

Supplementary B: Experiment Details

This supplementary material provides the experiment details for the manuscript “Optimizing Capacitated Multi-Trip Vehicle Routing with Time Windows: Joint Utilization of Route-Based and Trip-Based Formulations”.

EC.4. Supplements to Computational Results

EC.4.1. Detailed Computational Results on Benchmark Instances of CMTVRPTW

Table EC.1 shows detailed computational information about each step of our algorithm for solving the 54 CMTVRPTW instances. Each row corresponds to an individual instance. For each instance, the table shows the name of the solved instance (Name), the number of customers ($|\mathcal{V}|$), the relative gap between the initial lower bound and the guessed upper bound ($UB_g\%$), the objective value of the optimal integral solution (OBJ), the relative gaps between the lower bounds computed at different steps and the optimal objective value ($\hat{LB}_1\%/LB_1\%/LB_2\%$), the sizes of the route sets obtained at different steps ($|\hat{\mathcal{R}}_1|/|\mathcal{R}_1|/|\mathcal{R}_2|$), the computation time for calculating the integral solution at Step 5 of Algorithm 1 (T_{int}), the sum of the computation time of Step 1 of Algorithm 1 and the computation time from Step 2 to Step 5 of Algorithm 1 under valid upper bound (T_{valid}) and the computation time used by the overall solution procedure (T_{tot})

All the CMTVRPTW instances with 70 customers can be solved to optimality within three hours by both methods. Among the 27 instances with 100 customers, the EPCEM solves 14 of them to optimality, whereas our algorithm can solve all of them but one instance “R206”. In fact, the instance “R206” can be solved to optimality within four hours by our algorithm. The computation times reported under “ T_{int} ” and “ T_{tot} ” verify that our exact algorithm performs more efficiently than the EPCEM, particularly in the second phase of the price-cut-and-enumerate algorithm. This benefits from the utilization of the trip-based formulation as well as the improved lower bounds.

Table EC.1: Detailed computational results for CMTVRPTW instances

| Name | $ \mathcal{V} $ | $UB_g\%$ | OBJ | $\hat{LB}_1\%$ | $ \hat{\mathcal{R}}_1 $ | $LB_1\%$ | $ \mathcal{R}_1 $ | $LB_2\%$ | $ \mathcal{R}_2 $ | T_{int} | T_{valid} | T_{tot} |
|------|-----------------|----------|--------|----------------|-------------------------|----------|-------------------|----------|-------------------|-----------|-------------|-----------|
| C201 | 70 | 1.20 | 1052.2 | 0.63 | 223419 | 0.00 | 11755 | 0.00 | 7309 | 0.8 | 49.8 | 49.8 |
| C202 | 70 | 1.20 | 1047.7 | 1.09 | 227126 | 0.19 | 3875 | 0.19 | 3704 | 2.0 | 350.3 | 350.3 |
| C203 | 70 | 1.20 | 1040.4 | 1.05 | 374431 | 0.11 | 3437 | 0.11 | 3336 | 0.9 | 215.1 | 215.1 |
| C204 | 70 | 1.20 | 1036.8 | 1.02 | 595467 | 0.09 | 5939 | 0.09 | 5057 | 0.8 | 234.9 | 234.9 |
| C205 | 70 | 1.50 | 1047.9 | 1.31 | 596397 | 0.17 | 6323 | 0.15 | 4725 | 1.2 | 137.7 | 181.0 |
| C206 | 70 | 1.20 | 1042.0 | 1.07 | 308048 | 0.07 | 1226 | 0.07 | 1006 | 0.3 | 257.9 | 257.9 |
| C207 | 70 | 1.20 | 1040.3 | 1.07 | 314623 | 0.16 | 3027 | 0.16 | 2784 | 1.8 | 102.7 | 102.7 |
| C208 | 70 | 1.20 | 1040.3 | 1.09 | 284916 | 0.11 | 1805 | 0.11 | 1613 | 0.5 | 184.2 | 184.2 |
| R201 | 70 | 1.20 | 1118.4 | 0.67 | 19628 | 0.37 | 8191 | 0.37 | 7978 | 5.3 | 235.5 | 235.5 |
| R202 | 70 | 1.50 | 1041.1 | 1.31 | 89551 | 0.97 | 35885 | 0.97 | 34820 | 40.1 | 528.2 | 918.8 |
| R203 | 70 | 1.20 | 958.0 | 0.68 | 61950 | 0.32 | 22812 | 0.27 | 19881 | 13.4 | 922.0 | 922.0 |

| Name | $ \mathcal{V} $ | $UB_g\%$ | OBJ | $LB_1\%$ | $ \mathcal{R}_1 $ | $LB_1\%$ | $ \mathcal{R}_1 $ | $LB_2\%$ | $ \mathcal{R}_2 $ | T_{int} | T_{valid} | T_{tot} |
|-------|-----------------|----------|--------|----------|-------------------|----------|-------------------|----------|-------------------|-----------|-------------|-----------|
| R204 | 70 | 1.20 | 921.8 | 0.81 | 142361 | 0.26 | 22656 | 0.25 | 19884 | 15.9 | 736.2 | 736.2 |
| R205 | 70 | 1.50 | 1033.4 | 1.44 | 111260 | 1.01 | 36064 | 0.99 | 33336 | 62.7 | 827.1 | 1520.6 |
| R206 | 70 | 1.50 | 985.9 | 1.37 | 169768 | 0.83 | 37133 | 0.81 | 34354 | 43.1 | 1052.1 | 1813.2 |
| R207 | 70 | 1.20 | 942.0 | 0.86 | 79296 | 0.42 | 19350 | 0.42 | 18880 | 15.0 | 702.9 | 702.9 |
| R208 | 70 | 1.20 | 917.5 | 0.95 | 118782 | 0.37 | 17754 | 0.37 | 16464 | 8.6 | 607.2 | 607.2 |
| R209 | 70 | 1.20 | 955.3 | 1.02 | 43175 | 0.56 | 8858 | 0.47 | 7558 | 8.1 | 566.6 | 566.6 |
| R210 | 70 | 1.20 | 980.4 | 0.98 | 70284 | 0.52 | 19030 | 0.45 | 16162 | 25.8 | 1466.4 | 1466.4 |
| R211 | 70 | 1.20 | 914.8 | 0.71 | 87989 | 0.07 | 9851 | 0.06 | 8812 | 6.5 | 855.1 | 855.1 |
| RC201 | 70 | 1.20 | 1364.5 | 1.00 | 9993 | 0.25 | 1028 | 0.19 | 826 | 0.3 | 115.5 | 115.5 |
| RC202 | 70 | 1.20 | 1284.6 | 0.89 | 14719 | 0.27 | 2434 | 0.27 | 2310 | 1.1 | 239.5 | 239.5 |
| RC203 | 70 | 1.20 | 1230.5 | 0.53 | 31552 | 0.00 | 9510 | 0.00 | 9222 | 1.5 | 91.2 | 91.2 |
| RC204 | 70 | 1.20 | 1206.6 | 0.94 | 63649 | 0.00 | 2010 | 0.00 | 1887 | 0.2 | 161.2 | 161.2 |
| RC205 | 70 | 1.20 | 1335.3 | 0.86 | 19015 | 0.41 | 6132 | 0.41 | 5844 | 6.2 | 352.4 | 352.4 |
| RC206 | 70 | 1.50 | 1285.5 | 1.34 | 32954 | 0.37 | 3216 | 0.35 | 2775 | 2.2 | 208.2 | 353.9 |
| RC207 | 70 | 1.50 | 1236.5 | 1.27 | 64523 | 0.04 | 1092 | 0.01 | 806 | 0.3 | 244.6 | 275.1 |
| RC208 | 70 | 1.50 | 1208.2 | 1.26 | 126316 | 0.21 | 7620 | 0.19 | 6165 | 15.5 | 395.7 | 567.6 |
| C201 | 100 | 1.20 | 1473.3 | 0.89 | 741102 | 0.00 | 9282 | 0.00 | 7450 | 1.4 | 181.0 | 181.0 |
| C202 | 100 | 1.20 | 1464.1 | 0.89 | 916312 | 0.03 | 26207 | 0.03 | 21995 | 7.3 | 287.1 | 287.1 |
| C203 | 100 | 1.20 | 1456.3 | 1.06 | 1339713 | 0.00 | 3051 | 0.00 | 2828 | 0.3 | 229.3 | 229.3 |
| C204 | 100 | 1.20 | 1448.7 | 0.96 | 2345203 | 0.02 | 9886 | 0.01 | 7760 | 0.7 | 325.1 | 325.1 |
| C205 | 100 | 1.20 | 1460.2 | 1.00 | 867257 | 0.00 | 2303 | 0.00 | 1961 | 0.4 | 174.6 | 174.6 |
| C206 | 100 | 1.20 | 1455.1 | 1.03 | 967258 | 0.00 | 2163 | 0.00 | 1945 | 0.3 | 141.6 | 141.6 |
| C207 | 100 | 1.20 | 1454.5 | 0.81 | 1176278 | 0.02 | 31858 | 0.01 | 24800 | 3.9 | 215.8 | 215.8 |
| C208 | 100 | 1.20 | 1451.9 | 0.95 | 993160 | 0.00 | 4515 | 0.00 | 3917 | 1.1 | 160.9 | 160.9 |
| R201 | 100 | 1.20 | 1399.6 | 1.16 | 208603 | 0.88 | 84866 | 0.86 | 74888 | 262.4 | 1122.7 | 1122.7 |
| R202 | 100 | 1.20 | 1304.7 | 1.12 | 976035 | 0.81 | 317685 | 0.77 | 287807 | 3279.0 | 5105.5 | 5105.5 |
| R203 | 100 | 1.20 | 1204.8 | 0.91 | 1594226 | 0.52 | 355244 | 0.49 | 312880 | 906.4 | 2964.1 | 2964.1 |
| R204 | 100 | 1.20 | 1162.2 | 0.67 | 3765478 | 0.13 | 352035 | 0.12 | 333848 | 229.3 | 3067.0 | 3067.0 |
| R205 | 100 | 1.20 | 1267.3 | 1.08 | 479352 | 0.84 | 203819 | 0.79 | 182226 | 673.0 | 1958.5 | 1958.5 |
| R206 | 100 | 1.20 | 1220.9 | 1.08 | 1295889 | 0.70 | 353431 | 0.66 | 275796 | 10101.1 | 11322.1 | 11322.1 |
| R207 | 100 | 1.20 | 1182.5 | 0.82 | 2659985 | 0.34 | 367009 | 0.33 | 348065 | 568.2 | 3264.5 | 3264.5 |
| R208 | 100 | 1.20 | 1157.5 | 0.63 | 3952878 | 0.14 | 507400 | 0.13 | 491585 | 336.5 | 3795.1 | 3795.1 |
| R209 | 100 | 1.20 | 1205.4 | 0.56 | 1042074 | 0.30 | 436341 | 0.20 | 314977 | 645.8 | 2673.2 | 2673.2 |
| R210 | 100 | 1.20 | 1211.8 | 0.77 | 1461973 | 0.39 | 382356 | 0.34 | 326775 | 856.7 | 3725.7 | 3725.7 |
| R211 | 100 | 1.20 | 1160.6 | 0.84 | 3816467 | 0.31 | 386907 | 0.28 | 304425 | 2653.8 | 5694.2 | 5694.2 |
| RC201 | 100 | 1.20 | 1806.8 | 0.55 | 110637 | 0.34 | 50067 | 0.34 | 47055 | 18.6 | 316.1 | 316.1 |
| RC202 | 100 | 1.20 | 1680.2 | 1.03 | 221919 | 0.70 | 80056 | 0.68 | 74027 | 74.8 | 601.1 | 601.1 |
| RC203 | 100 | 1.20 | 1601.0 | 0.79 | 706614 | 0.32 | 108454 | 0.24 | 66433 | 45.9 | 1144.2 | 1144.2 |
| RC204 | 100 | 1.20 | 1574.6 | 0.78 | 1289820 | 0.04 | 42507 | 0.04 | 39637 | 12.4 | 970.4 | 970.4 |
| RC205 | 100 | 1.20 | 1732.6 | 1.13 | 279338 | 0.75 | 72479 | 0.74 | 67526 | 397.1 | 1219.5 | 1219.5 |
| RC206 | 100 | 1.50 | 1698.1 | 1.30 | 605242 | 0.68 | 92819 | 0.57 | 58452 | 108.8 | 737.3 | 1323.7 |
| RC207 | 100 | 1.50 | 1640.7 | 1.24 | 1265792 | 0.38 | 49855 | 0.28 | 37470 | 70.2 | 1399.4 | 2359.8 |
| RC208 | 100 | 1.20 | 1570.7 | 0.77 | 1655568 | 0.00 | 41888 | 0.00 | 32151 | 31.2 | 1030.7 | 1030.7 |

