Technical Appendices to
"On Managerially Efficient Experimental Designs"

Olivier Toubia and John Hauser, *Marketing Science*, forthcoming

Technical appendix 1: M-balanced and M-orthogonal designs may not minimize M-errors

Managerial quantities:

$$M=\begin{bmatrix} 0 & 0 & 1.1002 & 0 & -0.1375 & 0.1375 & -0.1375 \\ 0 & 0 & 0 & 0 & 1.0199 & -0.1298 & -0.1669 \\ 0 & 0 & 0 & 0 & 0 & 0.7547 & -0.4047 \\ 0 & 0 & 0 & 0 & 0 & 0 & 1 \end{bmatrix}$$

Balanced and Orthogonal design, X:

$$X=\begin{bmatrix} +1 & +1 & -1 & -1 & -1 & -1 & -1 \\ +1 & -1 & +1 & -1 & +1 & +1 & +1 \\ +1 & +1 & +1 & +1 & -1 & +1 & +1 \\ +1 & -1 & -1 & +1 & +1 & -1 & +1 \\ +1 & +1 & +1 & -1 & +1 & +1 & -1 \\ +1 & +1 & -1 & +1 & -1 & +1 & +1 \\ +1 & +1 & -1 & -1 & +1 & -1 & +1 \\ +1 & -1 & -1 & -1 & -1 & +1 & -1 \\ +1 & -1 & +1 & -1 & -1 & -1 & +1 \\ +1 & -1 & +1 & +1 & -1 & -1 & -1 \\ +1 & +1 & +1 & +1 & +1 & -1 & -1 \\ +1 & -1 & -1 & +1 & +1 & +1 & -1 \end{bmatrix}$$

Covariance matrix of managerial estimates under X:

$$M.(X'.X)^{-1}.M'=\begin{bmatrix} 0.1056 & -0.0113 & 0.0133 & -0.0115 \\ -0.0113 & 0.0904 & -0.0025 & -0.0139 \\ 0.0113 & -0.0025 & 0.0611 & -0.0337 \\ -0.0115 & -0.0139 & -0.0337 & 0.0833 \end{bmatrix}$$

M_A-error(X)= 1.0214
M_D-error(X)= 0.9202

M-orthogonal and M-balanced design, Y:

$$Y=\begin{bmatrix} +1 & -1 & -1 & -1 & -1 & -1 & -1 \\ +1 & +1 & +1 & -1 & +1 & +1 & +1 \\ +1 & +1 & +1 & +1 & -1 & +1 & +1 \\ +1 & -1 & -1 & +1 & +1 & -1 & +1 \\ +1 & +1 & +1 & -1 & +1 & +1 & -1 \\ +1 & +1 & -1 & -1 & -1 & +1 & +1 \\ +1 & +1 & -1 & +1 & +1 & -1 & +1 \\ +1 & -1 & -1 & -1 & -1 & +1 & -1 \\ +1 & -1 & +1 & -1 & -1 & -1 & +1 \\ +1 & -1 & +1 & +1 & -1 & -1 & -1 \\ +1 & +1 & +1 & +1 & +1 & +1 & -1 \\ +1 & -1 & -1 & +1 & +1 & -1 & -1 \end{bmatrix}$$

Covariance matrix of managerial estimates under Y:

$$M.(Y'.Y)^{-1}.M'=\begin{bmatrix} 0.1135 & 0 & 0 & 0 \\ 0 & 0.1135 & 0 & 0 \\ 0 & 0 & 0.1135 & 0 \\ 0 & 0 & 0 & 0.1135 \end{bmatrix}$$

M_A-error(Y)= 1.3618
M_D-error(Y)= 1.3618

Technical appendix 2: Illustrative Fast Food Restaurant Example

We extend the list of parameters to include the interactions of interest, resulting in design and managerial matrices with 18 columns corresponding respectively to the intercept, x_1, x_2, x_3, x_4, x_5 (3 columns), x_1*x_2, x_2*x_3, x_2*x_4, x_1*x_5 (3 columns), x_2*x_5 (3 columns), and x_2*x_3*x_4. For ease of exposition, we provide only the diagonal elements of W and we omit the columns corresponding to the interactions in the designs.

