0.34*	*0.01*	*0.42*	*0.07*
KO_{VT}	0.0035	0.0043	0.0041	0.0045	0.0029	0.0046	0.0048	0.0037
	0.10	*0.21*	*0.55*	*0.55*	*0.27*	*0.57*	*0.98*	*1.00*
	0.00	*0.00*	*0.02*	*0.12*	*0.01*	*0.00*	*0.83*	*0.98*
	0.03	*0.01*	*0.30*	*0.11*	*0.10*	*0.00*	*0.74*	*0.89*
	0.13	*0.78*	*0.78*	*0.09*	*0.54*	*0.12*	*0.69*	*0.13*
KO_{RT}	0.0046	0.0045	0.0034	0.0048	0.0045	0.0060	0.0037	0.0017
	0.16	*0.23*	*0.48*	*0.59*	*0.42*	*0.60*	*0.91*	*1.00*
	0.00	*0.00*	*0.01*	*0.13*	*0.03*	*0.00*	*0.51*	*0.59*
	0.05	*0.01*	*0.24*	*0.12*	*0.20*	*0.00*	*0.41*	*0.23*
	0.51	*0.76*	*0.48*	*0.16*	*0.86*	*0.42*	*0.38*	*0.02*
KO_{BT}	0.0049	0.0046	0.0026	0.0046	0.0049	0.0053	0.0040	0.0026
	0.19	*0.25*	*0.40*	*0.57*	*0.46*	*0.58*	*0.90*	*1.00*
	0.00	*0.00*	*0.01*	*0.13*	*0.05*	*0.00*	*0.58*	*0.79*
	0.06	*0.01*	*0.19*	*0.12*	*0.25*	*0.00*	*0.51*	*0.49*
	0.64	*0.78*	*0.25*	*0.14*	*0.92*	*0.26*	*0.46*	*0.08*

Table IA.20: CER Comparison with 10 bps Transaction Costs: $h = 240$ and $\gamma = 3$

This table reports the CER of the portfolios studied in this paper with $h = 240$, $\gamma = 3$, and a transaction cost of 10 bps, based on the eight datasets containing excess monthly returns. The four newly obtained optimal combining portfolios, i.e., $\hat{w}_{q,t}$, $\hat{w}_{q,t}^{LW2004}$, $\hat{w}_{q,t}^{LW2017}$, and $\hat{w}_{q,t}^{MP}$, are highlighted with a box around. In the three categories to which the four new portfolios belong, one-sided tests are conducted to assess the value of using the newly derived optimal combining coefficient $\hat{c}_t$, and the p-values are reported in *italics*. For the portfolios in the remaining three categories, one-sided tests are conducted to compare them with the four newly obtained portfolios, and the corresponding p-values are reported in the four rows below the portfolio CER. We set $\eta = 4$ for the timing strategies KO_{VT}, KO_{RT}, and KO_{BT}.

	Momentum $N = 10$	Size-B/M $N = 25$	IVOL $N = 10$	OP-Inv $N = 25$	NM-V (LT) $N = 16$	NM-V (All) $N = 46$	Industry $N = 49$	Stocks $N = 100$
w^*	0.0139	0.0200	0.0158	0.0229	0.0240	0.0678	0.0262	0.0334
				Invariant Optimal Portfolio Rules				
$\boxed{\hat{w}_{q,t}}$	0.0094	0.0094	0.0036	0.0094	0.0120	−0.3717	0.0009	0.0006
$\hat{w}_{p,t}$	0.0007	−0.0166	−0.0081	−0.0243	−0.0050	−0.6494	−0.1155	−0.3305
	0.00	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*
$\hat{w}_{u,t}$	0.0025	−0.0453	−0.0054	−0.0155	−0.0011	−0.4031	−0.0830	−0.1061
	0.00	*0.00*	*0.00*	*0.00*	*0.00*	*0.27*	*0.00*	*0.00*
$\hat{w}_{BS,t}$	0.0089	0.0066	0.0029	0.0044	0.0101	−0.3243	−0.0146	−0.0142
	0.03	*0.00*	*0.01*	*0.00*	*0.02*	*0.85*	*0.00*	*0.00*
				Rules with Shrinkage Covariance Matrix Estimators				
$\boxed{\hat{w}_{q,t}^{LW2004}}$	0.0114	0.0118	0.0075	0.0101	0.0143	−0.0070	0.0019	0.0024
$\hat{w}_{p,t}^{LW2004}$	0.0067	0.0036	0.0022	−0.0132	0.0074	−0.2111	−0.2137	−0.1452
	0.00	*0.00*	*0.00*	*0.00*	*0.02*	*0.00*	*0.00*	*0.00*
$\boxed{\hat{w}_{q,t}^{LW2017}}$	0.0102	0.0108	0.0045	0.0101	0.0134	−0.0425	0.0020	0.0034
$\hat{w}_{p,t}^{LW2017}$	0.0024	−0.0088	−0.0197	−0.0170	0.0002	−0.4729	−0.4427	−0.0854
	0.00	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*
				Rules with MacKinlay-Pástor Single Factor Structure				
$\boxed{\hat{w}_{q,t}^{MP}}$	0.0063	0.0049	0.0060	0.0085	0.0065	0.0061	0.0043	0.0047
$\hat{w}_{p,t}^{MP}$	0.0048	0.0028	0.0022	0.0028	0.0035	0.0029	0.0023	0.0013
	0.01	*0.08*	*0.00*	*0.00*	*0.00*	*0.02*	*0.19*	*0.14*
				Rule with No-Short-Sale Constraints				
$\hat{w}_{p,t}^{NS}$	0.0067	0.0052	0.0033	0.0051	0.0049	0.0060	0.0004	0.0027
	0.22	*0.10*	*0.47*	*0.12*	*0.09*	*1.00*	*0.43*	*0.83*
	0.06	*0.00*	*0.09*	*0.06*	*0.01*	*0.72*	*0.25*	*0.55*
	0.16	*0.03*	*0.38*	*0.07*	*0.04*	*0.96*	*0.24*	*0.35*
	0.64	*0.60*	*0.00*	*0.01*	*0.10*	*0.48*	*0.04*	*0.20*

Table IA.20: CER Comparison with 10 bps Transactions Costs: $h = 240$ and $\gamma = 3$ (Cont'd)

	Momentum $N=10$	Size-B/M $N=25$	IVOL $N=10$	OP-Inv $N=25$	NM-V (LT) $N=16$	NM-V (All) $N=46$	Industry $N=49$	Stocks $N=100$
				Other Rules from Portfolio Optimization				
$\hat{w}_{g,t}$	0.0055	0.0066	0.0027	0.0079	0.0072	0.0077	0.0019	0.0008
	0.14	*0.18*	*0.42*	*0.32*	*0.17*	*1.00*	*0.71*	*0.88*
	0.03	*0.01*	*0.08*	*0.21*	*0.03*	*0.75*	*0.48*	*0.00*
	0.09	*0.07*	*0.34*	*0.23*	*0.09*	*0.97*	*0.47*	*0.00*
	0.14	*0.97*	*0.00*	*0.17*	*0.72*	*0.76*	*0.07*	*0.01*
$\hat{w}^{NS}_{g,t}$	0.0039	0.0046	0.0047	0.0058	0.0042	0.0056	0.0043	0.0041
	0.07	*0.07*	*0.60*	*0.17*	*0.08*	*1.00*	*0.95*	*1.00*
	0.01	*0.00*	*0.19*	*0.09*	*0.01*	*0.72*	*0.91*	*0.96*
	0.04	*0.02*	*0.52*	*0.11*	*0.04*	*0.96*	*0.91*	*0.83*
	0.00	*0.32*	*0.02*	*0.00*	*0.00*	*0.36*	*0.48*	*0.33*
$\hat{w}_{KZ3,t}$	−0.0782	0.0081	−2.1757	0.0101	0.0121	−16.4941	0.0015	0.0003
	0.00	*0.28*	*0.00*	*0.64*	*0.52*	*0.00*	*0.90*	*0.16*
	0.00	*0.01*	*0.00*	*0.49*	*0.19*	*0.00*	*0.23*	*0.00*
	0.00	*0.09*	*0.00*	*0.50*	*0.32*	*0.00*	*0.26*	*0.00*
	0.00	*0.96*	*0.00*	*0.84*	*0.92*	*0.00*	*0.09*	*0.01*
				Non-Optimization Rules				
$1/N$	0.0030	0.0042	0.0026	0.0038	0.0023	0.0018	0.0039	0.0044
	0.05	*0.07*	*0.41*	*0.08*	*0.05*	*1.00*	*0.86*	*0.98*
	0.01	*0.00*	*0.08*	*0.04*	*0.01*	*0.65*	*0.79*	*0.90*
	0.03	*0.02*	*0.33*	*0.05*	*0.02*	*0.94*	*0.78*	*0.76*
	0.00	*0.27*	*0.00*	*0.00*	*0.00*	*0.08*	*0.42*	*0.44*
KO_{VT}	0.0039	0.0047	0.0046	0.0051	0.0039	0.0049	0.0045	0.0044
	0.07	*0.08*	*0.60*	*0.13*	*0.07*	*1.00*	*0.94*	*1.00*
	0.01	*0.00*	*0.19*	*0.07*	*0.01*	*0.70*	*0.90*	*0.97*
	0.05	*0.03*	*0.51*	*0.08*	*0.03*	*0.96*	*0.90*	*0.87*
	0.00	*0.38*	*0.02*	*0.00*	*0.00*	*0.24*	*0.53*	*0.40*
KO_{RT}	0.0052	0.0051	0.0042	0.0054	0.0051	0.0063	0.0038	0.0035
	0.12	*0.10*	*0.56*	*0.14*	*0.10*	*1.00*	*0.92*	*0.96*
	0.02	*0.00*	*0.15*	*0.07*	*0.01*	*0.73*	*0.86*	*0.79*
	0.08	*0.03*	*0.47*	*0.09*	*0.05*	*0.96*	*0.85*	*0.55*
	0.05	*0.58*	*0.01*	*0.00*	*0.04*	*0.53*	*0.37*	*0.25*
KO_{BT}	0.0055	0.0053	0.0034	0.0046	0.0045	0.0059	0.0035	0.0035
	0.14	*0.11*	*0.48*	*0.11*	*0.09*	*1.00*	*0.83*	*0.95*
	0.03	*0.00*	*0.11*	*0.05*	*0.01*	*0.72*	*0.74*	*0.76*
	0.09	*0.04*	*0.39*	*0.07*	*0.04*	*0.96*	*0.73*	*0.54*
	0.10	*0.62*	*0.01*	*0.00*	*0.03*	*0.46*	*0.36*	*0.27*

Table IA.21: CER Comparison with 10 bps Transaction Costs: $h = 120$ and $\gamma = 5$

This table reports the CER of the portfolios studied in this paper with $h = 120$, $\gamma = 5$, and a transaction cost of 10 bps, based on the eight datasets containing excess monthly returns. The four newly obtained optimal combining portfolios, i.e., $\hat{w}_{q,t}$, $\hat{w}_{q,t}^{LW2004}$, $\hat{w}_{q,t}^{LW2017}$, and $\hat{w}_{q,t}^{MP}$, are highlighted with a box around. In the three categories to which the four new portfolios belong, one-sided tests are conducted to assess the value of using the newly derived optimal combining coefficient $\hat{c}_t$, and the p-values are reported in *italics*. For the portfolios in the remaining three categories, one-sided tests are conducted to compare them with the four newly obtained portfolios, and the corresponding p-values are reported in the four rows below the portfolio CER. We set $\eta = 4$ for the timing strategies KO_{VT}, KO_{RT}, and KO_{BT}.

	Momentum $N = 10$	Size-B/M $N = 25$	IVOL $N = 10$	OP-Inv $N = 25$	NM-V (LT) $N = 16$	NM-V (All) $N = 46$	Industry $N = 49$	Stocks $N = 100$
w^*	0.0082	0.0119	0.0063	0.0148	0.0156	0.0640	0.0126	0.0160
				Invariant Optimal Portfolio Rules				
$\boxed{\hat{w}_{q,t}}$	0.0051	0.0049	0.0024	0.0025	0.0038	0.0060	−0.0003	−0.0158
$\hat{w}_{p,t}$	−0.0058	−0.0464	−0.0114	−0.0491	−0.0209	−16.7665	−0.3032	−208.9235
	0.00	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*
$\hat{w}_{u,t}$	−0.0025	−0.0225	−0.0071	−0.0264	−0.0126	−0.2972	−0.0855	−12.8386
	0.00	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*
$\hat{w}_{BS,t}$	0.0043	−0.0008	0.0012	−0.0032	0.0011	−0.1031	−0.0162	−0.0916
	0.01	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*
				Rules with Shrinkage Covariance Matrix Estimators				
$\boxed{\hat{w}_{q,t}^{2004}}$	0.0070	0.0069	0.0052	0.0050	0.0061	0.0406	0.0025	0.0000
$\hat{w}_{p,t}^{2004}$	0.0035	−0.0026	0.0013	−0.0160	−0.0005	−0.0377	−0.0817	−0.3399
	0.00	*0.00*	*0.00*	*0.00*	*0.01*	*0.00*	*0.00*	*0.00*
$\boxed{\hat{w}_{q,t}^{2017}}$	0.0062	0.0070	0.0037	0.0052	0.0050	0.0438	0.0028	0.0014
$\hat{w}_{p,t}^{2017}$	−0.0020	−0.0165	−0.0064	−0.0198	−0.0113	−0.1343	−0.0786	−0.1687
	0.00	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*
				Rules with MacKinlay-Pástor Single Factor Structure				
$\boxed{\hat{w}_{q,t}^{MP}}$	0.0023	0.0010	0.0026	0.0049	0.0015	0.0055	0.0026	0.0032
$\hat{w}_{p,t}^{MP}$	0.0022	0.0007	0.0008	0.0014	−0.0010	0.0020	0.0018	−0.0000
	0.44	*0.40*	*0.01*	*0.01*	*0.00*	*0.01*	*0.27*	*0.04*
				Rule with No-Short-Sale Constraints				
$\hat{w}_{p,t}^{NS}$	0.0030	0.0024	0.0015	0.0021	0.0014	0.0058	−0.0008	−0.0017
	0.15	*0.11*	*0.35*	*0.42*	*0.20*	*0.49*	*0.41*	*1.00*
	0.00	*0.00*	*0.00*	*0.05*	*0.01*	*0.00*	*0.05*	*0.19*
	0.05	*0.00*	*0.15*	*0.05*	*0.07*	*0.00*	*0.03*	*0.05*
	0.74	*0.83*	*0.10*	*0.04*	*0.48*	*0.55*	*0.08*	*0.02*

Table IA.21: CER Comparison with 10 bps Transactions Costs: $h = 120$ and $\gamma = 5$ (Cont'd)