EC.4.2. Detailed Computational Results on Four Variants of CMTVRPTW

Like the exact methods of [Paradiso et al. \(2020\)](#) and [Yang \(2023\)](#), our proposed exact algorithm also can be adapted to solve the four variants of the CMTVRPTW, where the labeling algorithm introduced in §[EC.3](#) need to be revised to address additional side constraints. Detailed computational results for the four problem variants of the CMTVRPTW are shown in Tables [EC.2–EC.5](#), using the same notations introduced in Table [EC.1](#).

Our reported optimal objective values align with those of [Yang \(2023\)](#), with three exceptions, including the 70-customer CMTVRPTW-LD instance C206 with $\bar{d} = 250$, the 100-customer

CMTVRPTW-LD instance C202 with $\bar{d} = 220$ and the 70-customer DRP instance R203. For these three instances claimed to be optimally solved by Yang (2023), our results show slightly lower objective values. Such slight differences in objective values could be attributed to tolerance errors of using the MIP solver during the solution algorithm. For the remaining instances, our reported objective values are equal to or less than those reported by Yang (2023).

Results on CMTVRPTW-LT. The CMTVRPTW-LT differs from the CMTVRPTW in the sense that goods' loading time at the depot is considered. Let lt_i be the time spent at the depot for loading the goods of customer $i \in \mathcal{V}$. For route r , a vehicle needs the amount $\sum_{i \in \mathcal{V}(r)} lt_i$ of time for loading goods before its departure from the depot. Based on the above 54 CMTVRPTW instances, we have the same number of instances for the CMTVRPTW-LT, where goods' loading time is incorporated in each instance. Following Yang (2023), the loading time is fixed as 20% of the service time, i.e., $lt_i = 0.2\theta_i$ for $i \in \mathcal{V}$.

For the CMTVRPTW-LT instances as shown in Table 2, our exact algorithm outperforms the EPCEM, in terms of both solution quality and computation time. Although all the 27 instances with 70 customers can be solved to optimality within three hours by both methods, our algorithm on average requires less time than the EPCEM for computing the optimal solutions. The strength of our algorithm is more remarkable when computing the other 27 instances with 100 customers, for which only 12 instances are solved to optimality by the EPCEM.

Results on CMTVRPTW-LD. The CMTVRPTW-LD differs from the CMTVRPTW-LT in the aspect that a limit \bar{d} is considered for the time that goods can be on board. For each trip, the time length between the vehicle's departure time from the depot and the arrival time at the last customer visited should be no greater than \bar{d} . Based on the 54 CMTVRPTW-LT instances which are derived from the type-2 Solomon instances of three groups (i.e., C, R, RC), we consider for each instance two alternative duration time limit values, thus having a total of 108 instances for the CMTVRPTW-LD. Following Yang (2023), we set $\bar{d} \in \{220, 250\}$ for the instances in group C and set $\bar{d} \in \{75, 100\}$ for the instances in group R and group RC. Moreover, we define $lt_i = 0.2\theta_i$ for $i \in \mathcal{V}$. The vehicle capacities are set as $Q = 700$ for the instances in group C and $Q = 1000$ for the instances in groups R and RC.

Computational results on the CMTVRPTW-LD instances in Table 2 reveal that the instances with 70 customers can be solved to optimality very quickly by both methods. For the instances with 100 customers, our algorithm solves to optimality three more instances than the EPCEM. The instance R211 with $\bar{d} = 100$ is not solved by our algorithm, because the number of trips contained in set $\tilde{\mathcal{S}}_2(\mathcal{T})$ exceeds the predefined number (i.e., two million) when performing the dynamic discretization procedure. Moreover, our exact algorithm outperforms the EPCEM in achieving tighter lower bounds and shorter computation time.

Results on CMTVRPTW-R. The CMTVRPTW-R differs from the CMTVRPTW in the sense that each customer has a release date for its demand, and the vehicle must depart from the depot no earlier than the time when demands of the visited customers are released. Following the procedure introduced in [Cattaruzza et al. \(2016\)](#), we set the release dates based on a parameter $\kappa \in \{0.25, 0.5, 0.75\}$ and have a total of 162 benchmark instances for the CMTVRPTW-R.

Computational results on the CMTVRPTW-R instances in Table 2 show that our algorithm can solve all the 162 instances to optimality, outperforming the EPCEM that solves 147 instances. The strength of our algorithm is particularly significant on the instances with 100 customers, in both lower bound tightness and computation time. Note that the average computation time used by our algorithm over the instances with 100 customers is about half of that used by the EPCEM. Such efficiency stems from our fast second-phase computation which only needs 4% of the time used in the EPCEM.

Results on DRP. The DRP considered in [Cheng et al. \(2020\)](#) is another variant of the CMTVRPTW, where each vehicle (or drone) is assigned with a battery capacity and the objective includes an additional energy cost component depending on the loaded goods. Moreover, a drone must return to the depot before running out of its battery power. To address these issues, we adapt the rollback pruning properly to solve the DRP (see §EC.3.4). [Cheng et al. \(2020\)](#) generate two sets of DRP instances with at most 50 customers for the computational test. We do not compare the results based on these instances, because they can be solved to optimality very quickly by both the EPCEM and our algorithm. For this reason, we use the 54 large DRP instances tested in [Yang \(2023\)](#) that are with 70 and 100 customers for comparisons.

The computational results on the DRP instances in Table 2 show that our algorithm can solve all the 54 benchmark instances to optimality very fast. Instead, the EPCEM fails to solve one instance with 70 customers and two instances with 100 customers. For the instances with 100 customers that are solved by the EPCEM, the average times used for the second-phase computation and for the entire exact algorithm are about 21% and 35% of that for the EPCEM, respectively. Furthermore, the average optimality gap provided by our algorithm is about 18% of that provided by the EPCEM. All these results validate the advantage of our algorithm over the EPCEM in solving the DRP.