Case 1: Different *W*

Managerial quantities:

$$M = \begin{bmatrix} 0&1&0&0&0&0&0&0&0&0&0&0&0&0&0&0&0&0 \\ 0&0&1&0&0&0&0&0&0&0&0&0&0&0&0&0&0&0 \\ 0&0&0&0&0&0&0&0&1&0&0&0&0&0&0&0&0&0 \\ 0&0&0&0&0&0&0&0&0&1&0&0&0&0&0&0&0&0 \\ 0&0&0&0&0&0&0&0&0&0&1&0&0&0&0&0&0&0 \\ 0&0&0&0&0&0&0&0&0&0&0&1&0&0&0&0&0&0 \\ 0&0&0&0&0&0&0&0&0&0&0&0&1&0&0&0&0&0 \\ 0&0&0&0&0&0&0&0&0&0&0&0&0&1&0&0&0&0 \\ 0&0&0&0&0&0&0&0&0&0&0&0&0&0&1&0&0&0 \\ 0&0&0&0&0&0&0&0&0&0&0&0&0&0&0&1&0&0 \\ 0&0&0&0&0&0&0&0&0&0&0&0&0&0&0&0&1&0 \\ 0&0&0&0&0&0&0&0&0&0&0&0&0&0&0&0&0&1 \end{bmatrix}$$

Weights on managerial quantities:

$$W = \begin{bmatrix} 3 \\ 3 \\ 3 \\ 1 \\ 1 \\ 1 \\ 1 \\ 1 \\ 1 \\ 1 \\ 1 \\ 1 \end{bmatrix}$$

D-efficient design, X_1:

$$X_1 = \begin{bmatrix} +1&+1&+1&+1&+1&0&0&1.73 \\ +1&+1&+1&+1&-1&0&1.63&-0.58 \\ +1&+1&+1&-1&+1&-1.41&-0.82&-0.58 \\ +1&+1&+1&-1&-1&1.41&-0.82&-0.58 \\ +1&+1&-1&+1&+1&1.41&-0.82&-0.58 \\ +1&+1&-1&+1&+1&0&0&1.73 \\ +1&+1&-1&+1&-1&0&1.63&-0.58 \\ +1&+1&-1&+1&-1&-1.41&-0.82&-0.58 \\ +1&+1&-1&-1&+1&0&1.63&-0.58 \\ +1&+1&-1&-1&+1&-1.41&-0.82&-0.58 \\ +1&+1&-1&-1&-1&1.41&-0.82&-0.58 \\ +1&+1&-1&-1&-1&0&0&1.73 \\ +1&-1&+1&+1&+1&0&1.63&-0.58 \\ +1&-1&+1&+1&+1&-1.41&-0.82&-0.58 \\ +1&-1&+1&+1&-1&1.41&-0.82&-0.58 \\ +1&-1&+1&+1&-1&0&0&1.73 \\ +1&-1&+1&-1&+1&1.41&-0.82&-0.58 \\ +1&-1&+1&-1&+1&0&0&1.73 \\ +1&-1&+1&-1&-1&0&1.63&-0.58 \\ +1&-1&+1&-1&-1&-1.41&-0.82&-0.58 \\ +1&-1&-1&+1&+1&-1.41&-0.82&-0.58 \\ +1&-1&-1&+1&-1&0&0&1.73 \\ +1&-1&-1&-1&+1&1.41&-0.82&-0.58 \\ +1&-1&-1&-1&-1&0&1.63&-0.58 \end{bmatrix}$$

Covariance matrix of the managerial estimates under X_1:

$$M.(X_1'.X_1)^{-1}.M' = \begin{bmatrix} 0.0469 & 0.0156 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0.0156 & 0.0469 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0.0469 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0.0547 & 0 & 0.0111 & -0.0064 & -0.018 & 0.0111 & -0.0064 & -0.0180 & 0 \\ 0 & 0 & 0 & 0 & 0.0547 & 0.0111 & 0.0191 & 0 & 0.0111 & 0.0191 & 0 & 0 \\ 0 & 0 & 0 & 0.011 & 0.0111 & 0.0550 & 0.0045 & -0.0064 & 0.0236 & 0.0045 & -0.0064 & 0 \\ 0 & 0 & 0 & -0.0064 & 0.0191 & 0.0045 & 0.0599 & 0.0036 & 0.0045 & 0.0286 & 0.0036 & 0 \\ 0 & 0 & 0 & -0.018 & 0 & -0.0064 & 0.0036 & 0.0573 & -0.0064 & 0.0036 & 0.0260 & 0 \\ 0 & 0 & 0 & 0.0111 & 0.0111 & 0.0236 & 0.0045 & -0.0064 & 0.0550 & 0.0045 & -0.0064 & 0 \\ 0 & 0 & 0 & -0.0064 & 0.0191 & 0.0045 & 0.0286 & 0.0036 & 0.0045 & 0.0599 & 0.0036 & 0 \\ 0 & 0 & 0 & -0.0180 & 0 & -0.0064 & 0.0036 & 0.0260 & -0.0064 & 0.0036 & 0.0573 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0.0469 \end{bmatrix}$$

M_1-error(X_1)= 1.2299

Managerial design obtained from the modified Federov algorithm, X_2:

$$X_2 = \begin{bmatrix} +1 & +1 & -1 & +1 & -1 & 1.41 & -0.82 & -0.58 \\ +1 & +1 & +1 & +1 & +1 & 0 & 0 & 1.73 \\ +1 & -1 & -1 & +1 & +1 & 1.41 & -0.82 & -0.58 \\ +1 & +1 & -1 & -1 & +1 & 1.41 & -0.82 & -0.58 \\ +1 & -1 & -1 & -1 & -1 & 0 & 1.63 & -0.58 \\ +1 & -1 & +1 & -1 & -1 & 0 & 1.63 & -0.58 \\ +1 & +1 & -1 & +1 & +1 & -1.41 & -0.82 & -0.58 \\ +1 & +1 & +1 & -1 & +1 & 0 & 1.63 & -0.58 \\ +1 & -1 & -1 & -1 & +1 & -1.41 & -0.82 & -0.58 \\ +1 & +1 & +1 & -1 & +1 & 1.41 & -0.82 & -0.58 \\ +1 & -1 & +1 & +1 & +1 & 1.41 & -0.82 & -0.58 \\ +1 & +1 & -1 & -1 & -1 & -1.41 & -0.82 & -0.58 \\ +1 & +1 & +1 & +1 & +1 & -1.41 & -0.82 & -0.58 \\ +1 & -1 & -1 & +1 & -1 & 0 & 0 & 1.73 \\ +1 & +1 & -1 & -1 & -1 & 0 & 0 & 1.73 \\ +1 & -1 & +1 & -1 & +1 & -1.41 & -0.82 & -0.58 \\ +1 & -1 & +1 & +1 & -1 & 0 & 0 & 1.73 \\ +1 & +1 & -1 & -1 & +1 & 0 & 1.63 & -0.58 \\ +1 & +1 & -1 & +1 & +1 & 0 & 0 & 1.73 \\ +1 & +1 & +1 & -1 & -1 & 0 & 0 & 1.73 \\ +1 & +1 & +1 & +1 & -1 & 1.41 & -0.82 & -0.58 \\ +1 & +1 & +1 & +1 & -1 & 0 & 1.63 & -0.58 \\ +1 & +1 & +1 & -1 & -1 & -1.41 & -0.82 & -0.58 \\ +1 & +1 & -1 & +1 & -1 & 0 & 1.63 & -0.58 \end{bmatrix}$$

Covariance matrix of the managerial estimates under X_2:

$$M..(X_2'.X_2)^{-1}.M' = \begin{bmatrix} 0.0469 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0.0469 & -0.0156 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & -0.0156 & 0.0469 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0.0469 & 0 & 0 & 0 & 0 & -0.0111 & 0.0064 & -0.0090 & 0 \\ 0 & 0 & 0 & 0 & 0.0469 & 0 & 0 & 0 & 0 & 0.0128 & 0.0090 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0.0550 & -0.0045 & 0.0064 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & -0.0045 & 0.0599 & 0.0036 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0.0064 & 0.0036 & 0.0573 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & -0.0111 & 0 & 0 & 0 & 0 & 0.0472 & 0 & 0 & 0.0111 \\ 0 & 0 & 0 & 0.0064 & 0.0128 & 0 & 0 & 0 & 0 & 0.0469 & 0 & 0.0064 \\ 0 & 0 & 0 & -0.0090 & 0.0090 & 0 & 0 & 0 & 0 & 0 & 0.0469 & -0.0090 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0.0111 & 0.0064 & -0.0090 & 0.0469 \end{bmatrix}$$