	Momentum $N = 10$	Size-B/M $N = 25$	IVOL $N = 10$	OP-Inv $N = 25$	NM-V (LT) $N = 16$	NM-V (All) $N = 46$	Industry $N = 49$	Stocks $N = 100$
				Other Rules from Portfolio Optimization				
$\hat{w}_{g,t}$	0.0029	0.0036	0.0004	0.0027	0.0029	0.0005	0.0001	−0.0150
	0.14	*0.20*	*0.22*	*0.53*	*0.34*	*0.33*	*0.67*	*0.98*
	0.00	*0.00*	*0.00*	*0.02*	*0.01*	*0.00*	*0.00*	*0.00*
	0.04	*0.00*	*0.08*	*0.02*	*0.13*	*0.00*	*0.00*	*0.00*
	0.80	*0.99*	*0.00*	*0.01*	*0.88*	*0.00*	*0.05*	*0.00*
$\hat{w}^{NS}_{g,t}$	0.0014	0.0022	0.0026	0.0032	0.0005	0.0046	0.0029	0.0013
	0.04	*0.09*	*0.53*	*0.62*	*0.11*	*0.45*	*0.98*	*1.00*
	0.00	*0.00*	*0.04*	*0.13*	*0.00*	*0.00*	*0.67*	*0.91*
	0.01	*0.00*	*0.31*	*0.12*	*0.03*	*0.00*	*0.51*	*0.45*
	0.16	*0.85*	*0.49*	*0.08*	*0.17*	*0.28*	*0.58*	*0.05*
$\hat{w}_{KZ3,t}$	−1.2266	−0.0888	−3.0966	−0.1260	−1.5811	−4.2635	−0.2103	−101.2831
	0.00	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*
	0.00	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*
	0.00	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*
	0.00	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*
				Non-Optimization Rules				
$1/N$	0.0002	0.0006	−0.0008	0.0012	−0.0005	−0.0015	0.0017	0.0005
	0.02	*0.03*	*0.12*	*0.30*	*0.08*	*0.28*	*0.81*	*1.00*
	0.00	*0.00*	*0.00*	*0.03*	*0.00*	*0.00*	*0.33*	*0.63*
	0.00	*0.00*	*0.04*	*0.03*	*0.02*	*0.00*	*0.25*	*0.25*
	0.05	*0.41*	*0.01*	*0.01*	*0.12*	*0.00*	*0.31*	*0.05*
KO_{VT}	0.0015	0.0023	0.0025	0.0027	0.0008	0.0030	0.0036	0.0024
	0.05	*0.10*	*0.51*	*0.53*	*0.14*	*0.40*	*0.99*	*1.00*
	0.00	*0.00*	*0.03*	*0.09*	*0.00*	*0.00*	*0.84*	*0.99*
	0.01	*0.00*	*0.29*	*0.09*	*0.04*	*0.00*	*0.74*	*0.88*
	0.21	*0.84*	*0.41*	*0.05*	*0.28*	*0.08*	*0.76*	*0.23*
KO_{RT}	0.0023	0.0017	0.0009	0.0028	0.0017	0.0041	0.0019	−0.0002
	0.09	*0.08*	*0.28*	*0.55*	*0.23*	*0.44*	*0.88*	*1.00*
	0.00	*0.00*	*0.00*	*0.10*	*0.01*	*0.00*	*0.33*	*0.44*
	0.02	*0.00*	*0.11*	*0.10*	*0.09*	*0.00*	*0.23*	*0.10*
	0.52	*0.68*	*0.08*	*0.08*	*0.54*	*0.24*	*0.33*	*0.02*
KO_{BT}	0.0026	0.0018	-0.0001	0.0026	0.0023	0.0033	0.0020	0.0007
	0.11	*0.09*	*0.18*	*0.52*	*0.31*	*0.41*	*0.85*	*1.00*
	0.00	*0.00*	*0.00*	*0.10*	*0.03*	*0.00*	*0.39*	*0.66*
	0.03	*0.00*	*0.06*	*0.10*	*0.14*	*0.00*	*0.31*	*0.29*
	0.63	*0.68*	*0.02*	*0.07*	*0.69*	*0.14*	*0.37*	*0.06*

Table IA.22: CER Comparison with 10 bps Transaction Costs: $h = 240$ and $\gamma = 5$

This table reports the CER of the portfolios studied in this paper with $h = 240$, $\gamma = 5$, and a transaction cost of 10 bps, based on the eight datasets containing excess monthly returns. The four newly obtained optimal combining portfolios, i.e., $\hat{w}_{q,t}$, $\hat{w}_{q,t}^{LW2004}$, $\hat{w}_{q,t}^{LW2017}$, and $\hat{w}_{q,t}^{MP}$, are highlighted with a box around. In the three categories to which the four new portfolios belong, one-sided tests are conducted to assess the value of using the newly derived optimal combining coefficient $\hat{c}_t$, and the p-values are reported in *italics*. For the portfolios in the remaining three categories, one-sided tests are conducted to compare them with the four newly obtained portfolios, and the corresponding p-values are reported in the four rows below the portfolio CER. We set $\eta = 4$ for the timing strategies KO_{VT}, KO_{RT}, and KO_{BT}.

	Momentum $N = 10$	Size-B/M $N = 25$	IVOL $N = 10$	OP-Inv $N = 25$	NM-V (LT) $N = 16$	NM-V (All) $N = 46$	Industry $N = 49$	Stocks $N = 100$
w^*	0.0093	0.0140	0.0103	0.0157	0.0169	0.0463	0.0175	0.0221
				Invariant Optimal Portfolio Rules				
$\boxed{\hat{w}_{q,t}}$	0.0066	0.0074	0.0029	0.0072	0.0093	−0.0635	0.0001	−0.0011
$\hat{w}_{p,t}$	0.0018	−0.0065	−0.0034	−0.0128	−0.0001	−0.7778	−0.0722	−0.1729
	0.00	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*
$\hat{w}_{u,t}$	0.0028	−0.0019	−0.0021	−0.0076	0.0021	−0.2738	−0.0401	−0.0611
	0.00	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*
$\hat{w}_{BS,t}$	0.0064	0.0060	0.0025	0.0042	0.0082	−0.1361	−0.0086	−0.0091
	0.04	*0.01*	*0.01*	*0.00*	*0.04*	*0.00*	*0.00*	*0.00*
				Rules with Shrinkage Covariance Matrix Estimators				
$\boxed{\hat{w}_{q,t}^{LW2004}}$	0.0078	0.0086	0.0049	0.0077	0.0106	0.0026	0.0013	0.0011
$\hat{w}_{p,t}^{LW2004}$	0.0052	0.0046	0.0020	−0.0062	0.0069	−0.3548	−0.0429	−0.0816
	0.00	*0.01*	*0.00*	*0.00*	*0.03*	*0.00*	*0.00*	*0.00*
$\boxed{\hat{w}_{q,t}^{LW2017}}$	0.0071	0.0082	0.0034	0.0077	0.0101	−0.0200	0.0014	0.0022
$\hat{w}_{p,t}^{LW2004}$	0.0028	−0.0021	−0.0022	−0.0085	0.0029	−0.2353	−0.0431	−0.0486
	0.00	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*
				Rules with MacKinlay-Pástor Single Factor Structure				
$\boxed{\hat{w}_{q,t}^{MP}}$	0.0046	0.0025	0.0047	0.0076	0.0062	0.0055	0.0028	0.0029
$\hat{w}_{p,t}^{MP}$	0.0042	0.0029	0.0033	0.0052	0.0045	0.0047	0.0026	0.0030
	0.14	*0.70*	*0.02*	*0.01*	*0.00*	*0.21*	*0.45*	*0.52*
				Rule with No-Short-Sale Constraints				
$\hat{w}_{p,t}^{NS}$	0.0040	0.0028	0.0027	0.0037	0.0030	0.0035	−0.0001	0.0013
	0.12	*0.02*	*0.47*	*0.08*	*0.04*	*1.00*	*0.45*	*0.90*
	0.02	*0.00*	*0.11*	*0.04*	*0.00*	*0.53*	*0.21*	*0.56*
	0.08	*0.00*	*0.38*	*0.04*	*0.02*	*0.92*	*0.18*	*0.30*
	0.28	*0.61*	*0.01*	*0.01*	*0.01*	*0.27*	*0.08*	*0.23*

Table IA.22: CER Comparison with 10 bps Transactions Costs: $h = 240$ and $\gamma = 5$ (Cont'd)

	Momentum $N = 10$	Size-B/M $N = 25$	IVOL $N = 10$	OP-Inv $N = 25$	NM-V (LT) $N = 16$	NM-V (All) $N = 46$	Industry $N = 49$	Stocks $N = 100$
				Other Rules from Portfolio Optimization				
$\hat{w}_{g,t}$	0.0038	0.0053	0.0015	0.0063	0.0058	0.0062	0.0006	−0.0010
	0.10	*0.13*	*0.31*	*0.34*	*0.13*	*1.00*	*0.67*	*0.81*
	0.02	*0.01*	*0.05*	*0.21*	*0.02*	*0.61*	*0.23*	*0.00*
	0.06	*0.05*	*0.23*	*0.23*	*0.06*	*0.95*	*0.21*	*0.00*
	0.14	*1.00*	*0.00*	*0.06*	*0.36*	*0.63*	*0.10*	*0.01*
$\hat{w}^{NS}_{g,t}$	0.0021	0.0030	0.0035	0.0042	0.0023	0.0043	0.0032	0.0030
	0.03	*0.02*	*0.60*	*0.12*	*0.03*	*1.00*	*0.97*	*1.00*
	0.00	*0.00*	*0.22*	*0.06*	*0.00*	*0.55*	*0.92*	*0.98*
	0.02	*0.01*	*0.52*	*0.08*	*0.01*	*0.93*	*0.90*	*0.85*
	0.00	*0.72*	*0.05*	*0.01*	*0.00*	*0.29*	*0.60*	*0.51*
$\hat{w}_{KZ3,t}$	−0.1453	0.0052	−3.5480	0.0076	0.0057	−27.4940	−0.0004	−0.0015
	0.00	*0.05*	*0.00*	*0.71*	*0.07*	*0.00*	*0.17*	*0.10*
	0.00	*0.00*	*0.00*	*0.48*	*0.03*	*0.00*	*0.01*	*0.00*
	0.00	*0.01*	*0.00*	*0.48*	*0.03*	*0.00*	*0.01*	*0.00*
	0.00	*0.93*	*0.00*	*0.51*	*0.45*	*0.00*	*0.07*	*0.01*
				Non-Optimization Rules				
$1/N$	0.0010	0.0019	0.0002	0.0019	−0.0002	−0.0010	0.0020	0.0028
	0.01	*0.01*	*0.17*	*0.03*	*0.01*	*1.00*	*0.78*	*0.99*
	0.00	*0.00*	*0.02*	*0.01*	*0.00*	*0.40*	*0.62*	*0.87*
	0.01	*0.00*	*0.12*	*0.02*	*0.00*	*0.86*	*0.59*	*0.67*
	0.00	*0.36*	*0.00*	*0.00*	*0.00*	*0.04*	*0.36*	*0.48*
KO_{VT}	0.0022	0.0029	0.0033	0.0035	0.0018	0.0033	0.0032	0.0033
	0.03	*0.02*	*0.56*	*0.08*	*0.02*	*1.00*	*0.95*	*1.00*
	0.00	*0.00*	*0.19*	*0.04*	*0.00*	*0.52*	*0.89*	*0.98*
	0.02	*0.01*	*0.48*	*0.05*	*0.01*	*0.92*	*0.87*	*0.89*
	0.00	*0.66*	*0.04*	*0.00*	*0.00*	*0.19*	*0.61*	*0.60*
KO_{RT}	0.0032	0.0031	0.0026	0.0038	0.0031	0.0046	0.0025	0.0020
	0.07	*0.03*	*0.46*	*0.09*	*0.04*	*1.00*	*0.91*	*0.97*
	0.01	*0.00*	*0.11*	*0.04*	*0.00*	*0.56*	*0.79*	*0.75*
	0.04	*0.01*	*0.37*	*0.05*	*0.02*	*0.93*	*0.77*	*0.45*
	0.05	*0.70*	*0.01*	*0.00*	*0.00*	*0.37*	*0.44*	*0.30*
KO_{BT}	0.0036	0.0030	0.0012	0.0028	0.0022	0.0040	0.0016	0.0018
	0.09	*0.03*	*0.27*	*0.06*	*0.03*	*1.00*	*0.72*	*0.95*
	0.02	*0.00*	*0.04*	*0.02*	*0.00*	*0.54*	*0.55*	*0.68*
	0.06	*0.01*	*0.20*	*0.03*	*0.01*	*0.92*	*0.52*	*0.40*
	0.10	*0.64*	*0.00*	*0.00*	*0.00*	*0.29*	*0.30*	*0.29*

Table IA.23: Sharpe Ratio Comparison with 10 bps Transaction Costs: $h = 120$ and $\gamma = 3$

This table reports the Sharpe ratio of the portfolios studied in this paper with $h = 120$, $\gamma = 3$, and a transaction cost of 10 bps, based on the eight datasets containing excess monthly returns. The four newly obtained optimal combining portfolios, i.e., $\hat{w}_{q,t}$, $\hat{w}_{q,t}^{LW2004}$, $\hat{w}_{q,t}^{LW2017}$, and $\hat{w}_{q,t}^{MP}$, are highlighted with a box around. In the three categories to which the four new portfolios belong, one-sided tests are conducted to assess the value of using the newly derived optimal combining coefficient $\hat{c}_t$, and the p-values are reported in *italics*. For the portfolios in the remaining three categories, one-sided tests are conducted to compare them with the four newly obtained portfolios, and the corresponding p-values are reported in the four rows below the portfolio Sharpe ratio. We set $\eta = 4$ for the timing strategies KO_{VT}, KO_{RT}, and KO_{BT}.

	Momentum $N = 10$	Size-B/M $N = 25$	IVOL $N = 10$	OP-Inv $N = 25$	NM-V (LT) $N = 16$	NM-V (All) $N = 46$	Industry $N = 49$	Stocks $N = 100$
w^*	0.2758	0.3258	0.2464	0.3688	0.3758	0.7555	0.3359	0.3894
				Invariant Optimal Portfolio Rules				
$\boxed{\hat{w}_{q,t}}$	0.2335	0.2095	0.2230	0.1655	0.1910	0.4893	0.0946	−0.0278
$\hat{w}_{p,t}$	0.2096	0.0023	0.2042	0.0860	0.1374	0.0958	−0.0881	−0.1364
	0.00	*0.00*	*0.02*	*0.00*	*0.00*	*0.00*	*0.00*	*0.03*
$\hat{w}_{u,t}$	0.2145	0.1411	0.2030	0.1075	0.1475	0.1974	−0.0417	−0.1979
	0.02	*0.00*	*0.01*	*0.00*	*0.01*	*0.00*	*0.00*	*0.00*
$\hat{w}_{BS,t}$	0.2310	0.1804	0.2199	0.1385	0.1765	0.4216	0.0441	−0.1292
	0.20	*0.00*	*0.13*	*0.02*	*0.07*	*0.00*	*0.05*	*0.01*
				Rules with Shrinkage Covariance Matrix Estimators				
$\boxed{\hat{w}_{q,t}^{LW2004}}$	0.2568	0.2611	0.2335	0.2119	0.2418	0.6661	0.1525	0.0929
$\hat{w}_{p,t}^{LW2004}$	0.2365	0.1985	0.2187	0.1418	0.1855	0.5199	0.0240	−0.1231
	0.02	*0.00*	*0.07*	*0.00*	*0.01*	*0.00*	*0.00*	*0.00*
$\boxed{\hat{w}_{q,t}^{LW2017}}$	0.2461	0.2496	0.2286	0.2161	0.2098	0.6504	0.1617	0.1273
$\hat{w}_{p,t}^{LW2017}$	0.2265	0.1792	0.2140	0.1494	0.1559	0.3469	0.0004	−0.0782
	0.02	*0.00*	*0.05*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*
				Rules with MacKinlay-Pástor Single Factor Structure				
$\boxed{\hat{w}_{q,t}^{MP}}$	0.1671	0.1433	0.1447	0.2153	0.1306	0.2290	0.1662	0.1796
$\hat{w}_{p,t}^{MP}$	0.1494	0.0883	0.0666	0.0603	0.0472	0.0583	0.0964	0.0596
	0.12	*0.04*	*0.00*	*0.00*	*0.00*	*0.00*	*0.08*	*0.01*
				Rule with No-Short-Sale Constraints				
$\hat{w}_{p,t}^{NS}$	0.1886	0.1688	0.1261	0.1604	0.1674	0.2484	0.0963	0.0900
	0.09	*0.15*	*0.00*	*0.46*	*0.32*	*0.00*	*0.51*	*0.99*
	0.01	*0.00*	*0.00*	*0.12*	*0.04*	*0.00*	*0.08*	*0.47*
	0.04	*0.01*	*0.00*	*0.11*	*0.20*	*0.00*	*0.06*	*0.18*
	0.83	*0.80*	*0.20*	*0.07*	*0.87*	*0.65*	*0.09*	*0.03*

Table IA.23: Sharpe Ratio Comparison with 10 bps Transactions Costs: $h = 120$ and $\gamma = 3$ (Cont'd)