Table EC.2: Detailed computational results for CMTVRPTW-LT

| Name | $ \mathcal{V} $ | $UB_g\%$ | OBJ | $LB_1\%$ | $ \hat{\mathcal{R}}_1 $ | $LB_1\%$ | $ \mathcal{R}_1 $ | $LB_2\%$ | $ \mathcal{R}_2 $ | T_{int} | T_{valid} | T_{tot} |
|------|-----------------|----------|--------|----------|-------------------------|----------|-------------------|----------|-------------------|-----------|-------------|-----------|
| C201 | 70 | 1.20 | 1052.2 | 0.63 | 223419 | 0.00 | 11755 | 0.00 | 7309 | 0.8 | 49.8 | 49.8 |
| C202 | 70 | 1.20 | 1047.7 | 1.09 | 227126 | 0.19 | 3875 | 0.19 | 3704 | 2.0 | 350.3 | 350.3 |
| C203 | 70 | 1.20 | 1040.4 | 1.05 | 374431 | 0.11 | 3437 | 0.11 | 3336 | 0.9 | 215.1 | 215.1 |

| Name | $ \mathcal{V} $ | $UB_g\%$ | OBJ | $\bar{LB}_1\%$ | $ \bar{\mathcal{R}}_1 $ | $LB_1\%$ | $ \mathcal{R}_1 $ | $LB_2\%$ | $ \mathcal{R}_2 $ | T_{int} | T_{valid} | T_{tot} |
|-------|-----------------|----------|--------|----------------|-------------------------|----------|-------------------|----------|-------------------|-----------|-------------|-----------|
| C204 | 70 | 1.20 | 1036.8 | 1.02 | 595467 | 0.09 | 5939 | 0.09 | 5057 | 0.8 | 234.9 | 234.9 |
| C205 | 70 | 1.50 | 1047.9 | 1.31 | 596397 | 0.17 | 6323 | 0.15 | 4725 | 1.2 | 137.7 | 181.0 |
| C206 | 70 | 1.20 | 1042.0 | 1.07 | 308048 | 0.07 | 1226 | 0.07 | 1006 | 0.3 | 257.9 | 257.9 |
| C207 | 70 | 1.20 | 1040.3 | 1.07 | 314623 | 0.16 | 3027 | 0.16 | 2784 | 1.8 | 102.7 | 102.7 |
| C208 | 70 | 1.20 | 1040.3 | 1.09 | 284916 | 0.11 | 1805 | 0.11 | 1613 | 0.5 | 184.2 | 184.2 |
| R201 | 70 | 1.20 | 1118.4 | 0.67 | 19628 | 0.37 | 8191 | 0.37 | 7978 | 5.3 | 235.5 | 235.5 |
| R202 | 70 | 1.50 | 1041.1 | 1.31 | 89551 | 0.97 | 35885 | 0.97 | 34820 | 40.1 | 528.2 | 918.8 |
| R203 | 70 | 1.20 | 958.0 | 0.68 | 61950 | 0.32 | 22812 | 0.27 | 19881 | 13.4 | 922.0 | 922.0 |
| R204 | 70 | 1.20 | 921.8 | 0.81 | 142361 | 0.26 | 22656 | 0.25 | 19884 | 15.9 | 736.2 | 736.2 |
| R205 | 70 | 1.50 | 1033.4 | 1.44 | 111260 | 1.01 | 36064 | 0.99 | 33336 | 62.7 | 827.1 | 1520.6 |
| R206 | 70 | 1.50 | 985.9 | 1.37 | 169768 | 0.83 | 37133 | 0.81 | 34354 | 43.1 | 1052.1 | 1813.2 |
| R207 | 70 | 1.20 | 942.0 | 0.86 | 79296 | 0.42 | 19350 | 0.42 | 18880 | 15.0 | 702.9 | 702.9 |
| R208 | 70 | 1.20 | 917.5 | 0.95 | 118782 | 0.37 | 17754 | 0.37 | 16464 | 8.6 | 607.2 | 607.2 |
| R209 | 70 | 1.20 | 955.3 | 1.02 | 43175 | 0.56 | 8858 | 0.47 | 7558 | 8.1 | 566.6 | 566.6 |
| R210 | 70 | 1.20 | 980.4 | 0.98 | 70284 | 0.52 | 19030 | 0.45 | 16162 | 25.8 | 1466.4 | 1466.4 |
| R211 | 70 | 1.20 | 914.8 | 0.71 | 87989 | 0.07 | 9851 | 0.06 | 8812 | 6.5 | 855.1 | 855.1 |
| RC201 | 70 | 1.20 | 1364.5 | 1.00 | 9993 | 0.25 | 1028 | 0.19 | 826 | 0.3 | 115.5 | 115.5 |
| RC202 | 70 | 1.20 | 1284.6 | 0.89 | 14719 | 0.27 | 2434 | 0.27 | 2310 | 1.1 | 239.5 | 239.5 |
| RC203 | 70 | 1.20 | 1230.5 | 0.53 | 31552 | 0.00 | 9510 | 0.00 | 9222 | 1.5 | 91.2 | 91.2 |
| RC204 | 70 | 1.20 | 1206.6 | 0.94 | 63649 | 0.00 | 2010 | 0.00 | 1887 | 0.2 | 161.2 | 161.2 |
| RC205 | 70 | 1.20 | 1335.3 | 0.86 | 19015 | 0.41 | 6132 | 0.41 | 5844 | 6.2 | 352.4 | 352.4 |
| RC206 | 70 | 1.50 | 1285.5 | 1.34 | 32954 | 0.37 | 3216 | 0.35 | 2775 | 2.2 | 208.2 | 353.9 |
| RC207 | 70 | 1.50 | 1236.5 | 1.27 | 64523 | 0.04 | 1092 | 0.01 | 806 | 0.3 | 244.6 | 275.1 |
| RC208 | 70 | 1.50 | 1208.2 | 1.26 | 126316 | 0.21 | 7620 | 0.19 | 6165 | 15.5 | 395.7 | 567.6 |
| C201 | 100 | 1.20 | 1473.3 | 0.89 | 741102 | 0.00 | 9282 | 0.00 | 7450 | 1.4 | 181.0 | 181.0 |
| C202 | 100 | 1.20 | 1464.1 | 0.89 | 916312 | 0.03 | 26207 | 0.03 | 21995 | 7.3 | 287.1 | 287.1 |
| C203 | 100 | 1.20 | 1456.3 | 1.06 | 1339713 | 0.00 | 3051 | 0.00 | 2828 | 0.3 | 229.3 | 229.3 |
| C204 | 100 | 1.20 | 1448.7 | 0.96 | 2345203 | 0.02 | 9886 | 0.01 | 7760 | 0.7 | 325.1 | 325.1 |
| C205 | 100 | 1.20 | 1460.2 | 1.00 | 867257 | 0.00 | 2303 | 0.00 | 1961 | 0.4 | 174.6 | 174.6 |
| C206 | 100 | 1.20 | 1455.1 | 1.03 | 967258 | 0.00 | 2163 | 0.00 | 1945 | 0.3 | 141.6 | 141.6 |
| C207 | 100 | 1.20 | 1454.5 | 0.81 | 1176278 | 0.02 | 31858 | 0.01 | 24800 | 3.9 | 215.8 | 215.8 |
| C208 | 100 | 1.20 | 1451.9 | 0.95 | 993160 | 0.00 | 4515 | 0.00 | 3917 | 1.1 | 160.9 | 160.9 |
| R201 | 100 | 1.20 | 1399.6 | 1.16 | 208603 | 0.88 | 84866 | 0.86 | 74888 | 262.4 | 1122.7 | 1122.7 |
| R202 | 100 | 1.20 | 1304.7 | 1.12 | 976035 | 0.81 | 317685 | 0.77 | 287807 | 3279.0 | 5105.5 | 5105.5 |
| R203 | 100 | 1.20 | 1204.8 | 0.91 | 1594226 | 0.52 | 355244 | 0.49 | 312880 | 906.4 | 2964.1 | 2964.1 |
| R204 | 100 | 1.20 | 1162.2 | 0.67 | 3765478 | 0.13 | 352035 | 0.12 | 333848 | 229.3 | 3067.0 | 3067.0 |
| R205 | 100 | 1.20 | 1267.3 | 1.08 | 479352 | 0.84 | 203819 | 0.79 | 182226 | 673.0 | 1958.5 | 1958.5 |
| R206 | 100 | 1.20 | 1220.9 | 1.08 | 1295889 | 0.70 | 353431 | 0.66 | 275796 | 10101.1 | 11322.1 | 11322.1 |
| R207 | 100 | 1.20 | 1182.5 | 0.82 | 2659985 | 0.34 | 367009 | 0.33 | 348065 | 568.2 | 3264.5 | 3264.5 |
| R208 | 100 | 1.20 | 1157.5 | 0.63 | 3952878 | 0.14 | 507400 | 0.13 | 491585 | 336.5 | 3795.1 | 3795.1 |
| R209 | 100 | 1.20 | 1205.4 | 0.56 | 1042074 | 0.30 | 436341 | 0.20 | 314977 | 645.8 | 2673.2 | 2673.2 |
| R210 | 100 | 1.20 | 1211.8 | 0.77 | 1461973 | 0.39 | 382356 | 0.34 | 326775 | 856.7 | 3725.7 | 3725.7 |
| R211 | 100 | 1.20 | 1160.6 | 0.84 | 3816467 | 0.31 | 386907 | 0.28 | 304425 | 2653.8 | 5694.2 | 5694.2 |
| RC201 | 100 | 1.20 | 1806.8 | 0.55 | 110637 | 0.34 | 50067 | 0.34 | 47055 | 18.6 | 316.1 | 316.1 |
| RC202 | 100 | 1.20 | 1680.2 | 1.03 | 221919 | 0.70 | 80056 | 0.68 | 74027 | 74.8 | 601.1 | 601.1 |
| RC203 | 100 | 1.20 | 1601.0 | 0.79 | 706614 | 0.32 | 108454 | 0.24 | 66433 | 45.9 | 1144.2 | 1144.2 |
| RC204 | 100 | 1.20 | 1574.6 | 0.78 | 1289820 | 0.04 | 42507 | 0.04 | 39637 | 12.4 | 970.4 | 970.4 |
| RC205 | 100 | 1.20 | 1732.6 | 1.13 | 279338 | 0.75 | 72479 | 0.74 | 67526 | 397.1 | 1219.5 | 1219.5 |
| RC206 | 100 | 1.50 | 1698.1 | 1.30 | 605242 | 0.68 | 92819 | 0.57 | 58452 | 108.8 | 737.3 | 1323.7 |
| RC207 | 100 | 1.50 | 1640.7 | 1.24 | 1265792 | 0.38 | 49855 | 0.28 | 37470 | 70.2 | 1399.4 | 2359.8 |
| RC208 | 100 | 1.20 | 1570.7 | 0.77 | 1655568 | 0.00 | 41888 | 0.00 | 32151 | 31.2 | 1030.7 | 1030.7 |