M_1-error(X_2)= 1.1673

Case 2: Different *M* and *W*

Managerial quantities:

Weights on managerial quantities:

$$M^{comb}=\begin{bmatrix}
+1 & +1 & -1 & +1 & +1 & 1.41 & -0.82 & -0.58 & -1 & -1 & -1 & 1.41 & -0.82 & -0.58 & -1.41 & 0.82 & 0.58 & -1\\
+1 & +1 & -1 & +1 & +1 & 0 & 1.61 & -0.58 & -1 & -1 & -1 & 0 & 1.61 & -0.58 & 0 & -1.61 & 0.58 & -1\\
+1 & +1 & -1 & +1 & +1 & 0 & 0 & 1.73 & -1 & -1 & -1 & 0 & 0 & 1.73 & 0 & 0 & -1.73 & -1\\
+1 & +1 & -1 & +1 & +1 & -1.41 & -0.82 & -0.58 & -1 & -1 & -1 & -1.41 & -0.82 & -0.58 & 1.41 & 0.82 & 0.58 & -1\\
+1 & -1 & -1 & +1 & +1 & 1.41 & -0.82 & -0.58 & +1 & -1 & -1 & -1.41 & 0.82 & 0.58 & -1.41 & 0.82 & 0.58 & -1\\
+1 & -1 & -1 & +1 & +1 & 0 & 1.61 & -0.58 & +1 & -1 & -1 & 0 & -1.61 & 0.58 & 0 & -1.61 & 0.58 & -1\\
+1 & -1 & -1 & +1 & +1 & 0 & 0 & 1.73 & +1 & -1 & -1 & 0 & 0 & -1.73 & 0 & 0 & -1.73 & -1\\
+1 & -1 & -1 & +1 & +1 & -1.41 & -0.82 & -0.58 & +1 & -1 & -1 & 1.41 & 0.82 & 0.58 & 1.41 & 0.82 & 0.58 & -1\\
+1 & -1 & +1 & +1 & +1 & 1.41 & -0.82 & -0.58 & -1 & +1 & +1 & -1.41 & 0.82 & 0.58 & 1.41 & -0.82 & -0.58 & +1\\
+1 & -1 & +1 & +1 & +1 & 0 & 1.61 & -0.58 & -1 & +1 & +1 & 0 & -1.61 & 0.58 & 0 & 1.61 & -0.58 & +1\\
+1 & -1 & +1 & +1 & +1 & 0 & 0 & 1.73 & -1 & +1 & +1 & 0 & 0 & -1.73 & 0 & 0 & 1.73 & +1\\
+1 & -1 & +1 & +1 & +1 & -1.41 & -0.82 & -0.58 & -1 & +1 & +1 & 1.41 & 0.82 & 0.58 & -1.41 & -0.82 & -0.58 & +1
\end{bmatrix}
\qquad
W^{comb}=\begin{bmatrix}3\\1\\1\\1\\3\\1\\1\\1\\3\\1\\1\\1\end{bmatrix}$$

Covariance matrix of the managerial estimates under X_1 (from case 1):

