

Problem	$\delta$	#Pert	ColdIters	WarmIters	$\ x^I - x^P\ $	$\ y^I - y^P\ $
biggsc4-1	0.0001	1	28	17	4.83E-08	1.11E-04
biggsc4-2	0.0001	1	26	15	1.24E-05	1.77E-03
biggsc4-3	0.0001	1	28	17	3.05E-06	8.79E-04
biggsc4-4	0.0001	1	28	17	2.21E-08	7.49E-05
biggsc4-5	0.0001	1	27	16	6.23E-08	1.27E-04
biggsc4-ave	0.0001	1.0	27.4	16.4	3.12E-06	5.93E-04
biggsc4-1	0.001	1	26	14	1.13E-09	6.98E-05
biggsc4-2	0.001	1	25	13	1.24E-04	5.62E-03
biggsc4-3	0.001	1	25	14	3.11E-05	2.80E-03
biggsc4-4	0.001	1	26	15	4.23E-08	1.10E-04
biggsc4-5	0.001	1	25	13	3.57E-08	2.22E-04
biggsc4-ave	0.001	1.0	25.4	13.8	3.11E-05	1.77E-03
biggsc4-1	0.01	1	23	12	5.98E-08	6.88E-04
biggsc4-2	0.01	1	24	10	1.25E-03	1.81E-02
biggsc4-3	0.01	1	22	11	3.11E-04	8.91E-03
biggsc4-4	0.01	1	23	12	2.10E-08	3.91E-04
biggsc4-5	0.01	1	23	11	6.28E-08	2.01E-03
biggsc4-ave	0.01	1.0	23.0	11.2	3.11E-04	6.01E-03
hatfddh-1	0.0001	1	23	17	6.92E-08	1.32E-04
hatfddh-2	0.0001	1	22	15	1.24E-05	1.77E-03
hatfddh-3	0.0001	1	22	17	3.03E-06	8.76E-04
hatfddh-4	0.0001	1	24	17	1.21E-09	1.79E-05
hatfddh-5	0.0001	1	22	16	8.32E-08	1.46E-04
hatfddh-ave	0.0001	1.0	22.6	16.4	3.12E-06	5.89E-04
hatfddh-1	0.001	1	21	14	2.20E-08	1.01E-04
hatfddh-2	0.001	1	19	13	1.24E-04	5.62E-03
hatfddh-3	0.001	1	19	14	3.10E-05	2.80E-03
hatfddh-4	0.001	1	21	15	6.32E-08	1.32E-04
hatfddh-5	0.001	1	20	13	5.65E-08	2.34E-04
hatfddh-ave	0.001	1.0	20.0	13.8	3.11E-05	1.78E-03
hatfddh-1	0.01	1	19	12	8.06E-08	6.92E-04
hatfddh-2	0.01	1	16	10	1.24E-03	1.81E-02
hatfddh-3	0.01	1	16	11	3.11E-04	8.91E-03
hatfddh-4	0.01	1	19	12	1.94E-10	3.84E-04
hatfddh-5	0.01	1	17	11	8.36E-08	2.02E-03
hatfddh-ave	0.01	1.0	17.4	11.2	3.11E-04	6.01E-03
hs035-1	0.0001	1	9	5	1.74E-06	1.74E-03
hs035-2	0.0001	1	9	5	3.93E-07	8.28E-04
hs035-3	0.0001	1	9	5	7.93E-07	1.18E-03
hs035-4	0.0001	1	9	5	6.57E-07	1.07E-03
hs035-5	0.0001	1	9	5	1.54E-06	1.64E-03
hs035-ave	0.0001	1.0	9.0	5.0	1.03E-06	1.29E-03
hs035-1	0.001	1	9	5	1.75E-05	5.52E-03
hs035-2	0.001	1	9	5	3.91E-06	2.61E-03
hs035-3	0.001	1	9	5	7.91E-06	3.71E-03
hs035-4	0.001	1	9	5	6.60E-06	3.39E-03
hs035-5	0.001	1	9	5	1.54E-05	5.19E-03
hs035-ave	0.001	1.0	9.0	5.0	1.03E-05	4.08E-03
hs035-1	0.01	1	9	6	1.75E-04	1.75E-02
hs035-2	0.01	1	9	5	3.90E-05	8.26E-03
hs035-3	0.01	1	9	5	7.90E-05	1.18E-02
hs035-4	0.01	1	9	5	6.60E-05	1.07E-02
hs035-5	0.01	1	9	5	1.54E-04	1.64E-02
hs035-ave	0.01	1.0	9.0	5.2	1.03E-04	1.29E-02

TABLE 1. Numerical performance of LOQO on the convex quadratic problems from the CUTer test suite when warmstarting a problem whose objective function coefficients,  $c$ , have been modified. Each problem is labeled under the column Problem, 5 instances of each problem are presented, “ave” refers to the average performance over the five problems,  $\delta$  is the perturbation parameter, and #Pert is the number of perturbed coefficients. The iteration counts for the warmstart and coldstart solution of five perturbed problems are given, and the last 2 columns are the scaled Euclidean norm of the distance between the optimal solutions and the Lagrange multipliers of the initial and the perturbed problem.