Table EC.3: Detailed computational results for CMTVRPTW-LD

| Name | $ \mathcal{V} $ | d | $UB_g\%$ | OBJ | $\bar{LB}_1\%$ | $ \bar{\mathcal{R}}_1 $ | $LB_1\%$ | $ \mathcal{R}_1 $ | $LB_2\%$ | $ \mathcal{R}_2 $ | T_{int} | T_{valid} | T_{tot} |
|------|-----------------|-------|----------|--------|----------------|-------------------------|----------|-------------------|----------|-------------------|-----------|-------------|-----------|
| C201 | 70 | 220.0 | 1.00 | 1918.7 | 0.00 | 270 | 0.00 | 264 | 0.00 | 263 | 0.0 | 1.8 | 1.8 |
| C201 | 70 | 250.0 | 1.00 | 1587.5 | 0.00 | 368 | 0.00 | 348 | 0.00 | 346 | 0.0 | 1.8 | 1.8 |
| C202 | 70 | 220.0 | 1.00 | 1896.6 | 0.30 | 785 | 0.16 | 655 | 0.16 | 651 | 0.1 | 5.2 | 5.2 |

| Name | $ \mathcal{V} $ | d | $UB_g\%$ | OBJ | $LB_1\%$ | $ \hat{\mathcal{R}}_1 $ | $LB_1\%$ | $ \mathcal{R}_1 $ | $LB_2\%$ | $ \mathcal{R}_2 $ | T_{int} | T_{valid} | T_{tot} |
|-------|-----------------|-------|----------|--------|----------|-------------------------|----------|-------------------|----------|-------------------|-----------|-------------|-----------|
| C202 | 70 | 250.0 | 1.00 | 1582.7 | 0.03 | 2003 | 0.00 | 1871 | 0.00 | 1861 | 0.0 | 3.0 | 3.0 |
| C203 | 70 | 220.0 | 1.00 | 1835.9 | 0.27 | 1708 | 0.05 | 1394 | 0.05 | 1386 | 0.1 | 11.9 | 11.9 |
| C203 | 70 | 250.0 | 1.00 | 1571.6 | 0.77 | 5095 | 0.46 | 3339 | 0.46 | 3224 | 0.4 | 22.9 | 22.9 |
| C204 | 70 | 220.0 | 1.00 | 1774.3 | 0.43 | 2846 | 0.39 | 2755 | 0.39 | 2716 | 17.4 | 41.7 | 41.7 |
| C204 | 70 | 250.0 | 1.00 | 1557.8 | 0.96 | 7588 | 0.82 | 6575 | 0.82 | 6203 | 41.8 | 53.9 | 53.9 |
| C205 | 70 | 220.0 | 1.00 | 1846.3 | 0.98 | 618 | 0.79 | 534 | 0.79 | 529 | 0.1 | 5.4 | 5.4 |
| C205 | 70 | 250.0 | 1.00 | 1580.5 | 0.26 | 1011 | 0.11 | 903 | 0.11 | 896 | 0.1 | 6.0 | 6.0 |
| C206 | 70 | 220.0 | 1.60 | 1842.3 | 1.37 | 1320 | 1.08 | 1229 | 1.08 | 1229 | 0.1 | 6.6 | 39.9 |
| C206 | 70 | 250.0 | 1.00 | 1573.0 | 0.23 | 1997 | 0.05 | 1752 | 0.05 | 1752 | 0.1 | 16.2 | 16.2 |
| C207 | 70 | 220.0 | 1.00 | 1798.6 | 0.41 | 1457 | 0.29 | 1357 | 0.29 | 1343 | 0.4 | 9.4 | 9.4 |
| C207 | 70 | 250.0 | 1.00 | 1568.6 | 0.08 | 3774 | 0.04 | 3625 | 0.04 | 3618 | 0.1 | 7.7 | 7.7 |
| C208 | 70 | 220.0 | 1.00 | 1815.5 | 0.41 | 1340 | 0.35 | 1271 | 0.35 | 1269 | 0.2 | 5.2 | 5.2 |
| C208 | 70 | 250.0 | 1.00 | 1568.6 | 0.08 | 3087 | 0.04 | 2975 | 0.04 | 2975 | 0.1 | 5.4 | 5.4 |
| R201 | 70 | 75.0 | 1.00 | 1838.1 | 0.06 | 807 | 0.00 | 768 | 0.00 | 731 | 0.0 | 3.3 | 3.3 |
| R201 | 70 | 100.0 | 1.00 | 1597.0 | 0.00 | 1050 | 0.00 | 940 | 0.00 | 893 | 0.1 | 2.4 | 2.4 |
| R202 | 70 | 75.0 | 1.00 | 1708.5 | 0.05 | 1949 | 0.00 | 1782 | 0.00 | 1770 | 0.0 | 4.1 | 4.1 |
| R202 | 70 | 100.0 | 1.00 | 1469.4 | 0.00 | 2326 | 0.00 | 2198 | 0.00 | 1898 | 0.1 | 4.0 | 4.0 |
| R203 | 70 | 75.0 | 1.00 | 1559.1 | 0.16 | 2656 | 0.00 | 1935 | 0.00 | 1878 | 0.1 | 7.5 | 7.5 |
| R203 | 70 | 100.0 | 1.00 | 1305.6 | 0.00 | 5108 | 0.00 | 4270 | 0.00 | 3996 | 0.1 | 7.9 | 7.9 |
| R204 | 70 | 75.0 | 1.00 | 1390.4 | 0.45 | 3785 | 0.29 | 2886 | 0.29 | 2684 | 7.5 | 21.7 | 21.7 |
| R204 | 70 | 100.0 | 1.00 | 1110.3 | 0.06 | 9425 | 0.00 | 7850 | 0.00 | 7716 | 0.3 | 38.5 | 38.5 |
| R205 | 70 | 75.0 | 1.00 | 1608.9 | 0.63 | 1664 | 0.00 | 416 | 0.00 | 371 | 0.1 | 9.7 | 9.7 |
| R205 | 70 | 100.0 | 1.00 | 1358.8 | 0.22 | 3110 | 0.22 | 2869 | 0.22 | 2802 | 0.1 | 6.1 | 6.1 |
| R206 | 70 | 75.0 | 1.00 | 1531.3 | 0.22 | 1965 | 0.01 | 1450 | 0.01 | 1392 | 0.3 | 7.3 | 7.3 |
| R206 | 70 | 100.0 | 1.00 | 1278.6 | 0.49 | 4914 | 0.32 | 3559 | 0.32 | 3509 | 0.5 | 57.3 | 57.3 |
| R207 | 70 | 75.0 | 1.00 | 1454.8 | 0.21 | 3587 | 0.03 | 2481 | 0.03 | 2355 | 0.1 | 14.1 | 14.1 |
| R207 | 70 | 100.0 | 1.00 | 1186.1 | 0.66 | 6045 | 0.30 | 2394 | 0.30 | 2370 | 0.5 | 107.2 | 107.2 |
| R208 | 70 | 75.0 | 1.00 | 1376.1 | 0.41 | 4546 | 0.22 | 3502 | 0.22 | 3352 | 11.4 | 32.6 | 32.6 |
| R208 | 70 | 100.0 | 1.00 | 1087.6 | 0.09 | 10040 | 0.00 | 6976 | 0.00 | 6430 | 0.3 | 59.6 | 59.6 |
| R209 | 70 | 75.0 | 1.00 | 1476.4 | 0.43 | 2853 | 0.13 | 1547 | 0.13 | 1512 | 0.2 | 29.4 | 29.4 |
| R209 | 70 | 100.0 | 1.00 | 1211.5 | 0.59 | 3985 | 0.51 | 3320 | 0.51 | 3287 | 0.6 | 56.4 | 56.4 |
| R210 | 70 | 75.0 | 1.00 | 1543.5 | 0.76 | 2437 | 0.41 | 1336 | 0.41 | 1238 | 0.5 | 41.6 | 41.6 |
| R210 | 70 | 100.0 | 1.00 | 1299.0 | 0.45 | 6226 | 0.09 | 2855 | 0.09 | 2737 | 0.3 | 75.0 | 75.0 |
| R211 | 70 | 75.0 | 1.00 | 1375.4 | 0.77 | 4988 | 0.70 | 4513 | 0.64 | 4032 | 14.4 | 50.2 | 50.2 |
| R211 | 70 | 100.0 | 1.00 | 1082.0 | 0.10 | 11822 | 0.10 | 8334 | 0.00 | 6677 | 0.4 | 36.1 | 36.1 |
| RC201 | 70 | 75.0 | 1.00 | 2392.0 | 0.09 | 407 | 0.00 | 362 | 0.00 | 343 | 0.2 | 4.7 | 4.7 |
| RC201 | 70 | 100.0 | 1.00 | 1798.5 | 0.00 | 611 | 0.00 | 557 | 0.00 | 533 | 0.1 | 3.1 | 3.1 |
| RC202 | 70 | 75.0 | 1.00 | 2167.3 | 0.50 | 691 | 0.43 | 654 | 0.43 | 642 | 0.3 | 5.9 | 5.9 |
| RC202 | 70 | 100.0 | 1.00 | 1664.8 | 0.58 | 1295 | 0.42 | 1072 | 0.42 | 1058 | 0.2 | 25.7 | 25.7 |
| RC203 | 70 | 75.0 | 1.00 | 1986.1 | 0.47 | 1037 | 0.18 | 870 | 0.18 | 793 | 0.1 | 7.0 | 7.0 |
| RC203 | 70 | 100.0 | 1.00 | 1482.0 | 0.00 | 3600 | 0.00 | 2956 | 0.00 | 2891 | 0.1 | 9.6 | 9.6 |
| RC204 | 70 | 75.0 | 1.00 | 1843.6 | 0.49 | 2425 | 0.20 | 1697 | 0.20 | 1615 | 3.6 | 38.2 | 38.2 |
| RC204 | 70 | 100.0 | 1.00 | 1290.9 | 0.83 | 6764 | 0.53 | 3396 | 0.53 | 3396 | 0.8 | 128.1 | 128.1 |
| RC205 | 70 | 75.0 | 1.00 | 2197.3 | 0.26 | 702 | 0.03 | 548 | 0.03 | 513 | 0.1 | 7.0 | 7.0 |
| RC205 | 70 | 100.0 | 1.00 | 1723.5 | 0.00 | 1335 | 0.00 | 1170 | 0.00 | 1111 | 0.1 | 3.7 | 3.7 |
| RC206 | 70 | 75.0 | 1.00 | 2095.4 | 0.79 | 729 | 0.35 | 461 | 0.35 | 445 | 0.3 | 25.1 | 25.1 |
| RC206 | 70 | 100.0 | 1.30 | 1582.4 | 1.11 | 3783 | 0.85 | 2609 | 0.84 | 2404 | 1.2 | 49.6 | 94.0 |
| RC207 | 70 | 75.0 | 1.60 | 1924.7 | 1.48 | 2800 | 0.86 | 1710 | 0.86 | 1623 | 0.5 | 48.4 | 139.0 |
| RC207 | 70 | 100.0 | 1.60 | 1367.3 | 1.45 | 8060 | 1.01 | 3496 | 1.01 | 3136 | 0.1 | 18.2 | 35.5 |
| RC208 | 70 | 75.0 | 1.30 | 1818.1 | 1.25 | 3802 | 0.86 | 2592 | 0.72 | 2196 | 11.0 | 60.3 | 107.6 |
| RC208 | 70 | 100.0 | 1.60 | 1249.3 | 1.56 | 27931 | 1.04 | 9829 | 0.95 | 8653 | 40.4 | 266.4 | 648.8 |
| C201 | 100 | 220.0 | 1.00 | 2902.4 | 0.50 | 591 | 0.24 | 530 | 0.24 | 519 | 0.1 | 5.8 | 5.8 |
| C201 | 100 | 250.0 | 1.00 | 2335.4 | 0.32 | 876 | 0.13 | 788 | 0.13 | 770 | 0.1 | 35.0 | 35.0 |
| C202 | 100 | 220.0 | 1.00 | 2830.4 | 0.50 | 2131 | 0.46 | 2051 | 0.46 | 2051 | 0.2 | 8.6 | 8.6 |
| C202 | 100 | 250.0 | 1.00 | 2311.8 | 0.56 | 8122 | 0.40 | 6386 | 0.40 | 6330 | 1.2 | 25.5 | 25.5 |
| C203 | 100 | 220.0 | 1.00 | 2763.0 | 0.52 | 3912 | 0.45 | 3679 | 0.45 | 3652 | 18.1 | 25.6 | 25.6 |
| C203 | 100 | 250.0 | 1.00 | 2292.2 | 0.78 | 16724 | 0.56 | 11612 | 0.56 | 11311 | 15.8 | 51.7 | 51.7 |
| C204 | 100 | 220.0 | 1.00 | 2704.4 | 0.56 | 5652 | 0.27 | 4560 | 0.27 | 4470 | 63.5 | 90.7 | 90.7 |
| C204 | 100 | 250.0 | 1.00 | 2283.6 | 0.74 | 23175 | 0.64 | 20489 | 0.64 | 19808 | 188.8 | 228.8 | 228.8 |
| C205 | 100 | 220.0 | 1.00 | 2793.2 | 0.97 | 1352 | 0.63 | 1156 | 0.63 | 1153 | 0.2 | 16.6 | 16.6 |