$$M^{comb}.(X_1'.X_1)^{-1}.M^{comb}{}'=\begin{bmatrix}
0.6875 & 0.3138 & 0.25 & 0.25 & 0.375 & 0.3737 & 0.1875 & 0.0625 & -0.0625 & 0.0617 & 0 & 0\\
0.3138 & 0.8044 & 0.312 & 0.3138 & 0.2503 & 0.6194 & 0.2495 & 0.1253 & -0.0625 & -0.0617 & -0.0622 & -0.0625\\
0.25 & 0.312 & 0.6875 & 0.25 & 0.1875 & 0.373 & 0.375 & 0.0625 & -0.0625 & -0.0005 & -0.125 & -0.0625\\
0.25 & 0.3138 & 0.25 & 0.6875 & 0.1875 & 0.3737 & 0.1875 & 0.25 & -0.0625 & -0.0008 & -0.0625 & -0.125\\
0.375 & 0.2503 & 0.1875 & 0.1875 & 1.125 & 0.5013 & 0.1875 & 0.1875 & 0 & -0.1247 & -0.1875 & -0.1875\\
0.3737 & 0.6194 & 0.373 & 0.3737 & 0.5013 & 1.4817 & 0.4974 & 0.2523 & -0.1245 & 0.1212 & -0.1253 & -0.1245\\
0.1875 & 0.2495 & 0.375 & 0.1875 & 0.1875 & 0.4974 & 1.125 & 0.1875 & 0 & 0.062 & 0.1875 & 0\\
0.0625 & 0.1253 & 0.0625 & 0.25 & 0.1875 & 0.2523 & 0.1875 & 0.875 & -0.125 & -0.0622 & -0.125 & 0.0625\\
-0.0625 & -0.0625 & -0.0625 & -0.0625 & 0 & -0.1245 & 0 & -0.125 & 0.8125 & 0.3145 & 0.3125 & 0.3125\\
0.0617 & -0.0617 & -0.0005 & -0.0008 & -0.1247 & 0.1212 & 0.062 & -0.0622 & 0.3145 & 0.6809 & 0.2503 & 0.252\\
0 & -0.0622 & -0.125 & -0.0625 & -0.1875 & -0.1253 & 0.1875 & -0.125 & 0.3125 & 0.2503 & 0.6875 & 0.25\\
0 & -0.0625 & -0.0635 & -0.125 & -0.1875 & -0.1245 & 0 & 0.0625 & 0.3125 & 0.252 & 0.25 & 0.6875
\end{bmatrix}$$

M_1-error(X_1)= 20.7894

Managerial design obtained from the modified Federov algorithm, X_2^{comb}:

$$X_2^{comb} = \begin{bmatrix}
+1 & -1 & -1 & +1 & +1 & 0 & 0 & 1.73 \\
+1 & -1 & +1 & -1 & -1 & 0 & 0 & 1.73 \\
+1 & -1 & +1 & +1 & +1 & 0 & 0 & 1.73 \\
+1 & +1 & +1 & +1 & -1 & 0 & 1.63 & -0.58 \\
+1 & -1 & -1 & +1 & +1 & 1.41 & -0.82 & -0.58 \\
+1 & -1 & +1 & +1 & +1 & 1.41 & -0.82 & -0.58 \\
+1 & -1 & +1 & +1 & +1 & -1.41 & -0.82 & -0.58 \\
+1 & +1 & +1 & +1 & -1 & -1.41 & -0.82 & -0.58 \\
+1 & -1 & -1 & +1 & +1 & 1.41 & -0.82 & -0.58 \\
+1 & +1 & -1 & +1 & +1 & 0 & 0 & 1.73 \\
+1 & +1 & -1 & +1 & +1 & 1.41 & -0.82 & -0.58 \\
+1 & +1 & -1 & +1 & +1 & 0 & 1.63 & -0.58 \\
+1 & +1 & -1 & +1 & +1 & -1.41 & -0.82 & -0.58 \\
+1 & -1 & +1 & -1 & +1 & 1.41 & -0.82 & -0.58 \\
+1 & -1 & -1 & +1 & +1 & -1.41 & -0.82 & -0.58 \\
+1 & -1 & -1 & +1 & -1 & 1.41 & -0.82 & -0.58 \\
+1 & +1 & +1 & +1 & -1 & 0 & 0 & 1.73 \\
+1 & +1 & -1 & +1 & +1 & 1.41 & -0.82 & -0.58 \\
+1 & -1 & -1 & -1 & +1 & 1.41 & -0.82 & -0.58 \\
+1 & +1 & -1 & -1 & -1 & 1.41 & -0.82 & -0.58 \\
+1 & -1 & +1 & +1 & +1 & 0 & 1.63 & -0.58 \\
+1 & -1 & -1 & +1 & +1 & 0 & 1.63 & -0.58 \\
+1 & +1 & +1 & +1 & +1 & 1.41 & -0.82 & -0.58 \\
+1 & -1 & +1 & +1 & -1 & 1.41 & -0.82 & -0.58
\end{bmatrix}$$