	Momentum $N = 10$	Size-B/M $N = 25$	IVOL $N = 10$	OP-Inv $N = 25$	NM-V (LT) $N = 16$	NM-V (All) $N = 46$	Industry $N = 49$	Stocks $N = 100$
				Other Rules from Portfolio Optimization				
$\hat{w}_{g,t}$	0.1760	0.1894	0.1015	0.1684	0.1720	0.1080	0.1022	−0.0138
	0.05	*0.28*	*0.00*	*0.53*	*0.35*	*0.00*	*0.60*	*0.97*
	0.01	*0.01*	*0.00*	*0.10*	*0.04*	*0.00*	*0.03*	*0.00*
	0.02	*0.03*	*0.00*	*0.09*	*0.20*	*0.00*	*0.02*	*0.00*
	0.69	*0.97*	*0.03*	*0.02*	*0.93*	*0.01*	*0.05*	*0.00*
$\hat{w}_{g,t}^{NS}$	0.1432	0.1579	0.1637	0.1797	0.1224	0.2178	0.1696	0.1250
	0.01	*0.10*	*0.05*	*0.62*	*0.10*	*0.00*	*0.97*	*1.00*
	0.00	*0.00*	*0.02*	*0.23*	*0.00*	*0.00*	*0.71*	*0.89*
	0.00	*0.01*	*0.04*	*0.21*	*0.05*	*0.00*	*0.60*	*0.46*
	0.10	*0.74*	*0.82*	*0.10*	*0.35*	*0.37*	*0.54*	*0.03*
$\hat{w}_{KZ3,t}$	0.0246	−0.0021	−0.0577	−0.0104	−0.0593	−0.2394	−0.0222	−0.0437
	0.00	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.01*	*0.39*
	0.00	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.01*
	0.00	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*
	0.00	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*
				Non-Optimization Rules				
$1/N$	0.1272	0.1481	0.1221	0.1422	0.1205	0.1030	0.1519	0.1190
	0.00	*0.07*	*0.01*	*0.33*	*0.11*	*0.00*	*0.87*	*1.00*
	0.00	*0.00*	*0.00*	*0.07*	*0.01*	*0.00*	*0.49*	*0.77*
	0.00	*0.01*	*0.00*	*0.07*	*0.05*	*0.00*	*0.41*	*0.40*
	0.06	*0.56*	*0.20*	*0.02*	*0.37*	*0.01*	*0.37*	*0.06*
KO_{VT}	0.1459	0.1629	0.1614	0.1695	0.1331	0.1742	0.1888	0.1564
	0.01	*0.13*	*0.05*	*0.53*	*0.15*	*0.00*	*0.99*	*1.00*
	0.00	*0.00*	*0.01*	*0.17*	*0.01*	*0.00*	*0.86*	*0.98*
	0.00	*0.01*	*0.03*	*0.16*	*0.07*	*0.00*	*0.79*	*0.89*
	0.14	*0.78*	*0.79*	*0.06*	*0.54*	*0.08*	*0.74*	*0.19*
KO_{RT}	0.1680	0.1636	0.1420	0.1743	0.1647	0.2027	0.1501	0.1041
	0.03	*0.13*	*0.02*	*0.57*	*0.31*	*0.00*	*0.90*	*1.00*
	0.00	*0.00*	*0.00*	*0.19*	*0.04*	*0.00*	*0.47*	*0.63*
	0.01	*0.01*	*0.01*	*0.17*	*0.18*	*0.00*	*0.37*	*0.22*
	0.52	*0.75*	*0.46*	*0.10*	*0.86*	*0.26*	*0.35*	*0.02*
KO_{BT}	0.1740	0.1664	0.1267	0.1702	0.1730	0.1850	0.1569	0.1252
	0.05	*0.15*	*0.01*	*0.54*	*0.37*	*0.00*	*0.89*	*1.00*
	0.01	*0.00*	*0.00*	*0.18*	*0.07*	*0.00*	*0.54*	*0.81*
	0.02	*0.02*	*0.00*	*0.17*	*0.24*	*0.00*	*0.46*	*0.47*
	0.65	*0.77*	*0.25*	*0.08*	*0.92*	*0.15*	*0.41*	*0.07*

Table IA.24: Sharpe Ratio Comparison with 10 bps Transaction Costs: $h = 240$ and $\gamma = 3$

This table reports the Sharpe ratio of the portfolios studied in this paper with $h = 240$, $\gamma = 3$, and a transaction cost of 10 bps, based on the eight datasets containing excess monthly returns. The four newly obtained optimal combining portfolios, i.e., $\hat{w}_{q,t}$, $\hat{w}^{LW2004}_{q,t}$, $\hat{w}^{LW2017}_{q,t}$, and $\hat{w}^{MP}_{q,t}$, are highlighted with a box around. In the three categories to which the four new portfolios belong, one-sided tests are conducted to assess the value of using the newly derived optimal combining coefficient $\hat{c}_t$, and the p-values are reported in *italics*. For the portfolios in the remaining three categories, one-sided tests are conducted to compare them with the four newly obtained portfolios, and the corresponding p-values are reported in the four rows below the portfolio Sharpe ratio. We set $\eta = 4$ for the timing strategies KO_{VT}, KO_{RT}, and KO_{BT}.

	Momentum $N = 10$	Size-B/M $N = 25$	IVOL $N = 10$	OP-Inv $N = 25$	NM-V (LT) $N = 16$	NM-V (All) $N = 46$	Industry $N = 49$	Stocks $N = 100$
w^*	0.2913	0.3473	0.3079	0.3721	0.3813	0.6382	0.3963	0.4479
				Invariant Optimal Portfolio Rules				
$\boxed{\hat{w}_{q,t}}$	0.2488	0.2406	0.2170	0.2373	0.2692	0.1909	0.0891	0.0780
$\hat{w}_{p,t}$	0.2313	0.1986	0.2008	0.1624	0.2241	0.2483	−0.0058	−0.1465
	0.00	*0.00*	*0.01*	*0.00*	*0.00*	*0.89*	*0.01*	*0.00*
$\hat{w}_{u,t}$	0.2339	0.1356	0.2041	0.1699	0.2295	0.2546	−0.0156	−0.0858
	0.01	*0.00*	*0.03*	*0.00*	*0.00*	*0.92*	*0.01*	*0.00*
$\hat{w}_{BS,t}$	0.2476	0.2319	0.2157	0.2057	0.2579	0.2440	0.0366	−0.0328
	0.24	*0.04*	*0.25*	*0.00*	*0.01*	*0.88*	*0.04*	*0.01*
				Rules with Shrinkage Covariance Matrix Estimators				
$\boxed{\hat{w}^{LW2004}_{q,t}}$	0.2629	0.2732	0.2242	0.2496	0.3018	0.4100	0.1088	0.1210
$\hat{w}^{LW2004}_{p,t}$	0.2493	0.2380	0.2145	0.1737	0.2517	0.3646	−0.0454	−0.0919
	0.01	*0.00*	*0.09*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*
$\boxed{\hat{w}^{LW2017}_{q,t}}$	0.2558	0.2547	0.2188	0.2473	0.2836	0.3922	0.1097	0.1483
$\hat{w}^{LW2017}_{p,t}$	0.2400	0.2154	0.1654	0.1739	0.2375	0.2772	−0.0526	−0.0712
	0.01	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.01*	*0.00*
				Rules with MacKinlay-Pástor Single Factor Structure				
$\boxed{\hat{w}^{MP}_{q,t}}$	0.2085	0.1794	0.2167	0.2850	0.2217	0.2341	0.1723	0.1754
$\hat{w}^{MP}_{p,t}$	0.1721	0.1375	0.1194	0.1309	0.1442	0.1320	0.1193	0.1092
	0.00	*0.05*	*0.00*	*0.00*	*0.00*	*0.01*	*0.17*	*0.15*
				Rule with No-Short-Sale Constraints				
$\hat{w}^{NS}_{p,t}$	0.2056	0.1792	0.1424	0.1802	0.1743	0.1919	0.0800	0.1283
	0.12	*0.07*	*0.03*	*0.15*	*0.08*	*0.50*	*0.43*	*0.86*
	0.05	*0.01*	*0.01*	*0.09*	*0.02*	*0.01*	*0.28*	*0.57*
	0.09	*0.04*	*0.02*	*0.11*	*0.05*	*0.02*	*0.27*	*0.32*
	0.44	*0.50*	*0.00*	*0.00*	*0.05*	*0.23*	*0.04*	*0.19*

Table IA.24: Sharpe Ratio Comparison with 10 bps Transactions Costs: $h = 240$ and $\gamma = 3$ (Cont'd)

	Momentum $N = 10$	Size-B/M $N = 25$	IVOL $N = 10$	OP-Inv $N = 25$	NM-V (LT) $N = 16$	NM-V (All) $N = 46$	Industry $N = 49$	Stocks $N = 100$
				Other Rules from Portfolio Optimization				
$\hat{w}_{g,t}$	0.1958	0.2360	0.1309	0.2592	0.2494	0.2598	0.1054	0.0837
	0.09	*0.45*	*0.02*	*0.68*	*0.37*	*0.79*	*0.66*	*0.89*
	0.04	*0.15*	*0.01*	*0.59*	*0.18*	*0.04*	*0.46*	*0.00*
	0.06	*0.31*	*0.02*	*0.60*	*0.29*	*0.06*	*0.46*	*0.00*
	0.26	*0.99*	*0.00*	*0.08*	*0.83*	*0.66*	*0.07*	*0.01*
$\hat{w}_{g,t}^{NS}$	0.1550	0.1752	0.1873	0.2054	0.1616	0.2112	0.1781	0.1725
	0.01	*0.07*	*0.23*	*0.29*	*0.06*	*0.59*	*0.96*	*1.00*
	0.01	*0.01*	*0.16*	*0.21*	*0.02*	*0.02*	*0.94*	*0.98*
	0.01	*0.03*	*0.21*	*0.23*	*0.04*	*0.03*	*0.93*	*0.86*
	0.00	*0.40*	*0.04*	*0.00*	*0.00*	*0.30*	*0.56*	*0.47*
$\hat{w}_{KZ3,t}$	0.0861	0.2310	−0.1001	0.2780	0.2714	0.0018	0.1003	0.0726
	0.00	*0.35*	*0.00*	*0.96*	*0.53*	*0.01*	*0.86*	*0.17*
	0.00	*0.03*	*0.00*	*0.91*	*0.17*	*0.00*	*0.25*	*0.00*
	0.00	*0.16*	*0.00*	*0.90*	*0.35*	*0.00*	*0.28*	*0.00*
	0.00	*0.92*	*0.00*	*0.42*	*0.79*	*0.01*	*0.08*	*0.01*
				Non-Optimization Rules				
$1/N$	0.1348	0.1604	0.1277	0.1522	0.1213	0.1147	0.1544	0.1699
	0.01	*0.04*	*0.02*	*0.09*	*0.02*	*0.22*	*0.86*	*0.98*
	0.00	*0.00*	*0.01*	*0.05*	*0.01*	*0.00*	*0.79*	*0.89*
	0.00	*0.02*	*0.02*	*0.06*	*0.01*	*0.00*	*0.78*	*0.72*
	0.00	*0.22*	*0.00*	*0.00*	*0.00*	*0.03*	*0.37*	*0.46*
KO_{VT}	0.1571	0.1744	0.1806	0.1867	0.1531	0.1816	0.1800	0.1810
	0.02	*0.07*	*0.18*	*0.20*	*0.05*	*0.46*	*0.95*	*1.00*
	0.01	*0.01*	*0.12*	*0.14*	*0.02*	*0.01*	*0.92*	*0.98*
	0.01	*0.03*	*0.17*	*0.15*	*0.03*	*0.02*	*0.92*	*0.90*
	0.00	*0.39*	*0.01*	*0.00*	*0.00*	*0.15*	*0.57*	*0.57*
KO_{RT}	0.1840	0.1815	0.1655	0.1951	0.1806	0.2144	0.1597	0.1493
	0.05	*0.09*	*0.10*	*0.23*	*0.10*	*0.60*	*0.92*	*0.96*
	0.02	*0.01*	*0.06*	*0.16*	*0.03*	*0.02*	*0.87*	*0.79*
	0.03	*0.04*	*0.09*	*0.18*	*0.06*	*0.03*	*0.87*	*0.51*
	0.06	*0.54*	*0.00*	*0.00*	*0.02*	*0.34*	*0.39*	*0.27*
KO_{BT}	0.1914	0.1818	0.1420	0.1723	0.1654	0.2004	0.1463	0.1471
	0.08	*0.09*	*0.04*	*0.14*	*0.07*	*0.54*	*0.82*	*0.95*
	0.03	*0.01*	*0.02*	*0.09*	*0.02*	*0.01*	*0.74*	*0.75*
	0.05	*0.05*	*0.03*	*0.10*	*0.04*	*0.02*	*0.73*	*0.49*
	0.12	*0.54*	*0.00*	*0.00*	*0.01*	*0.26*	*0.32*	*0.28*

Table IA.25: Sharpe Ratio Comparison with 10 bps Transaction Costs: $h = 120$ and $\gamma = 5$

This table reports the Sharpe ratio of the portfolios studied in this paper with $h = 120$, $\gamma = 5$, and a transaction cost of 10 bps, based on the eight datasets containing excess monthly returns. The four newly obtained optimal combining portfolios, i.e., $\hat{w}_{q,t}$, $\hat{w}_{q,t}^{LW2004}$, $\hat{w}_{q,t}^{LW2017}$, and $\hat{w}_{q,t}^{MP}$, are highlighted with a box around. In the three categories to which the four new portfolios belong, one-sided tests are conducted to assess the value of using the newly derived optimal combining coefficient $\hat{c}_t$, and the p-values are reported in *italics*. For the portfolios in the remaining three categories, one-sided tests are conducted to compare them with the four newly obtained portfolios, and the corresponding p-values are reported in the four rows below the portfolio Sharpe ratio. We set $\eta = 4$ for the timing strategies KO_{VT}, KO_{RT}, and KO_{BT}.

	Momentum $N = 10$	Size-B/M $N = 25$	IVOL $N = 10$	OP-Inv $N = 25$	NM-V (LT) $N = 16$	NM-V (All) $N = 46$	Industry $N = 49$	Stocks $N = 100$
w^*	0.2860	0.3457	0.2526	0.3852	0.3944	0.8004	0.3550	0.4001
				Invariant Optimal Portfolio Rules				
$\boxed{\hat{w}_{q,t}}$	0.2520	0.2349	0.2355	0.1849	0.2136	0.5221	0.1040	−0.0220
$\hat{w}_{p,t}$	0.2341	0.1620	0.2226	0.1233	0.1683	0.0557	−0.0184	−0.1442
	0.04	*0.00*	*0.08*	*0.01*	*0.02*	*0.00*	*0.01*	*0.01*
$\hat{w}_{u,t}$	0.2383	0.1784	0.2251	0.1367	0.1766	0.4035	0.0355	−0.0780
	0.08	*0.00*	*0.12*	*0.03*	*0.04*	*0.00*	*0.06*	*0.16*
$\hat{w}_{BS,t}$	0.2511	0.2127	0.2344	0.1658	0.2032	0.4873	0.0659	−0.1035
	0.37	*0.01*	*0.35*	*0.10*	*0.15*	*0.00*	*0.12*	*0.02*
				Rules with Shrinkage Covariance Matrix Estimators				
$\boxed{\hat{w}_{q,t}^{LW2004}}$	0.2661	0.2661	0.2374	0.2228	0.2466	0.6749	0.1581	0.0939
$\hat{w}_{p,t}^{LW2004}$	0.2578	0.2294	0.2313	0.1706	0.2115	0.6095	0.0500	−0.0681
	0.23	*0.04*	*0.27*	*0.04*	*0.09*	*0.00*	*0.01*	*0.00*
$\boxed{\hat{w}_{q,t}^{LW2017}}$	0.2620	0.2654	0.2385	0.2284	0.2284	0.6668	0.1689	0.1279
$\hat{w}_{p,t}^{LW2017}$	0.2497	0.2137	0.2302	0.1783	0.1843	0.6048	0.0572	−0.0358
	0.12	*0.00*	*0.19*	*0.04*	*0.03*	*0.00*	*0.01*	*0.00*
				Rules with MacKinlay-Pástor Single Factor Structure				
$\boxed{\hat{w}_{q,t}^{MP}}$	0.1680	0.1393	0.1658	0.2225	0.1419	0.2384	0.1648	0.1796
$\hat{w}_{p,t}^{MP}$	0.1682	0.1322	0.1248	0.1402	0.0935	0.1496	0.1426	0.1168
	0.51	*0.38*	*0.01*	*0.01*	*0.01*	*0.01*	*0.26*	*0.06*
				Rule with No-Short-Sale Constraints				
$\hat{w}_{p,t}^{NS}$	0.1896	0.1714	0.1413	0.1613	0.1605	0.2411	0.1233	0.1054
	0.02	*0.04*	*0.00*	*0.29*	*0.13*	*0.00*	*0.67*	*1.00*
	0.00	*0.00*	*0.00*	*0.05*	*0.01*	*0.00*	*0.18*	*0.61*
	0.01	*0.00*	*0.00*	*0.04*	*0.06*	*0.00*	*0.12*	*0.28*
	0.83	*0.85*	*0.14*	*0.05*	*0.72*	*0.52*	*0.20*	*0.05*