Problem	$\delta$	#Pert	ColdIters	WarmIters	$\ x^I - x^P\ $	$\ y^I - y^P\ $
hs044-1	0.0001	1	15	4	1.16E-08	9.38E-05
hs044-2	0.0001	1	15	3	2.16E-08	1.22E-04
hs044-3	0.0001	1	15	3	2.16E-08	1.22E-04
hs044-4	0.0001	1	15	3	2.16E-08	1.29E-04
hs044-5	0.0001	2	15	3	2.40E-08	1.33E-04
hs044-ave	0.0001	1.2	15.0	3.2	2.01E-08	1.20E-04
hs044-1	0.001	1	15	5	5.96E-09	2.90E-04
hs044-2	0.001	1	15	3	2.16E-08	1.42E-04
hs044-3	0.001	1	15	3	2.16E-08	1.27E-04
hs044-4	0.001	1	15	3	2.16E-08	4.31E-04
hs044-5	0.001	2	15	4	1.24E-08	3.56E-04
hs044-ave	0.001	1.2	15.0	3.6	1.66E-08	2.69E-04
hs044-1	0.01	1	15	6	8.88E-09	2.82E-03
hs044-2	0.01	1	15	3	2.16E-08	7.35E-04
hs044-3	0.01	1	15	3	2.16E-08	3.73E-04
hs044-4	0.01	1	15	4	1.38E-08	4.13E-03
hs044-5	0.01	2	15	5	1.09E-08	3.44E-03
hs044-ave	0.01	1.2	15.0	4.2	1.54E-08	2.30E-03
hs076-1	0.0001	1	10	4	9.38E-06	3.75E-03
hs076-2	0.0001	1	10	4	1.85E-06	1.67E-03
hs076-3	0.0001	1	10	4	1.14E-06	1.31E-03
hs076-4	0.0001	1	10	4	2.16E-06	1.80E-03
hs076-5	0.0001	1	10	4	2.78E-06	2.04E-03
hs076-ave	0.0001	1.0	10.0	4.0	3.46E-06	2.12E-03
hs076-1	0.001	1	10	5	9.34E-05	1.18E-02
hs076-2	0.001	1	10	4	1.84E-05	5.26E-03
hs076-3	0.001	1	10	4	1.16E-05	4.18E-03
hs076-4	0.001	1	10	4	2.14E-05	5.67E-03
hs076-5	0.001	1	10	4	2.76E-05	6.44E-03
hs076-ave	0.001	1.0	10.0	4.2	3.45E-05	6.68E-03
hs076-1	0.01	1	10	6	9.34E-04	3.75E-02
hs076-2	0.01	1	10	4	1.84E-04	1.66E-02
hs076-3	0.01	1	10	4	1.17E-04	1.32E-02
hs076-4	0.01	1	10	4	2.14E-04	1.79E-02
hs076-5	0.01	1	10	4	2.76E-04	2.04E-02
hs076-ave	0.01	1.0	10.0	4.4	3.45E-04	2.11E-02
hs118-1	0.0001	1	15	3	1.49E-09	7.86E-05
hs118-2	0.0001	1	15	3	1.48E-09	7.68E-05
hs118-3	0.0001	2	15	3	1.48E-09	8.65E-05
hs118-4	0.0001	1	15	3	1.48E-09	7.45E-05
hs118-5	0.0001	1	15	3	1.48E-09	7.37E-05
hs118-ave	0.0001	1.2	15.0	3.0	1.48E-09	7.80E-05
hs118-1	0.001	1	15	3	1.49E-09	2.99E-04
hs118-2	0.001	1	15	3	1.48E-09	2.51E-04
hs118-3	0.001	2	15	3	1.46E-09	4.70E-04
hs118-4	0.001	1	15	3	1.49E-09	1.68E-04
hs118-5	0.001	1	15	3	1.48E-09	1.27E-04
hs118-ave	0.001	1.2	15.0	3.0	1.48E-09	2.63E-04
hs118-1	0.01	1	15	6	8.12E-09	2.90E-03
hs118-2	0.01	1	15	3	1.48E-09	2.41E-03
hs118-3	0.01	2	15	4	6.03E-09	4.65E-03
hs118-4	0.01	1	15	5	1.88E-09	1.52E-03
hs118-5	0.01	1	15	3	1.48E-09	1.04E-03
hs118-ave	0.01	1.2	15.0	4.2	3.80E-09	2.50E-03