| Name | $ \mathcal{V} $ | d | $UB_g\%$ | OBJ | $\bar{LB}_1\%$ | $ \hat{\mathcal{R}}_1 $ | $LB_1\%$ | $ \mathcal{R}_1 $ | $LB_2\%$ | $ \mathcal{R}_2 $ | T_{int} | T_{valid} | T_{tot} |
|-------|-----------------|-------|----------|--------|----------------|-------------------------|----------|-------------------|----------|-------------------|-----------|-------------|-----------|
| C205 | 100 | 250.0 | 1.00 | 2320.4 | 0.92 | 2338 | 0.49 | 1570 | 0.49 | 1566 | 0.5 | 40.1 | 40.1 |
| C206 | 100 | 220.0 | 1.30 | 2770.6 | 1.04 | 2296 | 0.88 | 2179 | 0.88 | 2179 | 0.3 | 9.8 | 16.7 |
| C206 | 100 | 250.0 | 1.30 | 2308.8 | 1.00 | 5837 | 0.68 | 4365 | 0.68 | 4287 | 1.0 | 35.5 | 65.9 |
| C207 | 100 | 220.0 | 1.00 | 2743.2 | 0.65 | 2423 | 0.26 | 1851 | 0.26 | 1743 | 0.6 | 16.2 | 16.2 |
| C207 | 100 | 250.0 | 1.00 | 2305.7 | 0.78 | 6434 | 0.43 | 4573 | 0.43 | 4558 | 1.0 | 46.9 | 46.9 |
| C208 | 100 | 220.0 | 1.00 | 2738.9 | 0.39 | 2575 | 0.22 | 2424 | 0.22 | 2424 | 0.1 | 7.8 | 7.8 |
| C208 | 100 | 250.0 | 1.00 | 2302.2 | 0.93 | 6297 | 0.75 | 5514 | 0.75 | 5496 | 1.3 | 28.0 | 28.0 |
| R201 | 100 | 75.0 | 1.00 | 2273.4 | 0.28 | 3157 | 0.10 | 2274 | 0.10 | 2274 | 0.1 | 10.3 | 10.3 |
| R201 | 100 | 100.0 | 1.00 | 1916.9 | 0.00 | 6712 | 0.00 | 6189 | 0.00 | 5901 | 0.3 | 16.1 | 16.1 |
| R202 | 100 | 75.0 | 1.00 | 2100.3 | 0.34 | 20461 | 0.12 | 12540 | 0.12 | 12303 | 0.5 | 41.5 | 41.5 |
| R202 | 100 | 100.0 | 1.00 | 1756.3 | 0.08 | 67347 | 0.00 | 53038 | 0.00 | 52908 | 3.0 | 152.2 | 152.2 |
| R203 | 100 | 75.0 | 1.00 | 1869.9 | 0.40 | 45335 | 0.30 | 38890 | 0.28 | 37803 | 2.9 | 114.3 | 114.3 |
| R203 | 100 | 100.0 | 1.00 | 1548.9 | 0.52 | 154450 | 0.36 | 97060 | 0.36 | 97060 | 19.1 | 475.4 | 475.4 |
| R204 | 100 | 75.0 | 1.00 | 1712.0 | 0.00 | 51015 | 0.00 | 47407 | 0.00 | 46133 | 12.7 | 37.5 | 37.5 |
| R204 | 100 | 100.0 | 1.00 | 1361.0 | 0.58 | 234195 | 0.44 | 157994 | 0.44 | 154296 | 81.5 | 929.9 | 929.9 |
| R205 | 100 | 75.0 | 1.00 | 1961.7 | 0.10 | 9004 | 0.03 | 8134 | 0.03 | 8037 | 0.9 | 47.2 | 47.2 |
| R205 | 100 | 100.0 | 1.00 | 1604.5 | 0.39 | 20086 | 0.22 | 14304 | 0.22 | 14207 | 3.3 | 173.9 | 173.9 |
| R206 | 100 | 75.0 | 1.00 | 1854.1 | 0.47 | 27476 | 0.25 | 19756 | 0.25 | 19338 | 6.1 | 76.2 | 76.2 |
| R206 | 100 | 100.0 | 1.00 | 1518.9 | 0.27 | 120816 | 0.20 | 101143 | 0.20 | 100963 | 14.4 | 384.0 | 384.0 |
| R207 | 100 | 75.0 | 1.00 | 1771.5 | 0.56 | 43219 | 0.40 | 33542 | 0.40 | 33025 | 5.5 | 114.0 | 114.0 |
| R207 | 100 | 100.0 | 1.00 | 1411.7 | 0.71 | 135491 | 0.38 | 40078 | 0.38 | 39342 | 13.7 | 514.1 | 514.1 |
| R208 | 100 | 75.0 | 1.00 | 1687.7 | 0.37 | 49514 | 0.27 | 38382 | 0.27 | 37753 | 178.0 | 260.9 | 260.9 |
| R208 | 100 | 100.0 | 1.00 | 1322.7 | 0.48 | 290336 | 0.22 | 111228 | 0.22 | 111017 | 53.2 | 892.7 | 892.7 |
| R209 | 100 | 75.0 | 1.00 | 1833.2 | 0.51 | 22096 | 0.42 | 18959 | 0.41 | 18387 | 2.2 | 110.5 | 110.5 |
| R209 | 100 | 100.0 | 1.00 | 1462.5 | 0.33 | 60338 | 0.02 | 20640 | 0.02 | 19914 | 3.2 | 355.8 | 355.8 |
| R210 | 100 | 75.0 | 1.00 | 1841.6 | 0.12 | 27705 | 0.06 | 24384 | 0.06 | 24340 | 1.4 | 83.5 | 83.5 |
| R210 | 100 | 100.0 | 1.00 | 1532.4 | 0.59 | 101824 | 0.40 | 54526 | 0.40 | 54091 | 10.2 | 358.0 | 358.0 |
| R211 | 100 | 75.0 | 1.00 | 1678.9 | 0.43 | 71037 | 0.29 | 55799 | 0.27 | 51413 | 297.8 | 405.1 | 405.1 |
| R211 | 100 | 100.0 | - | - | - | - | - | - | - | - | - | - | - |
| RC201 | 100 | 75.0 | 1.00 | 3120.3 | 0.11 | 1437 | 0.04 | 1353 | 0.04 | 1277 | 0.2 | 9.7 | 9.7 |
| RC201 | 100 | 100.0 | 1.00 | 2370.2 | 0.02 | 2781 | 0.00 | 2452 | 0.00 | 2323 | 0.3 | 8.4 | 8.4 |
| RC202 | 100 | 75.0 | 1.00 | 2819.5 | 0.63 | 3263 | 0.56 | 2980 | 0.56 | 2919 | 0.8 | 22.0 | 22.0 |
| RC202 | 100 | 100.0 | 1.00 | 2148.6 | 0.48 | 7526 | 0.36 | 6187 | 0.36 | 6146 | 0.6 | 56.2 | 56.2 |
| RC203 | 100 | 75.0 | 1.00 | 2550.5 | 0.21 | 6194 | 0.06 | 4715 | 0.06 | 4628 | 0.9 | 39.9 | 39.9 |
| RC203 | 100 | 100.0 | 1.00 | 1896.4 | 0.21 | 19718 | 0.08 | 13693 | 0.08 | 13454 | 0.9 | 107.9 | 107.9 |
| RC204 | 100 | 75.0 | 1.00 | 2430.3 | 0.49 | 12013 | 0.31 | 8729 | 0.31 | 8572 | 3.1 | 74.5 | 74.5 |
| RC204 | 100 | 100.0 | 1.00 | 1725.8 | 0.55 | 37662 | 0.35 | 20507 | 0.35 | 20082 | 5.2 | 236.8 | 236.8 |
| RC205 | 100 | 75.0 | 1.00 | 2874.8 | 0.13 | 3338 | 0.04 | 2980 | 0.04 | 2915 | 0.8 | 21.8 | 21.8 |
| RC205 | 100 | 100.0 | 1.00 | 2206.2 | 0.13 | 8884 | 0.08 | 7668 | 0.08 | 7382 | 0.4 | 40.7 | 40.7 |
| RC206 | 100 | 75.0 | 1.00 | 2724.7 | 0.08 | 3513 | 0.00 | 3076 | 0.00 | 2879 | 0.3 | 19.7 | 19.7 |
| RC206 | 100 | 100.0 | 1.00 | 2064.1 | 0.35 | 11184 | 0.12 | 7406 | 0.12 | 7013 | 0.5 | 73.4 | 73.4 |
| RC207 | 100 | 75.0 | 1.00 | 2612.7 | 0.69 | 8083 | 0.47 | 5450 | 0.47 | 5139 | 3.0 | 57.6 | 57.6 |
| RC207 | 100 | 100.0 | 1.00 | 1876.2 | 0.73 | 15009 | 0.20 | 3265 | 0.20 | 3060 | 0.4 | 124.6 | 124.6 |
| RC208 | 100 | 75.0 | 1.00 | 2381.3 | 0.23 | 14429 | 0.09 | 11515 | 0.04 | 10759 | 454.2 | 520.0 | 520.1 |
| RC208 | 100 | 100.0 | 1.00 | 1667.7 | 0.89 | 41494 | 0.64 | 19130 | 0.53 | 15453 | 46.0 | 466.8 | 466.8 |