Table IA.25: Sharpe Ratio Comparison with 10 bps Transactions Costs: $h = 120$ and $\gamma = 5$ (Cont'd)

	Momentum $N = 10$	Size-B/M $N = 25$	IVOL $N = 10$	OP-Inv $N = 25$	NM-V (LT) $N = 16$	NM-V (All) $N = 46$	Industry $N = 49$	Stocks $N = 100$
				Other Rules from Portfolio Optimization				
$\hat{w}_{g,t}$	0.1760	0.1894	0.1015	0.1684	0.1720	0.1080	0.1022	−0.0138
	0.01	*0.05*	*0.00*	*0.29*	*0.14*	*0.00*	*0.46*	*0.96*
	0.00	*0.00*	*0.00*	*0.01*	*0.01*	*0.00*	*0.00*	*0.00*
	0.00	*0.00*	*0.00*	*0.01*	*0.06*	*0.00*	*0.00*	*0.00*
	0.69	*0.98*	*0.00*	*0.01*	*0.86*	*0.01*	*0.05*	*0.00*
$\hat{w}^{NS}_{g,t}$	0.1432	0.1579	0.1637	0.1797	0.1224	0.2178	0.1696	0.1250
	0.00	*0.02*	*0.02*	*0.45*	*0.03*	*0.00*	*0.96*	*1.00*
	0.00	*0.00*	*0.00*	*0.12*	*0.00*	*0.00*	*0.66*	*0.88*
	0.00	*0.00*	*0.01*	*0.10*	*0.01*	*0.00*	*0.51*	*0.44*
	0.10	*0.77*	*0.46*	*0.08*	*0.21*	*0.30*	*0.56*	*0.03*
$\hat{w}_{KZ3,t}$	0.0246	−0.0021	−0.0577	−0.0104	−0.0593	−0.2394	−0.0222	−0.0437
	0.00	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.01*	*0.35*
	0.00	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.01*
	0.00	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*
	0.00	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*
				Non-Optimization Rules				
$1/N$	0.1272	0.1481	0.1221	0.1422	0.1205	0.1030	0.1519	0.1190
	0.00	*0.01*	*0.00*	*0.18*	*0.04*	*0.00*	*0.84*	*1.00*
	0.00	*0.00*	*0.00*	*0.03*	*0.00*	*0.00*	*0.44*	*0.76*
	0.00	*0.00*	*0.00*	*0.03*	*0.01*	*0.00*	*0.34*	*0.39*
	0.06	*0.60*	*0.07*	*0.02*	*0.27*	*0.01*	*0.39*	*0.06*
KO_{VT}	0.1459	0.1629	0.1614	0.1695	0.1331	0.1742	0.1888	0.1564
	0.00	*0.03*	*0.01*	*0.36*	*0.05*	*0.00*	*0.98*	*1.00*
	0.00	*0.00*	*0.00*	*0.08*	*0.00*	*0.00*	*0.84*	*0.98*
	0.00	*0.00*	*0.01*	*0.07*	*0.02*	*0.00*	*0.74*	*0.88*
	0.14	*0.80*	*0.42*	*0.05*	*0.38*	*0.08*	*0.75*	*0.19*
KO_{RT}	0.1680	0.1636	0.1420	0.1743	0.1647	0.2027	0.1501	0.1041
	0.00	*0.03*	*0.00*	*0.40*	*0.15*	*0.00*	*0.86*	*1.00*
	0.00	*0.00*	*0.00*	*0.09*	*0.01*	*0.00*	*0.41*	*0.62*
	0.00	*0.00*	*0.00*	*0.08*	*0.08*	*0.00*	*0.29*	*0.22*
	0.50	*0.77*	*0.18*	*0.08*	*0.75*	*0.22*	*0.36*	*0.02*
KO_{BT}	0.1740	0.1664	0.1267	0.1702	0.1730	0.1850	0.1569	0.1252
	0.01	*0.04*	*0.00*	*0.37*	*0.21*	*0.00*	*0.86*	*1.00*
	0.00	*0.00*	*0.00*	*0.09*	*0.03*	*0.00*	*0.49*	*0.81*
	0.00	*0.00*	*0.00*	*0.08*	*0.12*	*0.00*	*0.39*	*0.47*
	0.63	*0.79*	*0.09*	*0.07*	*0.83*	*0.14*	*0.43*	*0.07*

Table IA.26: Sharpe Ratio Comparison with 10 bps Transaction Costs: $h = 240$ and $\gamma = 5$

This table reports the Sharpe ratio of the portfolios studied in this paper with $h = 240$, $\gamma = 5$, and a transaction cost of 10 bps, based on the eight datasets containing excess monthly returns. The four newly obtained optimal combining portfolios, i.e., $\hat{w}_{q,t}$, $\hat{w}_{q,t}^{LW2004}$, $\hat{w}_{q,t}^{LW2017}$, and $\hat{w}_{q,t}^{MP}$, are highlighted with a box around. In the three categories to which the four new portfolios belong, one-sided tests are conducted to assess the value of using the newly derived optimal combining coefficient $\hat{c}_t$, and the p-values are reported in *italics*. For the portfolios in the remaining three categories, one-sided tests are conducted to compare them with the four newly obtained portfolios, and the corresponding p-values are reported in the four rows below the portfolio Sharpe ratio. We set $\eta = 4$ for the timing strategies KO_{VT}, KO_{RT}, and KO_{BT}.

	Momentum $N = 10$	Size-B/M $N = 25$	IVOL $N = 10$	OP-Inv $N = 25$	NM-V (LT) $N = 16$	NM-V (All) $N = 46$	Industry $N = 49$	Stocks $N = 100$
w^*	0.3053	0.3749	0.3202	0.3972	0.4129	0.6804	0.4182	0.4701
				Invariant Optimal Portfolio Rules				
$\boxed{\hat{w}_{q,t}}$	0.2717	0.2744	0.2344	0.2685	0.3050	0.3641	0.1025	0.0805
$\hat{w}_{p,t}$	0.2580	0.2380	0.2231	0.1965	0.2620	0.1902	0.0041	−0.0879
	0.03	*0.00*	*0.06*	*0.00*	*0.00*	*0.00*	*0.02*	*0.00*
$\hat{w}_{u,t}$	0.2602	0.2464	0.2247	0.2046	0.2675	0.2806	0.0293	−0.0606
	0.04	*0.01*	*0.08*	*0.00*	*0.01*	*0.00*	*0.05*	*0.01*
$\hat{w}_{BS,t}$	0.2709	0.2681	0.2333	0.2421	0.2953	0.3373	0.0595	0.0003
	0.31	*0.14*	*0.29*	*0.01*	*0.04*	*0.00*	*0.09*	*0.02*
				Rules with Shrinkage Covariance Matrix Estimators				
$\boxed{\hat{w}_{q,t}^{LW2004}}$	0.2822	0.2972	0.2387	0.2775	0.3314	0.4525	0.1268	0.1229
$\hat{w}_{p,t}^{LW2004}$	0.2738	0.2735	0.2321	0.2082	0.2896	0.2461	0.0203	−0.0616
	0.12	*0.05*	*0.19*	*0.00*	*0.01*	*0.00*	*0.01*	*0.00*
$\boxed{\hat{w}_{q,t}^{LW2017}}$	0.2780	0.2860	0.2357	0.2770	0.3186	0.4265	0.1303	0.1500
$\hat{w}_{p,t}^{LW2017}$	0.2663	0.2545	0.2257	0.2078	0.2757	0.3533	0.0144	−0.0449
	0.05	*0.01*	*0.09*	*0.00*	*0.00*	*0.00*	*0.01*	*0.00*
				Rules with MacKinlay-Pástor Single Factor Structure				
$\boxed{\hat{w}_{q,t}^{MP}}$	0.2142	0.1667	0.2193	0.2920	0.2551	0.2403	0.1684	0.1748
$\hat{w}_{p,t}^{MP}$	0.2047	0.1775	0.1813	0.2304	0.2134	0.2240	0.1624	0.1753
	0.14	*0.71*	*0.02*	*0.01*	*0.00*	*0.28*	*0.44*	*0.50*
				Rule with No-Short-Sale Constraints				
$\hat{w}_{p,t}^{NS}$	0.2048	0.1759	0.1652	0.1933	0.1805	0.1951	0.1020	0.1408
	0.02	*0.01*	*0.02*	*0.06*	*0.02*	*0.03*	*0.50*	*0.92*
	0.01	*0.00*	*0.01*	*0.03*	*0.00*	*0.00*	*0.28*	*0.67*
	0.01	*0.00*	*0.02*	*0.04*	*0.01*	*0.01*	*0.25*	*0.41*
	0.34	*0.63*	*0.01*	*0.00*	*0.01*	*0.27*	*0.09*	*0.24*

Table IA.26: Sharpe Ratio Comparison with 10 bps Transactions Costs: $h = 240$ and $\gamma = 5$ (Cont'd)

	Momentum $N = 10$	Size-B/M $N = 25$	IVOL $N = 10$	OP-Inv $N = 25$	NM-V (LT) $N = 16$	NM-V (All) $N = 46$	Industry $N = 49$	Stocks $N = 100$
				Other Rules from Portfolio Optimization				
$\hat{w}_{g,t}$	0.1958	0.2360	0.1309	0.2592	0.2494	0.2598	0.1054	0.0837
	0.01	*0.12*	*0.00*	*0.40*	*0.14*	*0.11*	*0.54*	*0.88*
	0.00	*0.02*	*0.00*	*0.29*	*0.04*	*0.01*	*0.21*	*0.00*
	0.01	*0.06*	*0.00*	*0.31*	*0.09*	*0.02*	*0.19*	*0.00*
	0.12	*1.00*	*0.00*	*0.06*	*0.42*	*0.62*	*0.09*	*0.01*
$\hat{w}_{g,t}^{NS}$	0.1550	0.1752	0.1873	0.2054	0.1616	0.2112	0.1781	0.1725
	0.00	*0.01*	*0.09*	*0.10*	*0.01*	*0.05*	*0.96*	*1.00*
	0.00	*0.00*	*0.05*	*0.06*	*0.00*	*0.00*	*0.91*	*0.97*
	0.00	*0.00*	*0.08*	*0.07*	*0.01*	*0.01*	*0.90*	*0.85*
	0.00	*0.65*	*0.06*	*0.01*	*0.00*	*0.30*	*0.59*	*0.48*
$\hat{w}_{KZ3,t}$	0.0861	0.2310	−0.1001	0.2780	0.2714	0.0018	0.1003	0.0726
	0.00	*0.02*	*0.00*	*0.75*	*0.13*	*0.00*	*0.43*	*0.12*
	0.00	*0.00*	*0.00*	*0.51*	*0.03*	*0.00*	*0.05*	*0.00*
	0.00	*0.00*	*0.00*	*0.52*	*0.06*	*0.00*	*0.04*	*0.00*
	0.00	*0.96*	*0.00*	*0.34*	*0.61*	*0.00*	*0.10*	*0.01*
				Non-Optimization Rules				
$1/N$	0.1348	0.1604	0.1277	0.1522	0.1213	0.1147	0.1544	0.1699
	0.00	*0.00*	*0.00*	*0.02*	*0.00*	*0.01*	*0.82*	*0.98*
	0.00	*0.00*	*0.00*	*0.01*	*0.00*	*0.00*	*0.70*	*0.88*
	0.00	*0.00*	*0.00*	*0.01*	*0.00*	*0.00*	*0.67*	*0.70*
	0.00	*0.42*	*0.00*	*0.00*	*0.00*	*0.06*	*0.40*	*0.46*
KO_{VT}	0.1571	0.1744	0.1806	0.1867	0.1531	0.1816	0.1800	0.1810
	0.00	*0.01*	*0.07*	*0.06*	*0.01*	*0.03*	*0.94*	*1.00*
	0.00	*0.00*	*0.04*	*0.03*	*0.00*	*0.00*	*0.88*	*0.97*
	0.00	*0.00*	*0.06*	*0.04*	*0.01*	*0.01*	*0.87*	*0.88*
	0.00	*0.62*	*0.04*	*0.00*	*0.00*	*0.19*	*0.60*	*0.57*
KO_{RT}	0.1840	0.1815	0.1655	0.1951	0.1806	0.2144	0.1597	0.1493
	0.01	*0.01*	*0.03*	*0.07*	*0.02*	*0.06*	*0.89*	*0.96*
	0.00	*0.00*	*0.01*	*0.04*	*0.00*	*0.01*	*0.79*	*0.77*
	0.00	*0.00*	*0.02*	*0.05*	*0.01*	*0.01*	*0.76*	*0.49*
	0.05	*0.70*	*0.01*	*0.00*	*0.00*	*0.35*	*0.43*	*0.27*
KO_{BT}	0.1914	0.1818	0.1420	0.1723	0.1654	0.2004	0.1463	0.1471
	0.01	*0.01*	*0.01*	*0.04*	*0.02*	*0.04*	*0.78*	*0.94*
	0.00	*0.00*	*0.00*	*0.02*	*0.00*	*0.00*	*0.64*	*0.73*
	0.01	*0.00*	*0.01*	*0.02*	*0.01*	*0.01*	*0.62*	*0.47*
	0.10	*0.69*	*0.01*	*0.00*	*0.00*	*0.28*	*0.35*	*0.28*

Table IA.27: CER Comparison with 50 bps Transaction Costs: $h = 120$ and $\gamma = 3$

This table reports the CER of the portfolios studied in this paper with $h = 120$, $\gamma = 3$, and a transaction cost of 50 bps, based on the eight datasets containing excess monthly returns. The four newly obtained optimal combining portfolios, i.e., $\hat{w}_{q,t}$, $\hat{w}_{q,t}^{LW2004}$, $\hat{w}_{q,t}^{LW2017}$, and $\hat{w}_{q,t}^{MP}$, are highlighted with a box around. In the three categories to which the four new portfolios belong, one-sided tests are conducted to assess the value of using the newly derived optimal combining coefficient $\hat{c}_t$, and the p-values are reported in *italics*. For the portfolios in the remaining three categories, one-sided tests are conducted to compare them with the four newly obtained portfolios, and the corresponding p-values are reported in the four rows below the portfolio CER. We set $\eta = 4$ for the timing strategies KO_{VT}, KO_{RT}, and KO_{BT}.

