

Table 2 Overall comparison of nine reformulations for direct or relaxation algorithms in Group I

Dimension	Method	Direct					Relaxation				
		Dom	Gap	Inf	Inf_Lobj	Time	Dom	Gap	Inf	Inf_Lobj	Time
$m = 100$ $p = 110$ $q = 20$	MPCC	2	1.02	1.31e-06	4.94e-08	8.88	2	0.78	1.09e+02	0.00e+00	373.26
	WDP	8	0.84	2.73e-04	5.07e-08	12.41	10	0.18	1.59e-08	1.37e-08	148.50
	MDP	6	0.96	2.42e-04	8.26e-08	15.43	13	0.14	2.49e-04	9.19e-09	193.05
	eMDP	2	1.20	1.93e-06	9.09e-08	71.15	9	0.34	1.44e-07	5.06e-08	532.70
	TWDP	13	0.55	1.29e-04	4.11e-08	14.99	10	0.19	1.48e-04	1.12e-08	179.93
	TMDP	8	1.18	7.74e-05	1.45e-07	14.04	14	0.14	1.36e-08	1.32e-08	178.62
	eTMDP	3	1.56	9.00e-07	1.53e-08	65.18	5	0.40	7.04e-08	1.30e-08	470.67
	ETMDP	14	0.82	1.33e-04	4.76e-08	25.28	15	0.13	3.12e-05	9.91e-09	212.36
	eETMDP	0	1.48	3.17e-06	6.07e-08	17.46	3	0.36	3.09e-08	9.53e-09	53.84
$m = 120$ $p = 130$ $q = 40$	MPCC	3	0.78	5.79e-05	2.43e-08	9.66	1	0.83	8.74e+01	0.00e+00	526.49
	WDP	9	0.70	4.33e-06	1.93e-08	18.85	8	0.17	1.47e-08	1.08e-08	264.25
	MDP	8	0.52	1.43e-03	9.35e-08	28.83	9	0.15	6.51e-04	1.03e-08	271.29
	eMDP	3	0.94	4.05e-01	2.37e-07	196.65	9	0.25	9.67e-08	1.99e-08	1252.83
	TWDP	14	0.47	2.74e-05	1.47e-08	22.38	19	0.12	3.26e-08	1.04e-08	250.98
	TMDP	10	0.65	3.08e-05	2.69e-08	30.29	8	0.15	3.87e-05	1.23e-07	335.61
	eTMDP	6	0.99	4.56e-01	7.24e-08	156.55	8	0.26	8.15e-08	1.68e-08	1270.74
	ETMDP	12	0.60	9.95e-05	2.14e-07	31.86	10	0.13	4.71e-04	1.00e-08	290.53
	eETMDP	1	1.18	6.35e-01	1.30e-07	56.46	7	0.28	1.61e-08	1.23e-08	107.06
$m = 140$ $p = 150$ $q = 60$	MPCC	5	0.41	3.67e-02	1.33e-08	18.90	3	0.75	4.83e+01	1.08e-09	593.43
	WDP	11	0.31	3.74e-02	1.95e-07	46.36	14	0.22	3.41e-02	1.93e-07	376.51
	MDP	5	0.37	3.63e-02	2.82e-08	35.14	11	0.16	3.41e-02	9.92e-09	332.34
	eMDP	8	0.55	8.49e+00	2.00e+00	1090.96	8	0.20	3.38e-02	3.01e-08	2691.55
	TWDP	5	0.35	3.75e-02	1.02e-07	40.47	6	0.29	3.41e-02	1.00e-08	321.95
	TMDP	7	0.34	3.65e-02	3.16e-08	38.78	10	0.17	3.63e-02	1.32e-08	354.44
	eTMDP	6	0.51	6.16e+00	2.87e-08	862.49	7	0.26	8.27e-02	4.28e-08	2992.28
	ETMDP	17	0.33	3.69e-02	1.36e-08	77.10	11	0.15	3.38e-02	8.69e-09	370.36
	eETMDP	1	0.61	6.08e+00	4.04e-08	454.82	7	0.22	3.25e-02	2.13e-08	526.85