Table EC.4: Detailed computational results for CMTVRPTW-R

| Name | $ \mathcal{V} $ | κ | $UB_g\%$ | OBJ | $\bar{LB}_1\%$ | $ \hat{\mathcal{R}}_1 $ | $LB_1\%$ | $ \mathcal{R}_1 $ | $LB_2\%$ | $ \mathcal{R}_2 $ | T_{int} | T_{valid} | T_{tot} |
|------|-----------------|----------|----------|--------|----------------|-------------------------|----------|-------------------|----------|-------------------|-----------|-------------|-----------|
| C201 | 70 | 0.25 | 1.60 | 1068.7 | 1.47 | 53067 | 0.00 | 375 | 0.00 | 242 | 0.0 | 42.3 | 77.5 |
| C201 | 70 | 0.50 | 1.30 | 1072.0 | 1.24 | 22309 | 0.00 | 93 | 0.00 | 81 | 0.0 | 28.1 | 33.8 |
| C201 | 70 | 0.75 | 1.00 | 1080.9 | 0.43 | 9532 | 0.00 | 2043 | 0.00 | 1979 | 0.1 | 19.7 | 19.7 |
| C202 | 70 | 0.25 | 1.00 | 1121.0 | 0.39 | 18057 | 0.00 | 5832 | 0.00 | 5790 | 0.6 | 38.6 | 38.6 |
| C202 | 70 | 0.50 | 1.00 | 1121.0 | 0.29 | 10573 | 0.00 | 5222 | 0.00 | 5070 | 0.4 | 15.4 | 15.4 |
| C202 | 70 | 0.75 | 1.00 | 1121.0 | 0.33 | 7611 | 0.00 | 3484 | 0.00 | 3293 | 0.2 | 22.0 | 22.0 |
| C203 | 70 | 0.25 | 1.00 | 1156.3 | 0.24 | 55389 | 0.00 | 29273 | 0.00 | 24775 | 2.3 | 93.3 | 93.3 |
| C203 | 70 | 0.50 | 1.00 | 1156.3 | 0.19 | 61831 | 0.00 | 30463 | 0.00 | 27900 | 2.4 | 90.7 | 90.7 |
| C203 | 70 | 0.75 | 1.00 | 1156.3 | 0.13 | 65993 | 0.00 | 33470 | 0.00 | 28751 | 2.0 | 44.4 | 44.4 |