	Momentum $N = 10$	Size-B/M $N = 25$	IVOL $N = 10$	OP-Inv $N = 25$	NM-V (LT) $N = 16$	NM-V (All) $N = 46$	Industry $N = 49$	Stocks $N = 100$
w^*	0.0103	0.0099	0.0075	0.0152	0.0142	−0.0075	0.0119	0.0080
				Invariant Optimal Portfolio Rules				
$\boxed{\hat{w}_{q,t}}$	−0.0003	−0.0075	−0.0097	−0.0037	−0.0062	−0.1847	−0.0041	−0.0268
$\hat{w}_{p,t}$	−0.0328	−33.2265	−0.0569	−0.1956	−0.0847	−99.1853	−5.7917	−3762.8829
	0.00	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*
$\hat{w}_{u,t}$	−0.0235	−0.1147	−0.0703	−0.0897	−0.0578	−34.4228	−4.2450	−45.9927
	0.00	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*
$\hat{w}_{BS,t}$	−0.0032	−0.0312	−0.0169	−0.0226	−0.0165	−1.4718	−0.0494	−0.6785
	0.00	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*
				Rules with Shrinkage Covariance Matrix Estimators				
$\boxed{\hat{w}_{q,t}^{LW2004}}$	0.0069	0.0048	0.0047	0.0028	0.0049	0.0469	0.0016	−0.0011
$\hat{w}_{p,t}^{LW2004}$	−0.0053	−0.0361	−0.0091	−0.0598	−0.0165	−1.9669	−0.2475	−107.4774
	0.00	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*
$\boxed{\hat{w}_{q,t}^{LW2017}}$	0.0026	0.0018	−0.0045	0.0028	−0.0009	0.0379	0.0020	0.0011
$\hat{w}_{p,t}^{LW2017}$	−0.0228	−0.0916	−0.0402	−0.0709	−0.0511	−15.9465	−1.6634	−1.0395
	0.00	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*
				Rules with MacKinlay-Pástor Single Factor Structure				
$\boxed{\hat{w}_{q,t}^{MP}}$	0.0040	0.0027	0.0029	0.0053	0.0022	0.0056	0.0036	0.0039
$\hat{w}_{p,t}^{MP}$	0.0027	−0.0017	−0.0021	−0.0031	−0.0030	−0.0027	0.0004	−0.0043
	0.06	*0.01*	*0.00*	*0.00*	*0.00*	*0.00*	*0.07*	*0.00*
				Rule with No-Short-Sale Constraints				
$\hat{w}_{p,t}^{NS}$	0.0054	0.0038	0.0019	0.0035	0.0041	0.0088	−0.0008	−0.0013
	0.97	*1.00*	*1.00*	*0.99*	*1.00*	*1.00*	*0.89*	*1.00*
	0.25	*0.27*	*0.12*	*0.62*	*0.36*	*0.00*	*0.16*	*0.45*
	0.83	*0.80*	*0.96*	*0.61*	*0.93*	*0.00*	*0.12*	*0.14*
	0.89	*0.76*	*0.16*	*0.14*	*0.87*	*0.92*	*0.06*	*0.02*

Table IA.27: CER Comparison with 50 bps Transactions Costs: $h = 120$ and $\gamma = 3$ (Cont'd)

	Momentum $N = 10$	Size-B/M $N = 25$	IVOL $N = 10$	OP-Inv $N = 25$	NM-V (LT) $N = 16$	NM-V (All) $N = 46$	Industry $N = 49$	Stocks $N = 100$
				Other Rules from Portfolio Optimization				
$\hat{w}_{g,t}$	0.0037	0.0021	0.0007	0.0022	0.0025	−0.0042	−0.0016	−0.0250
	0.89	*1.00*	*0.99*	*0.99*	*0.99*	*1.00*	*0.96*	*1.00*
	0.08	*0.03*	*0.06*	*0.39*	*0.12*	*0.00*	*0.00*	*0.00*
	0.64	*0.57*	*0.91*	*0.39*	*0.88*	*0.00*	*0.00*	*0.00*
	0.36	*0.27*	*0.01*	*0.00*	*0.62*	*0.00*	*0.00*	*0.00*
$\hat{w}_{g,t}^{NS}$	0.0031	0.0037	0.0040	0.0045	0.0023	0.0057	0.0038	0.0020
	0.84	*1.00*	*1.00*	*1.00*	*0.99*	*1.00*	*1.00*	*1.00*
	0.06	*0.25*	*0.39*	*0.79*	*0.13*	*0.00*	*0.98*	*1.00*
	0.55	*0.81*	*0.99*	*0.77*	*0.83*	*0.00*	*0.94*	*0.88*
	0.15	*0.83*	*0.92*	*0.25*	*0.54*	*0.55*	*0.57*	*0.04*
$\hat{w}_{KZ3,t}$	−1.6036	−0.9985	−14.5431	−0.3822	−3.6827	−21.5163	−0.1987	−1514.4328
	0.00	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*
	0.00	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*
	0.00	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*
	0.00	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*
				Non-Optimization Rules				
$1/N$	0.0026	0.0035	0.0021	0.0033	0.0021	0.0012	0.0037	0.0021
	0.80	*1.00*	*1.00*	*0.98*	*0.98*	*1.00*	*1.00*	*1.00*
	0.05	*0.26*	*0.17*	*0.58*	*0.15*	*0.00*	*0.88*	*0.98*
	0.49	*0.76*	*0.95*	*0.57*	*0.80*	*0.00*	*0.81*	*0.78*
	0.12	*0.68*	*0.29*	*0.09*	*0.49*	*0.03*	*0.52*	*0.13*
KO_{VT}	0.0034	0.0042	0.0040	0.0043	0.0028	0.0044	0.0046	0.0034
	0.87	*1.00*	*1.00*	*1.00*	*0.99*	*1.00*	*1.00*	*1.00*
	0.08	*0.35*	*0.39*	*0.76*	*0.19*	*0.00*	*0.99*	*1.00*
	0.60	*0.85*	*0.99*	*0.73*	*0.87*	*0.00*	*0.98*	*1.00*
	0.27	*0.90*	*0.91*	*0.21*	*0.72*	*0.23*	*0.79*	*0.29*
KO_{RT}	0.0043	0.0041	0.0030	0.0043	0.0041	0.0057	0.0031	0.0011
	0.92	*1.00*	*1.00*	*1.00*	*1.00*	*1.00*	*1.00*	*1.00*
	0.13	*0.36*	*0.25*	*0.76*	*0.37*	*0.00*	*0.87*	*0.94*
	0.71	*0.84*	*0.98*	*0.74*	*0.94*	*0.00*	*0.79*	*0.49*
	0.63	*0.83*	*0.55*	*0.23*	*0.90*	*0.53*	*0.39*	*0.03*
KO_{BT}	0.0048	0.0045	0.0024	0.0044	0.0048	0.0051	0.0037	0.0021
	0.94	*1.00*	*1.00*	*0.99*	*1.00*	*1.00*	*1.00*	*1.00*
	0.18	*0.43*	*0.20*	*0.76*	*0.47*	*0.00*	*0.89*	*0.98*
	0.75	*0.86*	*0.96*	*0.74*	*0.95*	*0.00*	*0.83*	*0.77*
	0.81	*0.87*	*0.36*	*0.25*	*0.96*	*0.39*	*0.53*	*0.12*

Table IA.28: CER Comparison with 50 bps Transaction Costs: $h = 240$ and $\gamma = 3$

This table reports the CER of the portfolios studied in this paper with $h = 240$, $\gamma = 3$, and a transaction cost of 50 bps, based on the eight datasets containing excess monthly returns. The four newly obtained optimal combining portfolios, i.e., $\hat{w}_{q,t}$, $\hat{w}_{q,t}^{LW2004}$, $\hat{w}_{q,t}^{LW2017}$, and $\hat{w}_{q,t}^{MP}$, are highlighted with a box around. In the three categories to which the four new portfolios belong, one-sided tests are conducted to assess the value of using the newly derived optimal combining coefficient $\hat{c}_t$, and the p-values are reported in *italics*. For the portfolios in the remaining three categories, one-sided tests are conducted to compare them with the four newly obtained portfolios, and the corresponding p-values are reported in the four rows below the portfolio CER. We set $\eta = 4$ for the timing strategies KO_{VT}, KO_{RT}, and KO_{BT}.

	Momentum $N = 10$	Size-B/M $N = 25$	IVOL $N = 10$	OP-Inv $N = 25$	NM-V (LT) $N = 16$	NM-V (All) $N = 46$	Industry $N = 49$	Stocks $N = 100$
w^*	0.0116	0.0105	0.0104	0.0161	0.0150	0.0104	0.0146	0.0085
				Invariant Optimal Portfolio Rules				
$\boxed{\hat{w}_{q,t}}$	0.0027	−0.0010	−0.0051	0.0043	0.0025	−6.2476	−0.0018	−0.0026
$\hat{w}_{p,t}$	−0.0127	−0.0634	−0.0315	−0.0451	−0.0283	−2.5879	−0.1837	−0.9869
	0.00	*0.00*	*0.00*	*0.00*	*0.00*	*1.00*	*0.00*	*0.00*
$\hat{w}_{u,t}$	−0.0096	−0.9706	−0.0230	−0.0326	−0.0215	−2.6407	−0.4993	−0.1577
	0.00	*0.00*	*0.00*	*0.00*	*0.00*	*1.00*	*0.00*	*0.00*
$\hat{w}_{BS,t}$	0.0018	−0.0091	−0.0065	−0.0039	−0.0015	−3.2243	−0.0238	−0.0240
	0.00	*0.00*	*0.00*	*0.00*	*0.00*	*1.00*	*0.00*	*0.00*
				Rules with Shrinkage Covariance Matrix Estimators				
$\boxed{\hat{w}_{q,t}^{LW2004}}$	0.0069	0.0060	0.0028	0.0062	0.0094	−0.1581	0.0000	0.0005
$\hat{w}_{p,t}^{LW2004}$	−0.0020	−0.0156	−0.0068	−0.0286	−0.0038	−0.4709	−3.7612	−0.2240
	0.00	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*
$\boxed{\hat{w}_{q,t}^{LW2017}}$	0.0039	0.0024	−0.0035	0.0059	0.0054	−0.1605	0.0002	0.0021
$\hat{w}_{p,t}^{LW2017}$	−0.0103	−0.0536	−0.3433	−0.0334	−0.0190	−4.1000	−9.4988	−0.1167
	0.00	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*
				Rules with MacKinlay-Pástor Single Factor Structure				
$\boxed{\hat{w}_{q,t}^{MP}}$	0.0060	0.0045	0.0056	0.0080	0.0061	0.0055	0.0038	0.0039
$\hat{w}_{p,t}^{MP}$	0.0044	0.0022	0.0017	0.0023	0.0030	0.0023	0.0019	0.0007
	0.01	*0.06*	*0.00*	*0.00*	*0.00*	*0.03*	*0.21*	*0.15*
				Rule with No-Short-Sale Constraints				
$\hat{w}_{p,t}^{NS}$	0.0065	0.0046	0.0028	0.0047	0.0046	0.0057	−0.0003	0.0020
	0.86	*0.95*	*0.97*	*0.54*	*0.66*	*1.00*	*0.73*	*0.98*
	0.45	*0.29*	*0.50*	*0.32*	*0.12*	*1.00*	*0.45*	*0.77*
	0.78	*0.76*	*0.95*	*0.36*	*0.44*	*1.00*	*0.42*	*0.48*
	0.69	*0.53*	*0.00*	*0.01*	*0.12*	*0.52*	*0.04*	*0.21*

Table IA.28: CER Comparison with 50 bps Transactions Costs: $h = 240$ and $\gamma = 3$ (Cont'd)

	Momentum $N = 10$	Size-B/M $N = 25$	IVOL $N = 10$	OP-Inv $N = 25$	NM-V (LT) $N = 16$	NM-V (All) $N = 46$	Industry $N = 49$	Stocks $N = 100$
				Other Rules from Portfolio Optimization				
$\hat{w}_{g,t}$	0.0048	0.0050	0.0021	0.0069	0.0062	0.0045	0.0004	−0.0023
	0.72	*0.98*	*0.95*	*0.79*	*0.77*	*1.00*	*0.90*	*0.90*
	0.25	*0.33*	*0.42*	*0.60*	*0.19*	*1.00*	*0.59*	*0.00*
	0.60	*0.82*	*0.91*	*0.62*	*0.57*	*1.00*	*0.55*	*0.00*
	0.08	*0.70*	*0.00*	*0.04*	*0.51*	*0.31*	*0.02*	*0.00*
$\hat{w}^{NS}_{g,t}$	0.0037	0.0044	0.0047	0.0056	0.0041	0.0055	0.0041	0.0037
	0.60	*0.95*	*0.99*	*0.64*	*0.61*	*1.00*	*1.00*	*1.00*
	0.16	*0.27*	*0.72*	*0.43*	*0.11*	*1.00*	*0.99*	*1.00*
	0.47	*0.75*	*0.98*	*0.46*	*0.40*	*1.00*	*0.99*	*0.98*
	0.00	*0.47*	*0.06*	*0.01*	*0.00*	*0.50*	*0.57*	*0.43*
$\hat{w}_{KZ3,t}$	−0.3026	0.0021	−32.9888	0.0076	0.0033	−96.5848	−0.0011	−0.0030
	0.00	*0.92*	*0.00*	*0.95*	*0.61*	*0.00*	*0.92*	*0.04*
	0.00	*0.01*	*0.00*	*0.81*	*0.01*	*0.00*	*0.02*	*0.00*
	0.00	*0.45*	*0.00*	*0.81*	*0.24*	*0.00*	*0.03*	*0.00*
	0.00	*0.10*	*0.00*	*0.38*	*0.25*	*0.00*	*0.01*	*0.00*
				Non-Optimization Rules				
$1/N$	0.0030	0.0042	0.0026	0.0037	0.0022	0.0017	0.0037	0.0041
	0.53	*0.93*	*0.96*	*0.45*	*0.48*	*1.00*	*0.98*	*1.00*
	0.12	*0.25*	*0.47*	*0.25*	*0.06*	*1.00*	*0.94*	*0.99*
	0.40	*0.71*	*0.92*	*0.28*	*0.28*	*1.00*	*0.93*	*0.93*
	0.00	*0.39*	*0.00*	*0.00*	*0.00*	*0.10*	*0.49*	*0.54*
KO_{VT}	0.0039	0.0046	0.0046	0.0050	0.0038	0.0047	0.0043	0.0042
	0.62	*0.95*	*0.99*	*0.58*	*0.59*	*1.00*	*1.00*	*1.00*
	0.18	*0.29*	*0.71*	*0.36*	*0.10*	*1.00*	*0.99*	*1.00*
	0.50	*0.76*	*0.98*	*0.40*	*0.38*	*1.00*	*0.98*	*0.99*
	0.00	*0.56*	*0.05*	*0.00*	*0.00*	*0.34*	*0.62*	*0.56*
KO_{RT}	0.0051	0.0050	0.0041	0.0053	0.0049	0.0061	0.0035	0.0032
	0.75	*0.96*	*0.99*	*0.61*	*0.67*	*1.00*	*0.99*	*1.00*
	0.28	*0.34*	*0.65*	*0.39*	*0.14*	*1.00*	*0.98*	*0.97*
	0.63	*0.80*	*0.97*	*0.42*	*0.46*	*1.00*	*0.97*	*0.81*
	0.11	*0.69*	*0.02*	*0.01*	*0.08*	*0.63*	*0.43*	*0.32*
KO_{BT}	0.0054	0.0052	0.0033	0.0045	0.0044	0.0058	0.0034	0.0031
	0.78	*0.97*	*0.97*	*0.52*	*0.63*	*1.00*	*0.97*	*1.00*
	0.32	*0.37*	*0.55*	*0.31*	*0.13*	*1.00*	*0.91*	*0.96*
	0.67	*0.81*	*0.95*	*0.35*	*0.42*	*1.00*	*0.89*	*0.78*
	0.21	*0.74*	*0.01*	*0.00*	*0.05*	*0.55*	*0.42*	*0.34*

Table IA.29: CER Comparison with 50 bps Transaction Costs: $h = 120$ and $\gamma = 5$

This table reports the CER of the portfolios studied in this paper with $h = 120$, $\gamma = 5$, and a transaction cost of 50 bps, based on the eight datasets containing excess monthly returns. The four newly obtained optimal combining portfolios, i.e., $\hat{w}_{q,t}$, $\hat{w}_{q,t}^{LW2004}$, $\hat{w}_{q,t}^{LW2017}$, and $\hat{w}_{q,t}^{MP}$, are highlighted with a box around. In the three categories to which the four new portfolios belong, one-sided tests are conducted to assess the value of using the newly derived optimal combining coefficient $\hat{c}_t$, and the p-values are reported in *italics*. For the portfolios in the remaining three categories, one-sided tests are conducted to compare them with the four newly obtained portfolios, and the corresponding p-values are reported in the four rows below the portfolio CER. We set $\eta = 4$ for the timing strategies KO_{VT}, KO_{RT}, and KO_{BT}.