TABLE 2. Numerical performance of LOQO on the convex quadratic problems from the CUTer test suite when warmstarting a problem whose objective function coefficients,  $c$ , have been modified. Each problem is labeled under the column Problem, 5 instances of each problem are presented, “ave” refers to the average performance over the five problems,  $\delta$  is the perturbation parameter, and #Pert is the number of perturbed coefficients. The iteration counts for the warmstart and coldstart solution of five perturbed problems are given, and the last 2 columns are the scaled Euclidean norm of the distance between the optimal solutions and the Lagrange multipliers of the initial and the perturbed problem.

Problem	$\delta$	#Pert	ColdIters	WarmIters	$\ x^I - x^P\ $	$\ y^I - y^P\ $
hs21mod-1	0.0001	1	21	18	4.52E-01	1.32E+00
hs21mod-2	0.0001	1	19	15	4.52E-01	1.32E+00
hs21mod-3	0.0001	1	18	16	3.69E-01	1.19E+00
hs21mod-4	0.0001	1	18	16	3.69E-01	1.19E+00
hs21mod-5	0.0001	2	18	19	3.69E-01	1.19E+00
hs21mod-ave	0.0001	1.2	18.8	16.8	4.03E-01	1.24E+00
hs21mod-1	0.001	1	21	18	4.52E-01	1.32E+00
hs21mod-2	0.001	1	19	15	4.52E-01	1.32E+00
hs21mod-3	0.001	1	18	16	3.69E-01	1.19E+00
hs21mod-4	0.001	1	18	16	3.69E-01	1.19E+00
hs21mod-5	0.001	2	18	19	3.69E-01	1.19E+00
hs21mod-ave	0.001	1.2	18.8	16.8	4.03E-01	1.24E+00
hs21mod-1	0.01	1	21	18	4.52E-01	1.32E+00
hs21mod-2	0.01	1	19	15	4.52E-01	1.32E+00
hs21mod-3	0.01	1	18	16	3.69E-01	1.19E+00
hs21mod-4	0.01	1	18	16	3.70E-01	1.19E+00
hs21mod-5	0.01	2	17	19	3.69E-01	1.19E+00
hs21mod-ave	0.01	1.2	18.6	16.8	4.03E-01	1.24E+00
hs44new-1	0.0001	1	19	4	1.41E-08	1.03E-04
hs44new-2	0.0001	1	19	3	2.15E-08	1.22E-04
hs44new-3	0.0001	1	19	3	2.15E-08	1.22E-04
hs44new-4	0.0001	1	19	3	2.15E-08	1.28E-04
hs44new-5	0.0001	2	19	3	2.45E-08	1.34E-04
hs44new-ave	0.0001	1.2	19.0	3.2	2.06E-08	1.22E-04
hs44new-1	0.001	1	19	5	6.68E-09	2.90E-04
hs44new-2	0.001	1	19	3	2.15E-08	1.41E-04
hs44new-3	0.001	1	19	3	2.15E-08	1.27E-04
hs44new-4	0.001	1	19	3	2.14E-08	4.31E-04
hs44new-5	0.001	2	19	4	1.52E-08	3.59E-04
hs44new-ave	0.001	1.2	19.0	3.6	1.73E-08	2.70E-04
hs44new-1	0.01	1	19	6	1.13E-08	2.83E-03
hs44new-2	0.01	1	19	3	2.14E-08	7.35E-04
hs44new-3	0.01	1	19	3	2.14E-08	3.73E-04
hs44new-4	0.01	1	16	4	1.72E-08	4.13E-03
hs44new-5	0.01	2	18	5	1.24E-08	3.44E-03