Table 3 Overall comparison of nine reformulations for direct or relaxation algorithms in Group II

Dimension	Method	Direct					Relaxation				
		Dom	Gap	Inf	Inf.Lobj	Time	Dom	Gap	Inf	Inf.Lobj	Time
$m = 100$ $p = 110$ $q = 20$	MPCC	10	0.30	4.00e+00	6.39e-07	0.98	10	0.24	1.11e+02	1.68e-12	40.40
	WDP	9	0.22	2.01e+00	2.00e+00	1.78	19	0.12	1.37e-05	4.48e-07	24.69
	MDP	9	0.29	2.00e+00	2.00e+00	1.87	26	0.10	4.02e-07	3.82e-07	16.63
	eMDP	4	0.33	8.02e-07	6.67e-07	2.31	11	0.16	3.67e-07	3.06e-07	23.05
	TWDP	6	0.24	1.71e-05	5.59e-07	1.79	25	0.11	1.87e-05	4.24e-07	25.87
	TMDP	7	0.27	4.00e+00	4.00e+00	1.96	21	0.11	4.73e-07	4.67e-07	15.78
	eTMDP	4	0.32	1.67e-06	5.85e-07	2.34	8	0.20	3.39e-07	3.07e-07	24.53
	ETMDP	4	0.25	2.01e+00	2.00e+00	2.17	21	0.14	4.14e-07	3.97e-07	17.22
	eETMDP	0	0.54	1.74e-06	5.87e-07	0.86	6	0.18	2.94e-07	2.23e-07	9.49
$m = 120$ $p = 130$ $q = 40$	MPCC	6	0.47	1.83e-06	1.52e-06	1.87	7	0.48	2.27e+02	0.00e+00	102.78
	WDP	8	0.42	5.14e-04	7.67e-07	6.13	16	0.13	1.76e-05	9.58e-07	76.20
	MDP	6	0.37	2.00e+00	1.10e-06	6.51	13	0.15	5.12e-05	1.01e-06	73.34
	eMDP	4	0.57	2.42e-05	1.59e-06	8.64	3	0.23	2.44e-06	1.07e-06	153.82
	TWDP	5	0.42	2.00e+00	2.00e+00	5.46	8	0.14	1.17e-06	1.16e-06	85.36
	TMDP	10	0.33	2.00e+00	2.00e+00	8.46	11	0.10	2.68e-05	1.14e-06	64.59
	eTMDP	2	0.65	3.10e-06	1.15e-06	9.33	7	0.18	1.23e-06	1.17e-06	173.87
	ETMDP	12	0.24	2.00e+00	2.00e+00	7.03	12	0.12	7.82e-07	7.70e-07	49.85
	eETMDP	0	0.90	2.00e+00	2.00e+00	3.33	2	0.26	1.28e-06	9.14e-07	36.47
$m = 140$ $p = 150$ $q = 60$	MPCC	7	0.38	3.29e-06	1.56e-06	3.15	1	0.72	2.02e+02	0.00e+00	200.43
	WDP	8	0.18	4.81e-05	1.19e-06	12.14	14	0.07	1.09e-04	1.83e-06	262.78
	MDP	11	0.16	1.60e-04	9.96e-07	20.97	15	0.07	6.07e-05	2.06e-06	236.74
	eMDP	4	0.30	6.58e-06	1.68e-06	38.90	8	0.15	1.86e-06	1.75e-06	741.12
	TWDP	6	0.24	4.02e+00	4.00e+00	12.52	15	0.10	4.18e-05	2.54e-06	294.55
	TMDP	15	0.14	4.00e+00	4.00e+00	16.30	8	0.11	1.55e-05	1.75e-06	261.06
	eTMDP	2	0.42	6.23e-06	1.72e-06	35.57	10	0.16	1.90e-06	1.87e-06	639.51
	ETMDP	14	0.16	1.34e-02	8.69e-07	19.91	11	0.11	2.00e+00	2.00e+00	302.78
	eETMDP	1	0.70	4.75e-06	1.57e-06	6.84	6	0.18	2.64e-06	1.69e-06	89.26