	Momentum $N = 10$	Size-B/M $N = 25$	IVOL $N = 10$	OP-Inv $N = 25$	NM-V (LT) $N = 16$	NM-V (All) $N = 46$	Industry $N = 49$	Stocks $N = 100$
w^*	0.0072	0.0085	0.0051	0.0119	0.0119	0.0293	0.0096	0.0069
Invariant Optimal Portfolio Rules								
$\boxed{\hat{w}_{q,t}}$	0.0009	−0.0032	−0.0028	−0.0022	−0.0025	−0.0520	−0.0043	−0.0318
$\hat{w}_{p,t}$	−0.0151	−0.0874	−0.0234	−0.0766	−0.0407	−394.6175	−1.2048	−4780.0582
	0.00	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*
$\hat{w}_{u,t}$	−0.0107	−0.0498	−0.0173	−0.0452	−0.0285	−2.4581	−0.1205	−310.0468
	0.00	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*
$\hat{w}_{BS,t}$	−0.0005	−0.0147	−0.0049	−0.0121	−0.0077	−0.3091	−0.0281	−0.1693
	0.00	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*
Rules with Shrinkage Covariance Matrix Estimators								
$\boxed{\hat{w}_{q,t}^{LW2004}}$	0.0048	0.0037	0.0030	0.0021	0.0036	0.0317	0.0007	−0.0024
$\hat{w}_{p,t}^{LW2004}$	−0.0013	−0.0157	−0.0037	−0.0300	−0.0078	−0.1743	−0.1360	−0.5665
	0.00	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*
$\boxed{\hat{w}_{q,t}^{LW2017}}$	0.0026	0.0020	−0.0005	0.0022	0.0003	0.0290	0.0012	−0.0001
$\hat{w}_{p,t}^{LW2017}$	−0.0099	−0.0383	−0.0159	−0.0350	−0.0254	−0.2403	−0.1226	−0.2515
	0.00	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*
Rules with MacKinlay-Pástor Single Factor Structure								
$\boxed{\hat{w}_{q,t}^{MP}}$	0.0017	0.0003	0.0022	0.0041	0.0009	0.0046	0.0020	0.0023
$\hat{w}_{p,t}^{MP}$	0.0016	−0.0000	0.0002	0.0005	−0.0017	0.0011	0.0013	−0.0007
	0.37	*0.38*	*0.00*	*0.01*	*0.00*	*0.01*	*0.29*	*0.05*
Rule with No-Short-Sale Constraints								
$\hat{w}_{p,t}^{NS}$	0.0026	0.0016	0.0010	0.0013	0.0009	0.0054	−0.0016	−0.0027
	0.80	*0.99*	*0.94*	*0.94*	*0.89*	*1.00*	*0.88*	*1.00*
	0.06	*0.04*	*0.08*	*0.33*	*0.07*	*0.00*	*0.12*	*0.44*
	0.51	*0.39*	*0.76*	*0.32*	*0.59*	*0.00*	*0.08*	*0.09*
	0.76	*0.80*	*0.10*	*0.05*	*0.50*	*0.63*	*0.07*	*0.01*

Table IA.29: CER Comparison with 50 bps Transactions Costs: $h = 120$ and $\gamma = 5$ (Cont'd)

	Momentum $N = 10$	Size-B/M $N = 25$	IVOL $N = 10$	OP-Inv $N = 25$	NM-V (LT) $N = 16$	NM-V (All) $N = 46$	Industry $N = 49$	Stocks $N = 100$
				Other Rules from Portfolio Optimization				
$\hat{w}_{g,t}$	0.0018	0.0005	−0.0006	0.0005	0.0009	−0.0058	−0.0032	−0.0309
	0.68	*0.99*	*0.80*	*0.96*	*0.95*	*1.00*	*0.89*	*0.99*
	0.02	*0.00*	*0.01*	*0.07*	*0.02*	*0.00*	*0.00*	*0.00*
	0.35	*0.10*	*0.48*	*0.08*	*0.63*	*0.00*	*0.00*	*0.00*
	0.55	*0.56*	*0.00*	*0.00*	*0.52*	*0.00*	*0.00*	*0.00*
$\hat{w}_{g,t}^{NS}$	0.0010	0.0019	0.0026	0.0029	0.0003	0.0044	0.0026	0.0007
	0.52	*0.99*	*0.99*	*0.99*	*0.86*	*1.00*	*1.00*	*1.00*
	0.01	*0.06*	*0.38*	*0.68*	*0.03*	*0.00*	*0.97*	*1.00*
	0.22	*0.47*	*0.92*	*0.65*	*0.49*	*0.00*	*0.92*	*0.88*
	0.22	*0.91*	*0.70*	*0.16*	*0.29*	*0.45*	*0.68*	*0.08*
$\hat{w}_{KZ3,t}$	−2.6027	−1.6198	−24.0469	−0.6126	−6.0322	−35.1755	−0.3043	−2523.1372
	0.00	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*
	0.00	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*
	0.00	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*
	0.00	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*
				Non-Optimization Rules				
$1/N$	0.0001	0.0005	−0.0009	0.0012	−0.0006	−0.0016	0.0015	0.0002
	0.36	*0.94*	*0.76*	*0.92*	*0.74*	*1.00*	*1.00*	*1.00*
	0.00	*0.02*	*0.02*	*0.31*	*0.03*	*0.00*	*0.68*	*0.96*
	0.13	*0.22*	*0.44*	*0.31*	*0.37*	*0.00*	*0.57*	*0.61*
	0.10	*0.54*	*0.02*	*0.04*	*0.20*	*0.01*	*0.40*	*0.10*
KO_{VT}	0.0014	0.0021	0.0024	0.0026	0.0006	0.0028	0.0034	0.0021
	0.59	*1.00*	*0.98*	*0.98*	*0.88*	*1.00*	*1.00*	*1.00*
	0.02	*0.10*	*0.34*	*0.60*	*0.05*	*0.00*	*0.99*	*1.00*
	0.28	*0.53*	*0.91*	*0.58*	*0.55*	*0.00*	*0.97*	*1.00*
	0.36	*0.92*	*0.60*	*0.13*	*0.43*	*0.16*	*0.84*	*0.43*
KO_{RT}	0.0020	0.0014	0.0006	0.0024	0.0013	0.0037	0.0013	−0.0008
	0.71	*0.98*	*0.91*	*0.98*	*0.92*	*1.00*	*1.00*	*1.00*
	0.03	*0.05*	*0.06*	*0.56*	*0.11*	*0.00*	*0.67*	*0.87*
	0.39	*0.37*	*0.69*	*0.54*	*0.66*	*0.00*	*0.54*	*0.29*
	0.61	*0.75*	*0.10*	*0.12*	*0.61*	*0.33*	*0.34*	*0.02*
KO_{BT}	0.0024	0.0017	−0.0002	0.0024	0.0022	0.0031	0.0017	0.0001
	0.77	*0.99*	*0.83*	*0.98*	*0.95*	*1.00*	*1.00*	*1.00*
	0.06	*0.09*	*0.04*	*0.57*	*0.23*	*0.00*	*0.72*	*0.95*
	0.48	*0.43*	*0.55*	*0.55*	*0.77*	*0.00*	*0.62*	*0.58*
	0.78	*0.79*	*0.04*	*0.13*	*0.80*	*0.23*	*0.43*	*0.08*

Table IA.30: CER Comparison with 50 bps Transaction Costs: $h = 240$ and $\gamma = 5$

This table reports the CER of the portfolios studied in this paper with $h = 240$, $\gamma = 5$, and a transaction cost of 50 bps, based on the eight datasets containing excess monthly returns. The four newly obtained optimal combining portfolios, i.e., $\hat{w}_{q,t}$, $\hat{w}_{q,t}^{LW2004}$, $\hat{w}_{q,t}^{LW2017}$, and $\hat{w}_{q,t}^{MP}$, are highlighted with a box around. In the three categories to which the four new portfolios belong, one-sided tests are conducted to assess the value of using the newly derived optimal combining coefficient $\hat{c}_t$, and the p-values are reported in *italics*. For the portfolios in the remaining three categories, one-sided tests are conducted to compare them with the four newly obtained portfolios, and the corresponding p-values are reported in the four rows below the portfolio CER. We set $\eta = 4$ for the timing strategies KO_{VT}, KO_{RT}, and KO_{BT}.

	Momentum $N = 10$	Size-B/M $N = 25$	IVOL $N = 10$	OP-Inv $N = 25$	NM-V (LT) $N = 16$	NM-V (All) $N = 46$	Industry $N = 49$	Stocks $N = 100$
w^*	0.0082	0.0098	0.0080	0.0130	0.0132	0.0232	0.0127	0.0092
				Invariant Optimal Portfolio Rules				
$\boxed{\hat{w}_{q,t}}$	0.0034	0.0019	−0.0007	0.0043	0.0046	−0.2130	−0.0019	−0.0043
$\hat{w}_{p,t}$	−0.0036	−0.0223	−0.0098	−0.0221	−0.0100	−11.4542	−0.2536	−0.2356
	0.00	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*
$\hat{w}_{u,t}$	−0.0023	−0.0151	−0.0080	−0.0155	−0.0068	−1.7194	−0.0526	−0.0816
	0.00	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*
$\hat{w}_{BS,t}$	0.0030	−0.0016	−0.0014	−0.0002	0.0028	−0.5563	−0.0134	−0.0151
	0.00	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*
				Rules with Shrinkage Covariance Matrix Estimators				
$\boxed{\hat{w}_{q,t}^{LW2004}}$	0.0056	0.0054	0.0028	0.0054	0.0080	−0.0171	−0.0001	−0.0009
$\hat{w}_{p,t}^{LW2004}$	0.0015	−0.0040	−0.0017	−0.0133	0.0016	−4.9935	−0.0600	−0.1039
	0.00	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*
$\boxed{\hat{w}_{q,t}^{LW2017}}$	0.0041	0.0037	0.0001	0.0053	0.0062	−0.0517	0.0001	0.0009
$\hat{w}_{p,t}^{LW2017}$	−0.0023	−0.0146	−0.0079	−0.0159	−0.0055	−0.8272	−0.0632	−0.0610
	0.00	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*
				Rules with MacKinlay-Pástor Single Factor Structure				
$\boxed{\hat{w}_{q,t}^{MP}}$	0.0042	0.0020	0.0044	0.0070	0.0057	0.0048	0.0023	0.0022
$\hat{w}_{p,t}^{MP}$	0.0038	0.0026	0.0029	0.0047	0.0041	0.0041	0.0023	0.0026
	0.16	*0.74*	*0.03*	*0.01*	*0.00*	*0.25*	*0.50*	*0.60*
				Rule with No-Short-Sale Constraints				
$\hat{w}_{p,t}^{NS}$	0.0037	0.0023	0.0024	0.0033	0.0027	0.0031	−0.0007	0.0006
	0.55	*0.58*	*0.90*	*0.35*	*0.29*	*1.00*	*0.72*	*0.99*
	0.17	*0.03*	*0.42*	*0.17*	*0.03*	*0.94*	*0.37*	*0.81*
	0.43	*0.25*	*0.84*	*0.20*	*0.15*	*1.00*	*0.32*	*0.45*
	0.33	*0.60*	*0.01*	*0.01*	*0.01*	*0.31*	*0.07*	*0.24*

Table IA.30: CER Comparison with 50 bps Transactions Costs: $h = 240$ and $\gamma = 5$ (Cont'd)

	Momentum $N = 10$	Size-B/M $N = 25$	IVOL $N = 10$	OP-Inv $N = 25$	NM-V (LT) $N = 16$	NM-V (All) $N = 46$	Industry $N = 49$	Stocks $N = 100$
				Other Rules from Portfolio Optimization				
$\hat{w}_{g,t}$	0.0032	0.0036	0.0009	0.0053	0.0048	0.0030	−0.0009	−0.0042
	0.45	*0.83*	*0.74*	*0.70*	*0.52*	*1.00*	*0.82*	*0.82*
	0.10	*0.09*	*0.18*	*0.48*	*0.08*	*0.94*	*0.22*	*0.00*
	0.32	*0.49*	*0.62*	*0.51*	*0.31*	*1.00*	*0.17*	*0.00*
	0.06	*0.94*	*0.00*	*0.02*	*0.17*	*0.23*	*0.03*	*0.00*
$\hat{w}_{g,t}^{NS}$	0.0019	0.0028	0.0035	0.0040	0.0021	0.0043	0.0030	0.0026
	0.26	*0.67*	*0.96*	*0.46*	*0.25*	*1.00*	*1.00*	*1.00*
	0.04	*0.06*	*0.64*	*0.27*	*0.02*	*0.95*	*0.99*	*1.00*
	0.17	*0.34*	*0.92*	*0.30*	*0.12*	*1.00*	*0.98*	*0.99*
	0.00	*0.82*	*0.12*	*0.01*	*0.00*	*0.40*	*0.68*	*0.61*
$\hat{w}_{KZ3,t}$	−0.5021	−0.0009	−54.6254	0.0051	−0.0034	−160.2845	−0.0030	−0.0049
	0.00	*0.02*	*0.00*	*0.83*	*0.00*	*0.00*	*0.01*	*0.02*
	0.00	*0.00*	*0.00*	*0.34*	*0.00*	*0.00*	*0.00*	*0.00*
	0.00	*0.00*	*0.00*	*0.42*	*0.00*	*0.00*	*0.00*	*0.00*
	0.00	*0.06*	*0.00*	*0.11*	*0.01*	*0.00*	*0.01*	*0.00*
				Non-Optimization Rules				
$1/N$	0.0009	0.0018	0.0001	0.0018	−0.0003	−0.0011	0.0018	0.0026
	0.16	*0.49*	*0.62*	*0.20*	*0.12*	*1.00*	*0.94*	*1.00*
	0.02	*0.03*	*0.12*	*0.09*	*0.01*	*0.88*	*0.81*	*0.99*
	0.10	*0.21*	*0.50*	*0.10*	*0.05*	*1.00*	*0.78*	*0.88*
	0.00	*0.46*	*0.00*	*0.00*	*0.00*	*0.06*	*0.43*	*0.57*
KO_{VT}	0.0021	0.0028	0.0032	0.0034	0.0017	0.0032	0.0031	0.0030
	0.29	*0.66*	*0.94*	*0.37*	*0.22*	*1.00*	*1.00*	*1.00*
	0.05	*0.06*	*0.58*	*0.20*	*0.02*	*0.94*	*0.98*	*1.00*
	0.20	*0.34*	*0.90*	*0.23*	*0.11*	*1.00*	*0.97*	*0.99*
	0.01	*0.78*	*0.08*	*0.01*	*0.00*	*0.27*	*0.70*	*0.74*
KO_{RT}	0.0031	0.0030	0.0025	0.0036	0.0029	0.0044	0.0023	0.0016
	0.44	*0.69*	*0.90*	*0.40*	*0.32*	*1.00*	*0.99*	*1.00*
	0.10	*0.08*	*0.43*	*0.22*	*0.04*	*0.95*	*0.94*	*0.96*
	0.32	*0.37*	*0.84*	*0.25*	*0.17*	*1.00*	*0.93*	*0.73*
	0.08	*0.78*	*0.02*	*0.01*	*0.01*	*0.45*	*0.50*	*0.38*
KO_{BT}	0.0035	0.0029	0.0011	0.0027	0.0021	0.0039	0.0014	0.0015
	0.51	*0.67*	*0.75*	*0.28*	*0.25*	*1.00*	*0.91*	*1.00*
	0.14	*0.08*	*0.22*	*0.14*	*0.03*	*0.94*	*0.75*	*0.93*
	0.39	*0.36*	*0.65*	*0.16*	*0.13*	*1.00*	*0.72*	*0.66*
	0.18	*0.74*	*0.01*	*0.00*	*0.00*	*0.37*	*0.36*	*0.36*

Table IA.31: Sharpe Ratio Comparison with 50 bps Transaction Costs: $h = 120$ and $\gamma = 3$

This table reports the Sharpe ratio of the portfolios studied in this paper with $h = 120$, $\gamma = 3$, and a transaction cost of 50 bps, based on the eight datasets containing excess monthly returns. The four newly obtained optimal combining portfolios, i.e., $\hat{w}_{q,t}$, $\hat{w}^{LW2004}_{q,t}$, $\hat{w}^{LW2017}_{q,t}$, and $\hat{w}^{MP}_{q,t}$, are highlighted with a box around. In the three categories to which the four new portfolios belong, one-sided tests are conducted to assess the value of using the newly derived optimal combining coefficient $\hat{c}_t$, and the p-values are reported in *italics*. For the portfolios in the remaining three categories, one-sided tests are conducted to compare them with the four newly obtained portfolios, and the corresponding p-values are reported in the four rows below the portfolio Sharpe ratio. We set $\eta = 4$ for the timing strategies KO_{VT}, KO_{RT}, and KO_{BT}.