hs44new-ave	0.01	1.2	18.2	4.2	1.68E-08	2.30E-03
ksip-1	0.0001	1	33	48	1.48E+00	1.26E+00
ksip-2	0.0001	3	38	47	1.48E+00	1.32E+00
ksip-3	0.0001	1	33	46	1.48E+00	1.32E+00
ksip-4	0.0001	2	31	40	1.48E+00	1.26E+00
ksip-5	0.0001	4	30	46	1.48E+00	1.24E+00
ksip-ave	0.0001	2.2	33.0	45.4	1.48E+00	1.28E+00
ksip-1	0.001	1	32	43	1.48E+00	1.26E+00
ksip-2	0.001	3	31	47	1.48E+00	1.30E+00
ksip-3	0.001	1	34	42	1.48E+00	1.27E+00
ksip-4	0.001	2	31	34	1.48E+00	1.30E+00
ksip-5	0.001	4	23	34	1.48E+00	1.29E+00
ksip-ave	0.001	2.2	30.2	40.0	1.48E+00	1.28E+00
ksip-1	0.01	1	24	39	1.48E+00	1.23E+00
ksip-2	0.01	3	27	42	1.48E+00	1.29E+00
ksip-3	0.01	1	34	36	1.48E+00	1.31E+00
ksip-4	0.01	2	31	39	1.48E+00	1.28E+00
ksip-5	0.01	4	32	33	1.48E+00	1.29E+00
ksip-ave	0.01	2.2	29.6	37.8	1.48E+00	1.28E+00

TABLE 3. Numerical performance of LOQO on the convex quadratic problems from the CUTer test suite when warmstarting a problem whose objective function coefficients,  $c$ , have been modified. Each problem is labeled under the column Problem, 5 instances of each problem are presented, “ave” refers to the average performance over the five problems,  $\delta$  is the perturbation parameter, and #Pert is the number of perturbed coefficients. The iteration counts for the warmstart and coldstart solution of five perturbed problems are given, and the last 2 columns are the scaled Euclidean norm of the distance between the optimal solutions and the Lagrange multipliers of the initial and the perturbed problem.

Problem	$\delta$	#Pert	ColdIters	WarmIters	$\ x^I - x^P\ $	$\ y^I - y^P\ $
lsqfit-1	0.0001	1	8	4	8.29E-06	3.00E-03
lsqfit-2	0.0001	1	8	4	3.74E-06	2.02E-03
lsqfit-3	0.0001	1	8	4	4.83E-06	2.29E-03
lsqfit-4	0.0001	1	8	4	1.21E-05	3.63E-03
lsqfit-5	0.0001	1	8	4	8.96E-06	3.12E-03
lsqfit-ave	0.0001	1.0	8.0	4.0	7.58E-06	2.81E-03
lsqfit-1	0.001	1	8	4	8.28E-05	9.48E-03
lsqfit-2	0.001	1	8	4	3.73E-05	6.36E-03
lsqfit-3	0.001	1	8	4	4.81E-05	7.23E-03
lsqfit-4	0.001	1	8	4	1.21E-04	1.15E-02
lsqfit-5	0.001	1	8	5	8.90E-05	9.83E-03
lsqfit-ave	0.001	1.0	8.0	4.2	7.57E-05	8.88E-03
lsqfit-1	0.01	1	8	4	8.28E-04	3.00E-02
lsqfit-2	0.01	1	8	4	3.73E-04	2.01E-02
lsqfit-3	0.01	1	8	4	4.81E-04	2.29E-02
lsqfit-4	0.01	1	8	4	1.21E-03	3.63E-02
lsqfit-5	0.01	1	8	7	8.90E-04	3.12E-02
lsqfit-ave	0.01	1.0	8.0	4.6	7.57E-04	2.81E-02