Covariance matrix of the managerial estimates under X_2^{comb}:

$$M^{comb}.(X_2^{comb}{}'.X_2^{comb})^{-1}.M^{comb}{}' = \begin{bmatrix}
0.4239 & 0.026 & 0.0402 & 0.0244 & 0.1076 & -0.0239 & -0.0402 & -0.0244 & -0.0519 & 0.0241 & -0.0229 & 0.0244 \\
0.026 & 0.807 & 0.068 & 0.0725 & -0.0269 & 0.1767 & -0.068 & -0.0684 & 0.073 & -0.1765 & 0.0737 & 0.0684 \\
0.0402 & 0.068 & 0.8111 & 0.0681 & -0.054 & -0.0680 & 0.1889 & -0.0681 & 0.0501 & 0.0680 & -0.1612 & 0.0681 \\
0.0244 & 0.0725 & 0.0681 & 0.8196 & -0.0274 & -0.0684 & -0.0681 & 0.1804 & 0.0735 & 0.0686 & 0.0741 & -0.1804 \\
0.1076 & -0.0269 & -0.054 & -0.0274 & 0.3392 & 0.0287 & 0.054 & 0.0274 & 0.0052 & -0.0273 & 0.0523 & -0.0274 \\
-0.0239 & 0.1767 & -0.068 & -0.0684 & 0.0287 & 0.8071 & 0.068 & 0.0725 & -0.0731 & 0.1765 & -0.0736 & -0.0684 \\
-0.0402 & -0.0680 & 0.1889 & -0.0681 & 0.054 & 0.068 & 0.8111 & 0.0681 & -0.0501 & -0.0680 & 0.1612 & -0.0681 \\
-0.0244 & -0.0684 & -0.0681 & 0.1804 & 0.0274 & 0.0725 & 0.0681 & 0.8196 & -0.0735 & -0.0686 & -0.0741 & 0.1804 \\
-0.0519 & 0.073 & 0.0501 & 0.0735 & 0.0052 & -0.0731 & -0.0501 & -0.0735 & 0.4192 & 0.0749 & 0.1435 & 0.0735 \\
0.0241 & -0.1765 & 0.068 & 0.0686 & -0.0273 & 0.1765 & -0.068 & -0.0686 & 0.0749 & 0.8074 & 0.0744 & 0.0727 \\
-0.0229 & 0.0737 & -0.1612 & 0.0741 & 0.0523 & -0.0736 & 0.1612 & -0.0741 & 0.1435 & 0.0744 & 0.7800 & 0.0741 \\
0.0244 & 0.0684 & 0.0681 & -0.1804 & -0.0274 & -0.0684 & -0.0681 & 0.1804 & 0.0735 & 0.0727 & 0.0741 & 0.8196
\end{bmatrix}$$

M_1-error(X_2^{comb})= 14.4396

Technical appendix 3 : Choice-Based Experiment Example

We obtain choice designs from metric designs by cyclically generating alternatives as in Arora and Huber (2001) and Huber and Zwerina (1996). For ease of exposition, we use a diagonal matrix P, which is equivalent to assuming that all the parameters are zero. If prior knowledge is available on the parameters, the correct formulation follows Huber and Zwerina (1996) and Arora and Huber (2001).

Managerial quantities:

$$M_{WTP} = \begin{bmatrix} 1 & 0 & 0 & 0 & 0 & -0.33 \\ 0 & 1 & 0 & 0 & 0 & -0.33 \\ 0 & 0 & 1 & 0 & 0 & -0.33 \\ 0 & 0 & 0 & 1 & 0 & -0.33 \\ 0 & 0 & 0 & 0 & 1 & -0.33 \end{bmatrix}$$

Probability-centered D-efficient design based on X (from the main appendix), Z:

$$Z = \begin{bmatrix} +1 & -1 & -1 & -1 & -1 & -1 \\ -1 & +1 & +1 & +1 & +1 & +1 \\ -1 & +1 & -1 & +1 & +1 & +1 \\ +1 & -1 & +1 & -1 & -1 & -1 \\ +1 & +1 & +1 & -1 & +1 & +1 \\ -1 & -1 & -1 & +1 & -1 & -1 \\ -1 & -1 & +1 & +1 & -1 & +1 \\ +1 & +1 & -1 & -1 & +1 & -1 \\ +1 & +1 & -1 & +1 & +1 & -1 \\ -1 & -1 & +1 & -1 & -1 & +1 \\ +1 & -1 & +1 & -1 & +1 & +1 \\ -1 & +1 & -1 & +1 & -1 & -1 \\ +1 & -1 & -1 & +1 & -1 & +1 \\ -1 & +1 & +1 & -1 & +1 & -1 \\ -1 & -1 & -1 & -1 & +1 & -1 \\ +1 & +1 & +1 & +1 & -1 & +1 \\ -1 & +1 & -1 & -1 & -1 & +1 \\ +1 & -1 & +1 & +1 & +1 & -1 \\ -1 & +1 & +1 & -1 & -1 & -1 \\ +1 & -1 & -1 & +1 & +1 & +1 \\ +1 & +1 & +1 & +1 & -1 & -1 \\ -1 & -1 & -1 & -1 & +1 & +1 \\ -1 & -1 & +1 & +1 & +1 & -1 \\ +1 & +1 & -1 & -1 & -1 & +1 \end{bmatrix}$$

Covariance matrix of the managerial estimates under Z:

$$M_{WTP}.(Z'.P.Z)^{-1}.M_{WTP}' = \begin{bmatrix} 0.0924 & 0.0091 & 0.0091 & 0.0091 & 0.0091 \\ 0.0091 & 0.0924 & 0.0091 & 0.0091 & 0.0091 \\ 0.0091 & 0.0091 & 0.0924 & 0.0091 & 0.0091 \\ 0.0091 & 0.0091 & 0.0091 & 0.0924 & 0.0091 \\ 0.0091 & 0.0091 & 0.0091 & 0.0091 & 0.0924 \end{bmatrix}$$

M_A-error(Z)= 0.0924
M_D-error(Z)= 0.0909

Probability-centered M-efficient design matrix based on X_{WTP} (from the main appendix), Z_{WTP}:

$$Z_{WTP}=\begin{bmatrix} +1 & -1 & -1 & -1 & -1 & 0.98 \\ -1 & +1 & +1 & +1 & +1 & -0.98 \\ -1 & +1 & -1 & +1 & +1 & -0.32 \\ +1 & -1 & +1 & -1 & -1 & 0.32 \\ +1 & +1 & +1 & -1 & +1 & -0.98 \\ -1 & -1 & -1 & +1 & -1 & 0.98 \\ -1 & -1 & +1 & +1 & -1 & 0.34 \\ +1 & +1 & -1 & -1 & +1 & -0.34 \\ +1 & +1 & -1 & +1 & +1 & -1.00 \\ -1 & -1 & +1 & -1 & -1 & 1.00 \\ +1 & -1 & +1 & -1 & +1 & -0.32 \\ -1 & +1 & -1 & +1 & -1 & 0.32 \\ +1 & -1 & -1 & +1 & -1 & 0.34 \\ -1 & +1 & +1 & -1 & +1 & -0.34 \\ -1 & -1 & -1 & -1 & +1 & 0.98 \\ +1 & +1 & +1 & +1 & -1 & -0.98 \\ -1 & +1 & -1 & -1 & -1 & 1.00 \\ +1 & -1 & +1 & +1 & +1 & -1.00 \\ -1 & +1 & +1 & -1 & -1 & 0.32 \\ +1 & -1 & -1 & +1 & +1 & -0.32 \\ +1 & +1 & +1 & +1 & -1 & -1.00 \\ -1 & -1 & -1 & -1 & +1 & 1 \\ -1 & -1 & +1 & +1 & +1 & -0.34 \\ +1 & +1 & -1 & -1 & -1 & 0.34 \end{bmatrix}$$

Covariance matrix of the managerial estimates under Z_{WTP}:

$$M_{WTP}.(Z'.P.Z)^{-1}.M_{WTP}'=\begin{bmatrix} 0.0833 & 0 & 0 & 0 & 0 \\ 0 & 0.0833 & 0 & 0 & 0 \\ 0 & 0 & 0.0833 & 0 & 0 \\ 0 & 0 & 0 & 0.0833 & 0 \\ 0 & 0 & 0 & 0 & 0.0833 \end{bmatrix}$$

M_A-error(Z_{WTP})= 0.0833
M_D-error(Z_{WTP})= 0.0833