	Momentum $N = 10$	Size-B/M $N = 25$	IVOL $N = 10$	OP-Inv $N = 25$	NM-V (LT) $N = 16$	NM-V (All) $N = 46$	Industry $N = 49$	Stocks $N = 100$
w^*	0.2483	0.2501	0.2132	0.3055	0.2988	0.4175	0.2716	0.2625
				Invariant Optimal Portfolio Rules				
$\boxed{\hat{w}_{q,t}}$	0.1579	0.0529	0.1278	0.0605	0.0570	0.0597	−0.0048	−0.2267
$\hat{w}_{p,t}$	0.0964	−0.0459	0.0615	−0.1304	−0.0750	−0.1922	−0.2239	−0.1315
	0.00	*0.01*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.95*
$\hat{w}_{u,t}$	0.1093	−0.1106	0.0518	−0.0727	−0.0418	−0.0802	−0.1090	−0.2103
	0.00	*0.00*	*0.00*	*0.00*	*0.00*	*0.01*	*0.04*	*0.62*
$\hat{w}_{BS,t}$	0.1498	−0.0125	0.1106	0.0054	0.0257	−0.0883	−0.1012	−0.2344
	0.00	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.44*
				Rules with Shrinkage Covariance Matrix Estimators				
$\boxed{\hat{w}^{LW2004}_{q,t}}$	0.2067	0.1699	0.1842	0.1342	0.1722	0.5456	0.0981	0.0274
$\hat{w}^{LW2004}_{p,t}$	0.1642	0.0360	0.1384	−0.0076	0.0800	0.0613	−0.1482	−0.1271
	0.00	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*
$\boxed{\hat{w}^{LW2017}_{q,t}}$	0.1781	0.1321	0.1458	0.1370	0.1002	0.4810	0.1100	0.0838
$\hat{w}^{LW2017}_{p,t}$	0.1258	−0.0409	0.0892	−0.0066	−0.0112	−0.0576	−0.0923	−0.2041
	0.00	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*
				Rules with MacKinlay-Pástor Single Factor Structure				
$\boxed{\hat{w}^{MP}_{q,t}}$	0.1551	0.1285	0.1312	0.1952	0.1144	0.2071	0.1508	0.1581
$\hat{w}^{MP}_{p,t}$	0.1330	0.0704	0.0513	0.0383	0.0281	0.0380	0.0815	0.0432
	0.07	*0.04*	*0.00*	*0.00*	*0.00*	*0.00*	*0.08*	*0.01*
				Rule with No-Short-Sale Constraints				
$\hat{w}^{NS}_{p,t}$	0.1809	0.1504	0.1110	0.1445	0.1570	0.2441	0.0831	0.0732
	0.76	*0.99*	*0.32*	*0.96*	*0.97*	*1.00*	*0.97*	*1.00*
	0.19	*0.27*	*0.01*	*0.59*	*0.36*	*0.00*	*0.36*	*0.86*
	0.54	*0.69*	*0.16*	*0.57*	*0.88*	*0.00*	*0.26*	*0.40*
	0.88	*0.77*	*0.18*	*0.09*	*0.91*	*0.78*	*0.10*	*0.04*

Table IA.31: Sharpe Ratio Comparison with 50 bps Transactions Costs: $h = 120$ and $\gamma = 3$ (Cont'd)

	Momentum $N = 10$	Size-B/M $N = 25$	IVOL $N = 10$	OP-Inv $N = 25$	NM-V (LT) $N = 16$	NM-V (All) $N = 46$	Industry $N = 49$	Stocks $N = 100$
				Other Rules from Portfolio Optimization				
$\hat{w}_{g,t}$	0.1505	0.1127	0.0722	0.1163	0.1227	−0.0509	0.0199	−0.2106
	0.42	*0.96*	*0.08*	*0.92*	*0.92*	*0.06*	*0.80*	*0.98*
	0.04	*0.02*	*0.00*	*0.30*	*0.10*	*0.00*	*0.00*	*0.00*
	0.22	*0.27*	*0.03*	*0.28*	*0.69*	*0.00*	*0.00*	*0.00*
	0.40	*0.25*	*0.00*	*0.00*	*0.62*	*0.00*	*0.00*	*0.00*
$\hat{w}_{g,t}^{NS}$	0.1360	0.1514	0.1627	0.1721	0.1174	0.2135	0.1611	0.1085
	0.28	*0.99*	*0.83*	*0.99*	*0.87*	*0.98*	*1.00*	*1.00*
	0.02	*0.28*	*0.25*	*0.81*	*0.11*	*0.00*	*0.98*	*1.00*
	0.13	*0.70*	*0.68*	*0.78*	*0.63*	*0.00*	*0.95*	*0.88*
	0.15	*0.84*	*0.94*	*0.21*	*0.56*	*0.57*	*0.63*	*0.05*
$\hat{w}_{KZ3,t}$	−0.1050	−0.0845	−0.0932	−0.0761	−0.1034	−0.2780	−0.1239	−0.0433
	0.00	*0.00*	*0.00*	*0.01*	*0.01*	*0.00*	*0.01*	*1.00*
	0.00	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.10*
	0.00	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.01*
	0.00	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*
				Non-Optimization Rules				
$1/N$	0.1258	0.1468	0.1208	0.1405	0.1191	0.1013	0.1490	0.1130
	0.21	*0.99*	*0.43*	*0.94*	*0.86*	*0.71*	*1.00*	*1.00*
	0.01	*0.26*	*0.04*	*0.55*	*0.14*	*0.00*	*0.88*	*0.99*
	0.09	*0.64*	*0.26*	*0.53*	*0.64*	*0.00*	*0.82*	*0.82*
	0.12	*0.71*	*0.35*	*0.06*	*0.56*	*0.02*	*0.48*	*0.12*
KO_{VT}	0.1434	0.1602	0.1596	0.1662	0.1301	0.1704	0.1834	0.1484
	0.35	*1.00*	*0.80*	*0.98*	*0.91*	*0.94*	*1.00*	*1.00*
	0.04	*0.38*	*0.23*	*0.76*	*0.18*	*0.00*	*0.99*	*1.00*
	0.18	*0.77*	*0.65*	*0.73*	*0.72*	*0.00*	*0.98*	*1.00*
	0.28	*0.90*	*0.91*	*0.17*	*0.74*	*0.18*	*0.83*	*0.36*
KO_{RT}	0.1617	0.1578	0.1349	0.1644	0.1574	0.1951	0.1373	0.0894
	0.54	*1.00*	*0.58*	*0.99*	*0.97*	*0.97*	*1.00*	*1.00*
	0.08	*0.36*	*0.07*	*0.76*	*0.37*	*0.00*	*0.88*	*0.97*
	0.32	*0.75*	*0.38*	*0.73*	*0.88*	*0.00*	*0.79*	*0.57*
	0.64	*0.83*	*0.56*	*0.16*	*0.92*	*0.38*	*0.37*	*0.03*
KO_{BT}	0.1711	0.1640	0.1237	0.1659	0.1701	0.1812	0.1507	0.1128
	0.64	*1.00*	*0.46*	*0.98*	*0.98*	*0.95*	*1.00*	*1.00*
	0.14	*0.43*	*0.04*	*0.76*	*0.48*	*0.00*	*0.89*	*0.99*
	0.42	*0.79*	*0.28*	*0.73*	*0.91*	*0.00*	*0.83*	*0.81*
	0.82	*0.87*	*0.39*	*0.18*	*0.96*	*0.27*	*0.50*	*0.11*

Table IA.32: Sharpe Ratio Comparison with 50 bps Transaction Costs: $h = 240$ and $\gamma = 3$

This table reports the Sharpe ratio of the portfolios studied in this paper with $h = 240$, $\gamma = 3$, and a transaction cost of 50 bps, based on the eight datasets containing excess monthly returns. The four newly obtained optimal combining portfolios, i.e., $\hat{w}_{q,t}$, $\hat{w}_{q,t}^{LW2004}$, $\hat{w}_{q,t}^{LW2017}$, and $\hat{w}_{q,t}^{MP}$, are highlighted with a box around. In the three categories to which the four new portfolios belong, one-sided tests are conducted to assess the value of using the newly derived optimal combining coefficient $\hat{c}_t$, and the p-values are reported in *italics*. For the portfolios in the remaining three categories, one-sided tests are conducted to compare them with the four newly obtained portfolios, and the corresponding p-values are reported in the four rows below the portfolio Sharpe ratio. We set $\eta = 4$ for the timing strategies KO_{VT}, KO_{RT}, and KO_{BT}.

	Momentum $N = 10$	Size-B/M $N = 25$	IVOL $N = 10$	OP-Inv $N = 25$	NM-V (LT) $N = 16$	NM-V (All) $N = 46$	Industry $N = 49$	Stocks $N = 100$
w^*	0.2636	0.2588	0.2536	0.3124	0.3029	0.3878	0.3085	0.2905
				Invariant Optimal Portfolio Rules				
$\boxed{\hat{w}_{q,t}}$	0.1883	0.1296	0.1475	0.1722	0.1724	−0.0671	0.0319	0.0051
$\hat{w}_{p,t}$	0.1494	0.0050	0.0905	0.0504	0.0886	−0.1830	−0.1621	−0.3273
	0.00	*0.00*	*0.00*	*0.00*	*0.00*	*0.06*	*0.00*	*0.00*
$\hat{w}_{u,t}$	0.1557	−0.0242	0.1052	0.0674	0.1015	−0.1252	−0.0983	−0.2593
	0.00	*0.00*	*0.00*	*0.00*	*0.00*	*0.20*	*0.02*	*0.00*
$\hat{w}_{BS,t}$	0.1852	0.1004	0.1426	0.1287	0.1547	−0.1067	−0.0472	−0.1428
	0.03	*0.00*	*0.01*	*0.00*	*0.00*	*0.28*	*0.00*	*0.00*
				Rules with Shrinkage Covariance Matrix Estimators				
$\boxed{\hat{w}_{q,t}^{LW2004}}$	0.2160	0.1905	0.1776	0.1932	0.2370	0.1448	0.0636	0.0702
$\hat{w}_{p,t}^{LW2004}$	0.1868	0.1068	0.1482	0.0787	0.1643	0.0384	−0.0697	−0.2604
	0.00	*0.00*	*0.00*	*0.00*	*0.00*	*0.01*	*0.03*	*0.00*
$\boxed{\hat{w}_{q,t}^{LW2017}}$	0.1984	0.1588	0.1536	0.1909	0.1964	0.1336	0.0671	0.1110
$\hat{w}_{p,t}^{LW2017}$	0.1616	0.0391	0.0089	0.0772	0.1168	−0.0931	−0.0635	−0.1886
	0.00	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.04*	*0.00*
				Rules with MacKinlay-Pástor Single Factor Structure				
$\boxed{\hat{w}_{q,t}^{MP}}$	0.2000	0.1695	0.2067	0.2713	0.2115	0.2156	0.1586	0.1570
$\hat{w}_{p,t}^{MP}$	0.1627	0.1278	0.1112	0.1191	0.1340	0.1174	0.1101	0.0980
	0.00	*0.05*	*0.00*	*0.00*	*0.00*	*0.01*	*0.19*	*0.17*
				Rule with No-Short-Sale Constraints				
$\hat{w}_{p,t}^{NS}$	0.2016	0.1669	0.1301	0.1714	0.1680	0.1864	0.0668	0.1141
	0.64	*0.81*	*0.32*	*0.49*	*0.47*	*1.00*	*0.74*	*0.99*
	0.34	*0.27*	*0.09*	*0.34*	*0.14*	*0.68*	*0.53*	*0.84*
	0.53	*0.58*	*0.27*	*0.36*	*0.33*	*0.72*	*0.50*	*0.53*
	0.53	*0.46*	*0.00*	*0.00*	*0.06*	*0.31*	*0.04*	*0.21*

Table IA.32: Sharpe Ratio Comparison with 50 bps Transactions Costs: $h = 240$ and $\gamma = 3$ (Cont'd)

	Momentum $N = 10$	Size-B/M $N = 25$	IVOL $N = 10$	OP-Inv $N = 25$	NM-V (LT) $N = 16$	NM-V (All) $N = 46$	Industry $N = 49$	Stocks $N = 100$
				Other Rules from Portfolio Optimization				
$\hat{w}_{g,t}$	0.1793	0.1912	0.1135	0.2328	0.2209	0.1746	0.0640	0.0119
	0.41	*0.95*	*0.22*	*0.90*	*0.79*	*1.00*	*0.79*	*0.93*
	0.17	*0.51*	*0.06*	*0.81*	*0.39*	*0.64*	*0.50*	*0.00*
	0.31	*0.80*	*0.18*	*0.82*	*0.66*	*0.69*	*0.47*	*0.00*
	0.14	*0.82*	*0.00*	*0.02*	*0.63*	*0.25*	*0.02*	*0.00*
$\hat{w}^{NS}_{g,t}$	0.1500	0.1711	0.1871	0.2003	0.1584	0.2088	0.1723	0.1601
	0.19	*0.83*	*0.84*	*0.69*	*0.42*	*1.00*	*1.00*	*1.00*
	0.06	*0.32*	*0.60*	*0.55*	*0.12*	*0.76*	*0.99*	*1.00*
	0.13	*0.61*	*0.80*	*0.57*	*0.29*	*0.80*	*0.99*	*0.99*
	0.00	*0.54*	*0.12*	*0.01*	*0.00*	*0.44*	*0.63*	*0.53*
$\hat{w}_{KZ3,t}$	−0.0074	0.1218	−0.1148	0.2268	0.1642	−0.1297	0.0394	−0.0047
	0.00	*0.38*	*0.00*	*0.99*	*0.40*	*0.24*	*0.77*	*0.05*
	0.00	*0.00*	*0.00*	*0.95*	*0.01*	*0.00*	*0.03*	*0.00*
	0.00	*0.06*	*0.00*	*0.94*	*0.15*	*0.00*	*0.04*	*0.00*
	0.00	*0.10*	*0.00*	*0.10*	*0.22*	*0.00*	*0.01*	*0.00*
				Non-Optimization Rules				
$1/N$	0.1333	0.1590	0.1264	0.1503	0.1197	0.1127	0.1512	0.1636
	0.11	*0.74*	*0.31*	*0.36*	*0.24*	*0.97*	*0.98*	*1.00*
	0.03	*0.23*	*0.11*	*0.24*	*0.05*	*0.37*	*0.94*	*0.99*
	0.07	*0.50*	*0.26*	*0.26*	*0.15*	*0.42*	*0.93*	*0.92*
	0.00	*0.33*	*0.00*	*0.00*	*0.00*	*0.05*	*0.45*	*0.55*
KO_{VT}	0.1553	0.1724	0.1792	0.1844	0.1511	0.1790	0.1763	0.1743
	0.22	*0.83*	*0.79*	*0.58*	*0.38*	*1.00*	*1.00*	*1.00*
	0.07	*0.33*	*0.52*	*0.44*	*0.11*	*0.64*	*0.99*	*1.00*
	0.16	*0.62*	*0.74*	*0.46*	*0.26*	*0.68*	*0.98*	*0.99*
	0.00	*0.56*	*0.05*	*0.00*	*0.00*	*0.23*	*0.66*	*0.69*
KO_{RT}	0.1809	0.1783	0.1620	0.1906	0.1768	0.2106	0.1524	0.1396
	0.42	*0.87*	*0.64*	*0.63*	*0.53*	*1.00*	*0.99*	*1.00*
	0.18	*0.38*	*0.34*	*0.48*	*0.18*	*0.76*	*0.98*	*0.97*
	0.33	*0.68*	*0.59*	*0.50*	*0.39*	*0.80*	*0.97*	*0.80*
	0.11	*0.66*	*0.01*	*0.00*	*0.04*	*0.46*	*0.45*	*0.34*
KO_{BT}	0.1895	0.1800	0.1400	0.1696	0.1633	0.1977	0.1423	0.1383
	0.51	*0.87*	*0.43*	*0.48*	*0.45*	*1.00*	*0.96*	*1.00*
	0.24	*0.40*	*0.18*	*0.34*	*0.14*	*0.71*	*0.91*	*0.96*
	0.41	*0.69*	*0.37*	*0.36*	*0.32*	*0.75*	*0.90*	*0.77*
	0.24	*0.68*	*0.00*	*0.00*	*0.02*	*0.37*	*0.38*	*0.35*

Table IA.33: Sharpe Ratio Comparison with 50 bps Transaction Costs: $h = 120$ and $\gamma = 5$

This table reports the Sharpe ratio of the portfolios studied in this paper with $h = 120$, $\gamma = 5$, and a transaction cost of 50 bps, based on the eight datasets containing excess monthly returns. The four newly obtained optimal combining portfolios, i.e., $\hat{w}_{q,t}$, $\hat{w}_{q,t}^{LW2004}$, $\hat{w}_{q,t}^{LW2017}$, and $\hat{w}_{q,t}^{MP}$, are highlighted with a box around. In the three categories to which the four new portfolios belong, one-sided tests are conducted to assess the value of using the newly derived optimal combining coefficient $\hat{c}_t$, and the p-values are reported in *italics*. For the portfolios in the remaining three categories, one-sided tests are conducted to compare them with the four newly obtained portfolios, and the corresponding p-values are reported in the four rows below the portfolio Sharpe ratio. We set $\eta = 4$ for the timing strategies KO_{VT}, KO_{RT}, and KO_{BT}.