| Name | $ \mathcal{V} $ | κ | $UB_g\%$ | OBJ | $\bar{LB}_1\%$ | $ \bar{\mathcal{R}}_1 $ | $LB_1\%$ | $ \mathcal{R}_1 $ | $LB_2\%$ | $ \mathcal{R}_2 $ | T_{int} | T_{valid} | T_{tot} |
|-------|-----------------|----------|----------|--------|----------------|-------------------------|----------|-------------------|----------|-------------------|-----------|-------------|-----------|
| C204 | 70 | 0.25 | 1.00 | 1145.6 | 0.25 | 177052 | 0.00 | 52075 | 0.00 | 33736 | 5.5 | 71.5 | 71.5 |
| C204 | 70 | 0.50 | 1.00 | 1145.6 | 0.25 | 210293 | 0.00 | 44382 | 0.00 | 40597 | 3.1 | 69.2 | 69.2 |
| C204 | 70 | 0.75 | 1.00 | 1145.6 | 0.14 | 232237 | 0.00 | 89769 | 0.00 | 33707 | 2.7 | 72.2 | 72.2 |
| C205 | 70 | 0.25 | 1.60 | 1063.2 | 1.40 | 63549 | 0.00 | 766 | 0.00 | 632 | 0.1 | 51.0 | 80.4 |
| C205 | 70 | 0.50 | 1.00 | 1066.6 | 0.76 | 15629 | 0.00 | 650 | 0.00 | 558 | 0.0 | 39.9 | 39.9 |
| C205 | 70 | 0.75 | 1.00 | 1075.9 | 0.86 | 17521 | 0.00 | 342 | 0.00 | 228 | 0.0 | 34.7 | 34.7 |
| C206 | 70 | 0.25 | 1.60 | 1053.4 | 1.39 | 75712 | 0.00 | 722 | 0.00 | 642 | 0.1 | 39.5 | 58.5 |
| C206 | 70 | 0.50 | 1.60 | 1062.3 | 1.40 | 60121 | 0.00 | 695 | 0.00 | 652 | 0.1 | 50.9 | 80.7 |
| C206 | 70 | 0.75 | 1.30 | 1072.5 | 1.16 | 31826 | 0.00 | 386 | 0.00 | 358 | 0.0 | 59.0 | 76.3 |
| C207 | 70 | 0.25 | 1.00 | 1047.2 | 0.88 | 26349 | 0.00 | 259 | 0.00 | 239 | 0.0 | 35.5 | 35.5 |
| C207 | 70 | 0.50 | 1.00 | 1051.9 | 0.79 | 23267 | 0.00 | 624 | 0.00 | 522 | 0.0 | 47.1 | 47.1 |
| C207 | 70 | 0.75 | 1.00 | 1060.6 | 0.27 | 23277 | 0.00 | 8604 | 0.00 | 8364 | 0.5 | 52.9 | 52.9 |
| C208 | 70 | 0.25 | 1.60 | 1050.6 | 1.32 | 80815 | 0.00 | 825 | 0.00 | 742 | 0.1 | 31.5 | 49.4 |
| C208 | 70 | 0.50 | 1.30 | 1055.9 | 1.24 | 28461 | 0.00 | 195 | 0.00 | 156 | 0.0 | 35.7 | 42.7 |
| C208 | 70 | 0.75 | 1.00 | 1058.5 | 0.54 | 21883 | 0.00 | 2795 | 0.00 | 2425 | 0.2 | 67.4 | 67.4 |
| R201 | 70 | 0.25 | 1.00 | 1159.1 | 0.67 | 6617 | 0.46 | 2975 | 0.46 | 2926 | 1.0 | 82.4 | 82.4 |
| R201 | 70 | 0.50 | 1.00 | 1173.9 | 0.63 | 5459 | 0.24 | 2064 | 0.24 | 1835 | 0.3 | 80.7 | 80.7 |
| R201 | 70 | 0.75 | 1.00 | 1214.4 | 0.58 | 6143 | 0.36 | 3883 | 0.36 | 3700 | 1.4 | 129.5 | 129.5 |
| R202 | 70 | 0.25 | 1.00 | 1115.4 | 0.00 | 20050 | 0.00 | 6127 | 0.00 | 5389 | 0.3 | 93.5 | 93.5 |
| R202 | 70 | 0.50 | 1.00 | 1125.5 | 0.00 | 14748 | 0.00 | 6355 | 0.00 | 5217 | 0.2 | 75.0 | 75.0 |
| R202 | 70 | 0.75 | 1.00 | 1125.5 | 0.00 | 4432 | 0.00 | 2917 | 0.00 | 2859 | 0.1 | 5.5 | 5.5 |
| R203 | 70 | 0.25 | 1.00 | 1113.0 | 0.13 | 19794 | 0.00 | 9919 | 0.00 | 9551 | 0.6 | 125.8 | 125.8 |
| R203 | 70 | 0.50 | 1.00 | 1123.8 | 0.00 | 24943 | 0.00 | 15560 | 0.00 | 14412 | 1.2 | 102.8 | 102.8 |
| R203 | 70 | 0.75 | 1.00 | 1148.1 | 0.54 | 32375 | 0.36 | 16430 | 0.36 | 15734 | 3.0 | 247.8 | 247.8 |
| R204 | 70 | 0.25 | 1.00 | 1057.7 | 0.60 | 46923 | 0.02 | 4311 | 0.02 | 4227 | 0.8 | 382.2 | 382.2 |
| R204 | 70 | 0.50 | 1.00 | 1057.7 | 0.59 | 48684 | 0.02 | 4547 | 0.02 | 4296 | 0.9 | 607.8 | 607.8 |
| R204 | 70 | 0.75 | 1.00 | 1079.8 | 0.73 | 52370 | 0.22 | 8883 | 0.22 | 7890 | 1.3 | 383.7 | 383.7 |
| R205 | 70 | 0.25 | 1.00 | 1073.5 | 0.63 | 13449 | 0.47 | 7658 | 0.47 | 6977 | 1.9 | 104.5 | 104.5 |
| R205 | 70 | 0.50 | 1.00 | 1083.0 | 0.33 | 10492 | 0.13 | 4856 | 0.13 | 4639 | 0.6 | 104.6 | 104.6 |
| R205 | 70 | 0.75 | 1.00 | 1084.6 | 0.00 | 11989 | 0.00 | 7139 | 0.00 | 6980 | 0.5 | 131.2 | 131.2 |
| R206 | 70 | 0.25 | 1.00 | 1039.6 | 0.00 | 20659 | 0.00 | 11306 | 0.00 | 10517 | 0.7 | 373.1 | 373.1 |
| R206 | 70 | 0.50 | 1.00 | 1059.3 | 0.50 | 21880 | 0.16 | 6237 | 0.16 | 6077 | 1.6 | 427.2 | 427.2 |
| R206 | 70 | 0.75 | 1.00 | 1070.6 | 0.45 | 26045 | 0.24 | 9970 | 0.24 | 9006 | 1.8 | 335.0 | 335.0 |
| R207 | 70 | 0.25 | 1.00 | 1049.3 | 0.65 | 38833 | 0.16 | 3654 | 0.16 | 3619 | 0.6 | 217.0 | 217.0 |
| R207 | 70 | 0.50 | 1.00 | 1056.5 | 0.35 | 30804 | 0.00 | 10878 | 0.00 | 10498 | 1.1 | 220.0 | 220.0 |
| R207 | 70 | 0.75 | 1.00 | 1056.5 | 0.33 | 32411 | 0.00 | 8396 | 0.00 | 6529 | 0.5 | 286.5 | 286.5 |
| R208 | 70 | 0.25 | 1.00 | 997.4 | 0.00 | 80757 | 0.00 | 32197 | 0.00 | 27179 | 2.1 | 386.9 | 386.9 |
| R208 | 70 | 0.50 | 1.00 | 997.4 | 0.00 | 74367 | 0.00 | 38141 | 0.00 | 32972 | 2.1 | 275.8 | 275.8 |
| R208 | 70 | 0.75 | 1.00 | 997.4 | 0.00 | 76883 | 0.00 | 36851 | 0.00 | 29443 | 2.4 | 251.2 | 251.2 |
| R209 | 70 | 0.25 | 1.00 | 995.4 | 0.90 | 24796 | 0.46 | 5590 | 0.46 | 5106 | 5.1 | 303.6 | 303.6 |
| R209 | 70 | 0.50 | 1.00 | 997.4 | 0.77 | 21272 | 0.35 | 5183 | 0.35 | 4793 | 2.3 | 341.7 | 341.7 |
| R209 | 70 | 0.75 | 1.00 | 1033.8 | 0.66 | 12677 | 0.39 | 4778 | 0.39 | 4513 | 2.8 | 401.2 | 401.2 |
| R210 | 70 | 0.25 | 1.00 | 1026.5 | 0.42 | 17909 | 0.22 | 6683 | 0.21 | 6570 | 1.6 | 261.3 | 261.3 |
| R210 | 70 | 0.50 | 1.00 | 1032.7 | 0.08 | 12597 | 0.00 | 6958 | 0.00 | 6692 | 0.6 | 128.9 | 128.9 |
| R210 | 70 | 0.75 | 1.00 | 1094.5 | 0.33 | 16205 | 0.00 | 6128 | 0.00 | 5852 | 1.3 | 237.6 | 237.6 |
| R211 | 70 | 0.25 | 1.00 | 930.4 | 0.86 | 29210 | 0.39 | 5012 | 0.38 | 4697 | 7.3 | 747.7 | 747.7 |
| R211 | 70 | 0.50 | 1.00 | 930.4 | 0.83 | 28574 | 0.37 | 5355 | 0.37 | 4818 | 8.1 | 617.6 | 617.6 |
| R211 | 70 | 0.75 | 1.30 | 958.8 | 1.15 | 68304 | 0.65 | 16164 | 0.65 | 15491 | 39.9 | 673.3 | 1166.2 |
| RC201 | 70 | 0.25 | 1.00 | 1367.5 | 0.12 | 2710 | 0.00 | 1902 | 0.00 | 1696 | 0.1 | 31.8 | 31.8 |
| RC201 | 70 | 0.50 | 1.30 | 1397.6 | 1.06 | 5139 | 0.38 | 1767 | 0.38 | 1497 | 0.6 | 73.8 | 142.8 |
| RC201 | 70 | 0.75 | 1.00 | 1434.6 | 0.83 | 3289 | 0.26 | 932 | 0.26 | 841 | 0.3 | 113.8 | 113.8 |
| RC202 | 70 | 0.25 | 1.60 | 1409.8 | 1.53 | 11714 | 0.76 | 3454 | 0.76 | 3214 | 1.1 | 99.1 | 257.5 |
| RC202 | 70 | 0.50 | 2.20 | 1413.9 | 1.99 | 23541 | 0.51 | 3326 | 0.51 | 3143 | 1.4 | 90.4 | 279.8 |
| RC202 | 70 | 0.75 | 1.00 | 1438.3 | 0.23 | 2607 | 0.11 | 1647 | 0.11 | 1475 | 0.2 | 65.2 | 65.2 |
| RC203 | 70 | 0.25 | 1.00 | 1397.9 | 0.19 | 11662 | 0.00 | 5415 | 0.00 | 4999 | 0.3 | 94.1 | 94.1 |
| RC203 | 70 | 0.50 | 1.00 | 1407.7 | 0.86 | 9927 | 0.00 | 305 | 0.00 | 113 | 0.0 | 147.0 | 147.0 |
| RC203 | 70 | 0.75 | 1.00 | 1483.9 | 0.00 | 8834 | 0.00 | 5343 | 0.00 | 4174 | 0.2 | 30.5 | 30.5 |
| RC204 | 70 | 0.25 | 1.00 | 1354.0 | 0.97 | 24805 | 0.00 | 353 | 0.00 | 203 | 0.0 | 115.1 | 115.1 |
| RC204 | 70 | 0.50 | 1.30 | 1354.0 | 1.03 | 43963 | 0.00 | 2227 | 0.00 | 1692 | 0.2 | 110.5 | 142.0 |
| RC204 | 70 | 0.75 | 1.00 | 1409.5 | 0.75 | 23133 | 0.00 | 1524 | 0.00 | 1236 | 0.2 | 127.6 | 127.6 |