powell20-1	0.0001	22	351	15	3.54E-04	6.30E-03
powell20-2	0.0001	17	351	15	3.61E-04	6.30E-03
powell20-3	0.0001	31	351	15	3.53E-04	6.30E-03
powell20-4	0.0001	14	351	15	3.60E-04	6.30E-03
powell20-5	0.0001	16	358	15	3.61E-04	6.29E-03
powell20-ave	0.0001	20.0	352.4	15.0	3.58E-04	6.30E-03
powell20-1	0.001	22	352	15	3.51E-04	6.31E-03
powell20-2	0.001	17	349	15	3.60E-04	6.30E-03
powell20-3	0.001	31	350	15	3.51E-04	6.31E-03
powell20-4	0.001	14	346	15	3.63E-04	6.30E-03
powell20-5	0.001	16	350	15	3.61E-04	6.29E-03
powell20-ave	0.001	20.0	349.4	15.0	3.57E-04	6.30E-03
powell20-1	0.01	22	355	15	3.16E-04	6.39E-03
powell20-2	0.01	17	353	15	3.49E-04	6.39E-03
powell20-3	0.01	31	357	15	3.38E-04	6.42E-03
powell20-4	0.01	14	354	15	3.95E-04	6.25E-03
powell20-5	0.01	16	353	15	3.65E-04	6.07E-03
powell20-ave	0.01	20.0	354.4	15.0	3.53E-04	6.30E-03
s224-1	0.0001	1	10	3	7.52E-05	6.79E-04
s224-2	0.0001	1	10	3	1.00E-05	2.47E-04
s224-3	0.0001	1	10	3	3.35E-05	4.52E-04
s224-4	0.0001	1	10	3	4.34E-05	5.15E-04
s224-5	0.0001	1	10	3	1.11E-04	8.27E-04
s224-ave	0.0001	1.0	10.0	3.0	5.46E-05	5.44E-04
s224-1	0.001	1	10	5	7.55E-04	2.19E-03
s224-2	0.001	1	10	3	9.50E-05	7.64E-04
s224-3	0.001	1	10	3	3.40E-04	1.44E-03
s224-4	0.001	1	10	3	4.39E-04	1.64E-03
s224-5	0.001	1	10	3	1.11E-03	2.68E-03
s224-ave	0.001	1.0	10.0	3.4	5.47E-04	1.74E-03
s224-1	0.01	1	10	7	7.56E-03	8.05E-03
s224-2	0.01	1	10	3	9.45E-04	2.46E-03
s224-3	0.01	1	10	3	3.40E-03	4.66E-03
s224-4	0.01	1	10	3	4.39E-03	5.33E-03
s224-5	0.01	1	10	4	1.11E-02	1.04E-02
s224-ave	0.01	1.0	10.0	4.0	5.47E-03	6.17E-03

TABLE 4. Numerical performance of LOQO on the convex quadratic problems from the CUTER test suite when warmstarting a problem whose objective function coefficients,  $c$ , have been modified. Each problem is labeled under the column Problem, 5 instances of each problem are presented, “ave” refers to the average performance over the five problems,  $\delta$  is the perturbation parameter, and #Pert is the number of perturbed coefficients. The iteration counts for the warmstart and coldstart solution of five perturbed problems are given, and the last 2 columns are the scaled Euclidean norm of the distance between the optimal solutions and the Lagrange multipliers of the initial and the perturbed problem.