	Momentum $N = 10$	Size-B/M $N = 25$	IVOL $N = 10$	OP-Inv $N = 25$	NM-V (LT) $N = 16$	NM-V (All) $N = 46$	Industry $N = 49$	Stocks $N = 100$
w^*	0.2688	0.2942	0.2305	0.3468	0.3473	0.5924	0.3116	0.2952
				Invariant Optimal Portfolio Rules				
$\boxed{\hat{w}_{q,t}}$	0.1941	0.1053	0.1707	0.0996	0.1102	0.2153	0.0135	−0.2197
$\hat{w}_{p,t}$	0.1526	−0.0538	0.1269	−0.0290	0.0170	−0.0624	−0.1792	−0.1393
	0.00	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.92*
$\hat{w}_{u,t}$	0.1608	−0.0128	0.1350	0.0020	0.0370	−0.0492	−0.1251	−0.0729
	0.00	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.99*
$\hat{w}_{BS,t}$	0.1892	0.0568	0.1634	0.0579	0.0871	0.0592	−0.0573	−0.3203
	0.04	*0.00*	*0.00*	*0.00*	*0.01*	*0.00*	*0.02*	*0.01*
				Rules with Shrinkage Covariance Matrix Estimators				
$\boxed{\hat{w}_{q,t}^{LW2004}}$	0.2284	0.1955	0.1999	0.1623	0.1941	0.5802	0.1097	0.0284
$\hat{w}_{p,t}^{LW2004}$	0.2037	0.1042	0.1735	0.0576	0.1291	0.3196	−0.0739	−0.2525
	0.01	*0.00*	*0.00*	*0.00*	*0.01*	*0.00*	*0.00*	*0.00*
$\boxed{\hat{w}_{q,t}^{LW2017}}$	0.2100	0.1702	0.1822	0.1666	0.1435	0.5393	0.1228	0.0844
$\hat{w}_{p,t}^{LW2017}$	0.1764	0.0539	0.1467	0.0642	0.0606	0.3031	−0.0613	−0.1516
	0.00	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*
				Rules with MacKinlay-Pástor Single Factor Structure				
$\boxed{\hat{w}_{q,t}^{MP}}$	0.1572	0.1249	0.1537	0.2026	0.1259	0.2162	0.1494	0.1581
$\hat{w}_{p,t}^{MP}$	0.1559	0.1168	0.1115	0.1203	0.0771	0.1287	0.1290	0.1027
	0.45	*0.37*	*0.01*	*0.01*	*0.01*	*0.01*	*0.28*	*0.09*
				Rule with No-Short-Sale Constraints				
$\hat{w}_{p,t}^{NS}$	0.1816	0.1545	0.1295	0.1459	0.1498	0.2338	0.1080	0.0863
	0.34	*0.92*	*0.10*	*0.86*	*0.80*	*0.61*	*0.98*	*1.00*
	0.03	*0.06*	*0.00*	*0.33*	*0.11*	*0.00*	*0.48*	*0.93*
	0.16	*0.31*	*0.04*	*0.30*	*0.56*	*0.00*	*0.35*	*0.52*
	0.86	*0.83*	*0.14*	*0.06*	*0.77*	*0.63*	*0.20*	*0.06*

Table IA.33: Sharpe Ratio Comparison with 50 bps Transactions Costs: $h = 120$ and $\gamma = 5$ (Cont'd)

	Momentum $N = 10$	Size-B/M $N = 25$	IVOL $N = 10$	OP-Inv $N = 25$	NM-V (LT) $N = 16$	NM-V (All) $N = 46$	Industry $N = 49$	Stocks $N = 100$
				Other Rules from Portfolio Optimization				
$\hat{w}_{g,t}$	0.1505	0.1127	0.0722	0.1163	0.1227	−0.0509	0.0199	−0.2106
	0.07	*0.61*	*0.00*	*0.72*	*0.63*	*0.00*	*0.63*	*0.97*
	0.00	*0.00*	*0.00*	*0.03*	*0.01*	*0.00*	*0.00*	*0.00*
	0.02	*0.01*	*0.00*	*0.03*	*0.28*	*0.00*	*0.00*	*0.00*
	0.34	*0.31*	*0.00*	*0.00*	*0.45*	*0.00*	*0.00*	*0.00*
$\hat{w}_{g,t}^{NS}$	0.1360	0.1514	0.1627	0.1721	0.1174	0.2135	0.1611	0.1085
	0.04	*0.90*	*0.40*	*0.96*	*0.56*	*0.49*	*1.00*	*1.00*
	0.00	*0.05*	*0.08*	*0.61*	*0.02*	*0.00*	*0.97*	*1.00*
	0.01	*0.28*	*0.27*	*0.56*	*0.28*	*0.00*	*0.92*	*0.88*
	0.13	*0.85*	*0.67*	*0.16*	*0.36*	*0.47*	*0.64*	*0.05*
$\hat{w}_{KZ3,t}$	−0.1050	−0.0845	−0.0932	−0.0761	−0.1034	−0.2780	−0.1239	−0.0433
	0.00	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.01*	*1.00*
	0.00	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.10*
	0.00	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.01*
	0.00	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*
				Non-Optimization Rules				
$1/N$	0.1258	0.1468	0.1208	0.1405	0.1191	0.1013	0.1490	0.1130
	0.03	*0.86*	*0.09*	*0.81*	*0.57*	*0.06*	*1.00*	*1.00*
	0.00	*0.06*	*0.01*	*0.30*	*0.04*	*0.00*	*0.83*	*0.99*
	0.01	*0.26*	*0.04*	*0.28*	*0.31*	*0.00*	*0.74*	*0.81*
	0.12	*0.73*	*0.13*	*0.05*	*0.42*	*0.02*	*0.50*	*0.12*
KO_{VT}	0.1434	0.1602	0.1596	0.1662	0.1301	0.1704	0.1834	0.1484
	0.06	*0.93*	*0.37*	*0.94*	*0.66*	*0.26*	*1.00*	*1.00*
	0.00	*0.10*	*0.07*	*0.54*	*0.05*	*0.00*	*0.99*	*1.00*
	0.02	*0.38*	*0.24*	*0.50*	*0.39*	*0.00*	*0.97*	*1.00*
	0.25	*0.90*	*0.61*	*0.13*	*0.56*	*0.16*	*0.83*	*0.36*
KO_{RT}	0.1617	0.1578	0.1349	0.1644	0.1574	0.1951	0.1373	0.0894
	0.15	*0.92*	*0.15*	*0.94*	*0.84*	*0.39*	*1.00*	*1.00*
	0.01	*0.10*	*0.01*	*0.52*	*0.16*	*0.00*	*0.79*	*0.97*
	0.05	*0.36*	*0.08*	*0.48*	*0.62*	*0.00*	*0.67*	*0.57*
	0.59	*0.84*	*0.23*	*0.13*	*0.83*	*0.32*	*0.39*	*0.03*
KO_{BT}	0.1711	0.1640	0.1237	0.1659	0.1701	0.1812	0.1507	0.1128
	0.23	*0.94*	*0.10*	*0.93*	*0.89*	*0.32*	*1.00*	*1.00*
	0.02	*0.15*	*0.01*	*0.54*	*0.27*	*0.00*	*0.85*	*0.99*
	0.10	*0.43*	*0.05*	*0.49*	*0.72*	*0.00*	*0.75*	*0.81*
	0.77	*0.88*	*0.15*	*0.15*	*0.91*	*0.23*	*0.51*	*0.11*

Table IA.34: Sharpe Ratio Comparison with 50 bps Transaction Costs: $h = 240$ and $\gamma = 5$

This table reports the Sharpe ratio of the portfolios studied in this paper with $h = 240$, $\gamma = 5$, and a transaction cost of 50 bps, based on the eight datasets containing excess monthly returns. The four newly obtained optimal combining portfolios, i.e., $\hat{w}_{q,t}$, $\hat{w}_{q,t}^{LW2004}$, $\hat{w}_{q,t}^{LW2017}$, and $\hat{w}_{q,t}^{MP}$, are highlighted with a box around. In the three categories to which the four new portfolios belong, one-sided tests are conducted to assess the value of using the newly derived optimal combining coefficient $\hat{c}_t$, and the p-values are reported in *italics*. For the portfolios in the remaining three categories, one-sided tests are conducted to compare them with the four newly obtained portfolios, and the corresponding p-values are reported in the four rows below the portfolio Sharpe ratio. We set $\eta = 4$ for the timing strategies KO_{VT}, KO_{RT}, and KO_{BT}.

	Momentum $N = 10$	Size-B/M $N = 25$	IVOL $N = 10$	OP-Inv $N = 25$	NM-V (LT) $N = 16$	NM-V (All) $N = 46$	Industry $N = 49$	Stocks $N = 100$
w^*	0.2870	0.3149	0.2858	0.3608	0.3628	0.5117	0.3598	0.3381
				Invariant Optimal Portfolio Rules				
$\boxed{\hat{w}_{q,t}}$	0.2283	0.1871	0.1877	0.2178	0.2340	0.0942	0.0525	0.0081
$\hat{w}_{p,t}$	0.2029	0.1058	0.1598	0.1168	0.1680	−0.0670	−0.0912	−0.2648
	0.00	*0.00*	*0.00*	*0.00*	*0.00*	*0.01*	*0.01*	*0.00*
$\hat{w}_{u,t}$	0.2067	0.1226	0.1634	0.1297	0.1778	−0.0363	−0.0643	−0.1924
	0.00	*0.00*	*0.00*	*0.00*	*0.00*	*0.01*	*0.01*	*0.00*
$\hat{w}_{BS,t}$	0.2263	0.1681	0.1841	0.1824	0.2203	0.0209	−0.0078	−0.0968
	0.11	*0.00*	*0.02*	*0.00*	*0.01*	*0.00*	*0.03*	*0.00*
				Rules with Shrinkage Covariance Matrix Estimators				
$\boxed{\hat{w}_{q,t}^{LW2004}}$	0.2488	0.2330	0.2059	0.2340	0.2829	0.3311	0.0881	0.0724
$\hat{w}_{p,t}^{LW2004}$	0.2317	0.1769	0.1873	0.1389	0.2257	−0.0274	−0.0711	−0.1807
	0.01	*0.00*	*0.01*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*
$\boxed{\hat{w}_{q,t}^{LW2017}}$	0.2370	0.2107	0.1925	0.2332	0.2545	0.2680	0.0937	0.1128
$\hat{w}_{p,t}^{LW2017}$	0.2141	0.1403	0.1672	0.1388	0.1911	0.0425	−0.0737	−0.1335
	0.00	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*
				Rules with MacKinlay-Pástor Single Factor Structure				
$\boxed{\hat{w}_{q,t}^{MP}}$	0.2060	0.1564	0.2096	0.2773	0.2436	0.2209	0.1545	0.1564
$\hat{w}_{p,t}^{MP}$	0.1969	0.1691	0.1734	0.2186	0.2032	0.2058	0.1528	0.1648
	0.15	*0.74*	*0.03*	*0.02*	*0.00*	*0.29*	*0.48*	*0.57*
				Rule with No-Short-Sale Constraints				
$\hat{w}_{p,t}^{NS}$	0.2002	0.1647	0.1580	0.1840	0.1738	0.1884	0.0880	0.1253
	0.20	*0.28*	*0.19*	*0.24*	*0.16*	*0.85*	*0.77*	*1.00*
	0.06	*0.02*	*0.06*	*0.13*	*0.02*	*0.06*	*0.50*	*0.90*
	0.14	*0.11*	*0.15*	*0.14*	*0.09*	*0.19*	*0.45*	*0.63*
	0.40	*0.62*	*0.01*	*0.01*	*0.01*	*0.33*	*0.09*	*0.26*

Table IA.34: Sharpe Ratio Comparison with 50 bps Transactions Costs: $h = 240$ and $\gamma = 5$ (Cont'd)

	Momentum $N = 10$	Size-B/M $N = 25$	IVOL $N = 10$	OP-Inv $N = 25$	NM-V (LT) $N = 16$	NM-V (All) $N = 46$	Industry $N = 49$	Stocks $N = 100$
				Other Rules from Portfolio Optimization				
$\hat{w}_{g,t}$	0.1793	0.1912	0.1135	0.2328	0.2209	0.1746	0.0640	0.0119
	0.07	*0.55*	*0.03*	*0.66*	*0.40*	*0.84*	*0.66*	*0.92*
	0.01	*0.07*	*0.01*	*0.49*	*0.09*	*0.03*	*0.18*	*0.00*
	0.04	*0.27*	*0.02*	*0.50*	*0.25*	*0.13*	*0.15*	*0.00*
	0.05	*0.91*	*0.00*	*0.02*	*0.20*	*0.23*	*0.03*	*0.00*
$\hat{w}^{NS}_{g,t}$	0.1500	0.1711	0.1871	0.2003	0.1584	0.2088	0.1723	0.1601
	0.02	*0.34*	*0.49*	*0.36*	*0.12*	*0.90*	*1.00*	*1.00*
	0.00	*0.04*	*0.28*	*0.23*	*0.02*	*0.09*	*0.99*	*1.00*
	0.01	*0.15*	*0.44*	*0.25*	*0.06*	*0.25*	*0.98*	*0.98*
	0.00	*0.75*	*0.13*	*0.01*	*0.00*	*0.42*	*0.66*	*0.54*
$\hat{w}_{KZ3,t}$	−0.0074	0.1218	−0.1148	0.2268	0.1642	−0.1297	0.0394	−0.0047
	0.00	*0.00*	*0.00*	*0.74*	*0.01*	*0.00*	*0.13*	*0.03*
	0.00	*0.00*	*0.00*	*0.29*	*0.00*	*0.00*	*0.00*	*0.00*
	0.00	*0.00*	*0.00*	*0.34*	*0.00*	*0.00*	*0.00*	*0.00*
	0.00	*0.18*	*0.00*	*0.06*	*0.09*	*0.00*	*0.01*	*0.00*
				Non-Optimization Rules				
$1/N$	0.1333	0.1590	0.1264	0.1503	0.1197	0.1127	0.1512	0.1636
	0.01	*0.25*	*0.07*	*0.11*	*0.05*	*0.58*	*0.96*	*1.00*
	0.00	*0.02*	*0.02*	*0.06*	*0.01*	*0.01*	*0.88*	*0.99*
	0.00	*0.10*	*0.05*	*0.07*	*0.02*	*0.06*	*0.86*	*0.91*
	0.00	*0.53*	*0.01*	*0.00*	*0.00*	*0.09*	*0.48*	*0.56*
KO_{VT}	0.1553	0.1724	0.1792	0.1844	0.1511	0.1790	0.1763	0.1743
	0.03	*0.36*	*0.41*	*0.26*	*0.10*	*0.82*	*0.99*	*1.00*
	0.00	*0.04*	*0.21*	*0.16*	*0.02*	*0.05*	*0.98*	*1.00*
	0.01	*0.16*	*0.35*	*0.17*	*0.05*	*0.17*	*0.97*	*0.99*
	0.00	*0.74*	*0.08*	*0.01*	*0.00*	*0.26*	*0.69*	*0.70*
KO_{RT}	0.1809	0.1783	0.1620	0.1906	0.1768	0.2106	0.1524	0.1396
	0.09	*0.41*	*0.24*	*0.29*	*0.18*	*0.90*	*0.98*	*1.00*
	0.02	*0.06*	*0.09*	*0.18*	*0.03*	*0.10*	*0.94*	*0.97*
	0.05	*0.20*	*0.19*	*0.19*	*0.10*	*0.27*	*0.92*	*0.79*
	0.09	*0.78*	*0.03*	*0.01*	*0.01*	*0.44*	*0.48*	*0.35*
KO_{BT}	0.1895	0.1800	0.1400	0.1696	0.1633	0.1977	0.1423	0.1383
	0.13	*0.43*	*0.11*	*0.18*	*0.13*	*0.87*	*0.94*	*1.00*
	0.04	*0.07*	*0.04*	*0.10*	*0.02*	*0.08*	*0.84*	*0.95*
	0.09	*0.22*	*0.09*	*0.11*	*0.07*	*0.23*	*0.82*	*0.76*
	0.18	*0.78*	*0.01*	*0.00*	*0.00*	*0.37*	*0.41*	*0.35*