Table 4 Overall comparison of nine reformulations for direct or relaxation algorithms in Group III

Dimension	Method	Direct					Relaxation				
		Dom	Gap	Inf	Inf.Lobj	Time	Dom	Gap	Inf	Inf.Lobj	Time
$m = 100$ $p = 110$ $q = 20$	MPCC	10	0.27	2.00e+00	2.00e+00	1.53	11	0.37	1.14e+02	1.30e-13	79.20
	WDP	4	0.19	3.72e-04	1.41e-07	2.79	19	0.04	4.58e-05	3.04e-07	143.44
	MDP	5	0.22	1.83e-04	2.41e-07	2.59	14	0.06	4.72e-03	3.73e-07	119.53
	eMDP	5	0.27	8.21e-05	5.52e-07	4.46	1	0.37	2.52e-04	2.17e-07	118.22
	TWDP	6	0.21	2.71e-04	3.54e-07	2.40	6	0.09	1.00e-04	4.55e-07	131.82
	TMDP	9	0.18	2.00e+00	2.00e+00	2.61	5	0.09	4.78e-05	8.35e-07	126.57
	eTMDP	12	0.22	2.00e+00	3.80e-07	3.92	2	0.33	4.67e-06	2.22e-07	103.40
	ETMDP	1	0.22	1.33e-04	6.30e-07	2.63	11	0.37	1.14e+02	3.39e-14	97.90
	eETMDP	0	0.46	2.80e-07	1.86e-07	1.15	0	0.55	1.14e-07	7.06e-08	25.53
$m = 120$ $p = 130$ $q = 40$	MPCC	14	0.52	5.25e-04	7.82e-07	3.59	15	0.71	1.77e+02	2.35e-13	160.02
	WDP	2	0.76	2.00e+00	5.60e-07	6.39	14	0.19	1.02e-04	3.76e-07	337.85
	MDP	0	0.66	2.08e-04	7.17e-07	8.40	10	0.18	2.00e+00	5.94e-07	264.95
	eMDP	9	0.92	3.08e-04	2.51e-07	21.09	2	0.75	3.18e-05	1.89e-07	523.77
	TWDP	7	0.72	1.52e-03	3.64e-07	6.71	6	0.29	1.12e-04	6.74e-07	318.56
	TMDP	3	0.75	2.66e-03	5.04e-07	7.97	3	0.28	2.60e-04	7.12e-07	288.93
	eTMDP	8	0.88	2.01e+00	5.04e-07	20.50	3	0.73	2.85e-05	2.08e-07	517.29
	ETMDP	8	0.44	2.13e-03	4.34e-07	7.10	15	0.71	1.77e+02	4.57e-13	199.16
	eETMDP	0	1.14	5.44e-07	2.10e-07	2.80	0	0.94	1.79e-07	1.42e-07	62.46
$m = 140$ $p = 150$ $q = 60$	MPCC	12	0.55	4.00e+00	4.67e-07	8.27	10	0.78	1.78e+02	0.00e+00	323.23
	WDP	6	0.74	1.70e-04	7.24e-07	18.99	17	0.14	3.17e-04	3.16e-07	739.62
	MDP	3	0.61	1.40e+00	3.77e-07	17.12	12	0.14	1.12e-04	3.46e-07	664.61
	eMDP	7	0.82	4.00e+00	4.00e+00	86.68	2	0.50	4.72e-05	3.63e-07	1788.77
	TWDP	4	0.58	1.18e-03	1.13e-07	15.63	3	0.19	3.52e-04	2.32e-07	859.73
	TMDP	4	0.59	2.68e-04	2.43e-07	24.37	9	0.19	2.00e+00	5.16e-07	810.08
	eTMDP	6	0.38	5.35e-02	4.68e-07	72.42	2	0.55	2.00e+00	2.00e+00	2021.96
	ETMDP	7	0.57	3.67e-03	4.89e-07	21.52	10	0.78	1.80e+02	0.00e+00	398.94
	eETMDP	1	1.10	2.00e+00	2.00e+00	14.31	1	0.88	3.09e-07	4.56e-08	154.47