Problem	$\delta$	#Pert	ColdIters	WarmIters	$\ x^I - x^P\ $	$\ y^I - y^P\ $
s268-1	0.0001	1	11	10	4.85E-01	1.78E+00
s268-2	0.0001	1	14	10	4.85E-01	1.78E+00
s268-3	0.0001	1	18	10	4.85E-01	1.78E+00
s268-4	0.0001	1	13	10	4.85E-01	1.78E+00
s268-5	0.0001	1	13	10	4.85E-01	1.78E+00
s268-ave	0.0001	1.0	13.8	10.0	4.85E-01	1.78E+00
s268-1	0.001	1	11	10	4.85E-01	1.78E+00
s268-2	0.001	1	13	10	4.85E-01	1.78E+00
s268-3	0.001	1	12	10	4.85E-01	1.78E+00
s268-4	0.001	1	15	10	4.85E-01	1.78E+00
s268-5	0.001	1	13	10	4.85E-01	1.78E+00
s268-ave	0.001	1.0	12.8	10.0	4.85E-01	1.78E+00
s268-1	0.01	1	11	10	4.85E-01	1.78E+00
s268-2	0.01	1	11	10	4.85E-01	1.78E+00
s268-3	0.01	1	11	10	4.85E-01	1.78E+00
s268-4	0.01	1	12	10	4.85E-01	1.78E+00
s268-5	0.01	1	13	10	4.85E-01	1.78E+00
s268-ave	0.01	1.0	11.6	10.0	4.85E-01	1.78E+00
s392-1	0.0001	2	32	13	1.12E-05	9.39E-04
s392-2	0.0001	4	32	13	5.06E-05	9.44E-04
s392-3	0.0001	1	32	13	2.93E-05	9.39E-04
s392-4	0.0001	3	32	13	6.13E-05	9.52E-04
s392-5	0.0001	2	32	13	1.30E-05	9.36E-04
s392-ave	0.0001	2.4	32.0	13.0	3.31E-05	9.42E-04
s392-1	0.001	2	32	13	1.12E-04	9.65E-04
s392-2	0.001	4	32	13	5.06E-04	1.05E-03
s392-3	0.001	1	32	13	2.93E-04	9.72E-04
s392-4	0.001	3	34	13	6.13E-04	1.12E-03
s392-5	0.001	2	32	13	1.30E-04	9.43E-04
s392-ave	0.001	2.4	32.4	13.0	3.31E-04	1.01E-03
s392-1	0.01	2	43	13	1.12E-03	1.28E-03
s392-2	0.01	4	32	13	5.06E-03	3.01E-03
s392-3	0.01	1	45	13	2.93E-03	1.59E-03
s392-4	0.01	3	41	13	6.13E-03	3.65E-03
s392-5	0.01	2	48	13	1.30E-03	1.30E-03
s392-ave	0.01	2.4	41.8	13.0	3.31E-03	2.17E-03
zecevic2-1	0.0001	1	11	5	1.70E-05	2.29E-03
zecevic2-2	0.0001	1	11	5	2.17E-06	8.16E-04
zecevic2-3	0.0001	1	11	5	7.63E-06	1.53E-03
zecevic2-4	0.0001	1	11	5	9.87E-06	1.74E-03
zecevic2-5	0.0001	1	11	5	2.50E-05	2.77E-03
zecevic2-ave	0.0001	1.0	11.0	5.0	1.23E-05	1.83E-03
zecevic2-1	0.001	1	11	5	1.71E-04	7.26E-03
zecevic2-2	0.001	1	11	5	2.13E-05	2.56E-03
zecevic2-3	0.001	1	11	5	7.67E-05	4.86E-03
zecevic2-4	0.001	1	11	5	9.90E-05	5.52E-03
zecevic2-5	0.001	1	11	5	2.49E-04	8.78E-03
zecevic2-ave	0.001	1.0	11.0	5.0	1.23E-04	5.79E-03
zecevic2-1	0.01	1	11	7	1.70E-03	2.33E-02
zecevic2-2	0.01	1	11	5	2.13E-04	8.11E-03
zecevic2-3	0.01	1	11	5	7.67E-04	1.54E-02
zecevic2-4	0.01	1	11	5	9.90E-04	1.75E-02
zecevic2-5	0.01	1	11	5	2.49E-03	2.84E-02
zecevic2-ave	0.01	1.0	11.0	5.4	1.23E-03	1.85E-02

TABLE 5. Numerical performance of LOQO on the convex quadratic problems from the CUTer test suite when warmstarting a problem whose objective function coefficients,  $c$ , have been modified. Each problem is labeled under the column Problem, 5 instances of each problem are presented, “ave” refers to the average performance over the five problems,  $\delta$  is the perturbation parameter, and #Pert is the number of perturbed coefficients. The iteration counts for the warmstart and coldstart solution of five perturbed problems are given, and the last 2 columns are the scaled Euclidean norm of the distance between the optimal solutions and the Lagrange multipliers of the initial and the perturbed problem.