| Name | $ \mathcal{V} $ | κ | $UB_g\%$ | OBJ | $\bar{LB}_1\%$ | $ \bar{\mathcal{R}}_1 $ | $LB_1\%$ | $ \mathcal{R}_1 $ | $LB_2\%$ | $ \mathcal{R}_2 $ | T_{int} | T_{valid} | T_{tot} |
|-------|-----------------|----------|----------|--------|----------------|-------------------------|----------|-------------------|----------|-------------------|-----------|-------------|-----------|
| RC205 | 70 | 0.25 | 1.00 | 1361.5 | 0.45 | 5505 | 0.00 | 1887 | 0.00 | 1711 | 0.1 | 73.0 | 73.0 |
| RC205 | 70 | 0.50 | 1.00 | 1433.0 | 0.55 | 5929 | 0.39 | 4497 | 0.39 | 4264 | 1.7 | 157.7 | 157.7 |
| RC205 | 70 | 0.75 | 1.00 | 1474.6 | 0.42 | 3120 | 0.22 | 2088 | 0.22 | 1999 | 0.3 | 39.7 | 39.7 |
| RC206 | 70 | 0.25 | 1.00 | 1309.1 | 0.49 | 6438 | 0.00 | 1868 | 0.00 | 1349 | 0.1 | 48.7 | 48.7 |
| RC206 | 70 | 0.50 | 1.00 | 1309.9 | 0.50 | 4730 | 0.00 | 1419 | 0.00 | 977 | 0.1 | 32.7 | 32.7 |
| RC206 | 70 | 0.75 | 1.00 | 1347.7 | 0.09 | 4935 | 0.00 | 2955 | 0.00 | 2634 | 0.1 | 51.5 | 51.5 |
| RC207 | 70 | 0.25 | 1.90 | 1281.8 | 1.59 | 53564 | 0.31 | 5358 | 0.31 | 5027 | 2.7 | 345.4 | 735.4 |
| RC207 | 70 | 0.50 | 1.60 | 1281.8 | 1.48 | 33860 | 0.30 | 2086 | 0.29 | 1835 | 1.1 | 251.2 | 422.0 |
| RC207 | 70 | 0.75 | 1.00 | 1382.5 | 0.64 | 10640 | 0.33 | 4835 | 0.33 | 4035 | 1.4 | 171.9 | 171.9 |
| RC208 | 70 | 0.25 | 1.60 | 1216.4 | 1.55 | 76432 | 0.44 | 5158 | 0.30 | 3198 | 2.3 | 434.8 | 696.5 |
| RC208 | 70 | 0.50 | 1.60 | 1216.4 | 1.44 | 79264 | 0.34 | 5054 | 0.19 | 3119 | 4.0 | 435.1 | 726.3 |
| RC208 | 70 | 0.75 | 1.30 | 1235.3 | 1.17 | 32821 | 0.35 | 4081 | 0.34 | 3830 | 5.0 | 469.4 | 745.4 |
| C201 | 100 | 0.25 | 1.90 | 1500.6 | 1.78 | 256736 | 0.00 | 364 | 0.00 | 349 | 0.1 | 110.6 | 150.2 |
| C201 | 100 | 0.50 | 1.90 | 1500.6 | 1.84 | 180460 | 0.00 | 214 | 0.00 | 147 | 0.0 | 99.5 | 129.0 |
| C201 | 100 | 0.75 | 1.30 | 1504.0 | 1.21 | 60718 | 0.00 | 373 | 0.00 | 215 | 0.0 | 66.5 | 73.8 |
| C202 | 100 | 0.25 | 1.30 | 1545.4 | 1.18 | 136735 | 0.00 | 870 | 0.00 | 740 | 0.1 | 147.4 | 176.2 |
| C202 | 100 | 0.50 | 1.00 | 1547.3 | 0.90 | 60331 | 0.00 | 557 | 0.00 | 537 | 0.1 | 117.2 | 117.2 |
| C202 | 100 | 0.75 | 1.30 | 1552.9 | 1.12 | 134134 | 0.00 | 1733 | 0.00 | 1466 | 0.2 | 160.9 | 209.2 |
| C203 | 100 | 0.25 | 1.00 | 1577.7 | 0.93 | 175473 | 0.11 | 3518 | 0.11 | 3421 | 2.5 | 422.4 | 422.4 |
| C203 | 100 | 0.50 | 1.30 | 1578.7 | 1.11 | 439431 | 0.00 | 4141 | 0.00 | 3889 | 0.7 | 349.4 | 401.2 |
| C203 | 100 | 0.75 | 1.30 | 1579.6 | 1.02 | 574744 | 0.00 | 8033 | 0.00 | 4778 | 0.5 | 209.3 | 258.5 |
| C204 | 100 | 0.25 | 1.00 | 1560.5 | 0.57 | 326790 | 0.00 | 30360 | 0.00 | 25009 | 3.7 | 195.8 | 195.8 |
| C204 | 100 | 0.50 | 1.00 | 1560.9 | 0.60 | 329153 | 0.00 | 19488 | 0.00 | 16322 | 1.1 | 359.0 | 359.0 |
| C204 | 100 | 0.75 | 1.00 | 1569.1 | 0.57 | 814916 | 0.00 | 52238 | 0.00 | 39963 | 13.1 | 441.3 | 441.3 |
| C205 | 100 | 0.25 | 1.90 | 1488.2 | 1.75 | 325203 | 0.00 | 722 | 0.00 | 573 | 0.1 | 96.6 | 139.8 |
| C205 | 100 | 0.50 | 1.90 | 1490.0 | 1.80 | 235143 | 0.00 | 286 | 0.00 | 229 | 0.0 | 116.7 | 153.4 |
| C205 | 100 | 0.75 | 1.90 | 1491.7 | 1.61 | 212144 | 0.00 | 2801 | 0.00 | 1612 | 0.1 | 103.8 | 137.2 |
| C206 | 100 | 0.25 | 1.90 | 1476.0 | 1.64 | 413726 | 0.00 | 2002 | 0.00 | 1397 | 0.1 | 135.9 | 187.1 |
| C206 | 100 | 0.50 | 2.20 | 1481.7 | 1.90 | 463502 | 0.00 | 2759 | 0.00 | 2584 | 0.2 | 153.6 | 236.3 |
| C206 | 100 | 0.75 | 1.30 | 1490.5 | 1.18 | 104432 | 0.00 | 586 | 0.00 | 540 | 0.1 | 113.1 | 131.0 |
| C207 | 100 | 0.25 | 1.60 | 1472.8 | 1.35 | 251367 | 0.00 | 2819 | 0.00 | 1909 | 0.1 | 125.9 | 157.2 |
| C207 | 100 | 0.50 | 1.60 | 1474.4 | 1.32 | 202128 | 0.00 | 3021 | 0.00 | 1856 | 0.1 | 123.1 | 156.0 |
| C207 | 100 | 0.75 | 1.60 | 1480.4 | 1.42 | 201820 | 0.00 | 865 | 0.00 | 800 | 0.1 | 149.7 | 189.7 |
| C208 | 100 | 0.25 | 1.90 | 1471.2 | 1.58 | 497697 | 0.00 | 5305 | 0.00 | 3660 | 0.3 | 120.0 | 178.5 |
| C208 | 100 | 0.50 | 1.90 | 1477.4 | 1.77 | 322387 | 0.00 | 453 | 0.00 | 396 | 0.1 | 147.8 | 203.5 |
| C208 | 100 | 0.75 | 1.60 | 1481.2 | 1.56 | 178858 | 0.00 | 197 | 0.00 | 150 | 0.1 | 126.8 | 159.2 |
| R201 | 100 | 0.25 | 1.00 | 1435.6 | 0.65 | 60740 | 0.39 | 24258 | 0.39 | 23358 | 12.7 | 599.2 | 599.2 |
| R201 | 100 | 0.50 | 1.00 | 1442.6 | 0.63 | 54911 | 0.46 | 26760 | 0.46 | 25754 | 13.1 | 681.1 | 681.1 |
| R201 | 100 | 0.75 | 1.00 | 1483.6 | 0.63 | 44812 | 0.31 | 16576 | 0.31 | 15545 | 5.9 | 450.9 | 450.9 |
| R202 | 100 | 0.25 | 1.00 | 1401.4 | 0.55 | 154654 | 0.19 | 42376 | 0.19 | 42207 | 26.0 | 917.8 | 917.8 |
| R202 | 100 | 0.50 | 1.00 | 1413.8 | 0.68 | 187036 | 0.44 | 91273 | 0.43 | 84989 | 68.3 | 984.2 | 984.2 |
| R202 | 100 | 0.75 | 1.00 | 1429.0 | 0.38 | 189322 | 0.24 | 121422 | 0.23 | 117666 | 78.1 | 900.3 | 900.3 |
| R203 | 100 | 0.25 | 1.00 | 1370.9 | 0.14 | 309371 | 0.00 | 203004 | 0.00 | 187375 | 37.3 | 604.2 | 604.2 |
| R203 | 100 | 0.50 | 1.00 | 1372.8 | 0.14 | 336727 | 0.00 | 216720 | 0.00 | 200537 | 29.5 | 448.0 | 448.0 |
| R203 | 100 | 0.75 | 1.00 | 1394.7 | 0.26 | 311601 | 0.05 | 145870 | 0.05 | 143514 | 39.7 | 783.9 | 783.9 |
| R204 | 100 | 0.25 | 1.00 | 1324.6 | 0.78 | 957157 | 0.39 | 154173 | 0.39 | 147391 | 71.8 | 1866.7 | 1866.7 |
| R204 | 100 | 0.50 | 1.00 | 1324.6 | 0.78 | 782559 | 0.38 | 142067 | 0.37 | 128730 | 59.8 | 2208.6 | 2208.6 |
| R204 | 100 | 0.75 | 1.00 | 1334.6 | 0.42 | 719106 | 0.09 | 190923 | 0.08 | 175417 | 110.3 | 1900.1 | 1900.1 |
| R205 | 100 | 0.25 | 1.00 | 1314.4 | 0.61 | 110177 | 0.43 | 56516 | 0.42 | 53461 | 28.9 | 849.1 | 849.1 |
| R205 | 100 | 0.50 | 1.00 | 1332.3 | 0.67 | 96390 | 0.39 | 36160 | 0.39 | 33477 | 21.7 | 827.7 | 827.7 |
| R205 | 100 | 0.75 | 1.00 | 1361.8 | 0.56 | 123052 | 0.36 | 54343 | 0.36 | 53234 | 27.0 | 784.8 | 784.8 |
| R206 | 100 | 0.25 | 1.00 | 1274.8 | 0.01 | 297683 | 0.00 | 233756 | 0.00 | 230187 | 51.0 | 986.8 | 986.8 |
| R206 | 100 | 0.50 | 1.00 | 1298.1 | 0.35 | 375427 | 0.18 | 169334 | 0.18 | 168466 | 134.5 | 1491.7 | 1491.7 |
| R206 | 100 | 0.75 | 1.00 | 1323.5 | 0.50 | 403135 | 0.17 | 101079 | 0.17 | 96871 | 52.1 | 1342.0 | 1342.0 |
| R207 | 100 | 0.25 | 1.00 | 1286.7 | 0.67 | 522577 | 0.43 | 185273 | 0.42 | 175409 | 86.5 | 1702.8 | 1702.8 |
| R207 | 100 | 0.50 | 1.00 | 1297.3 | 0.51 | 429299 | 0.15 | 107307 | 0.15 | 105852 | 34.4 | 1784.9 | 1784.9 |
| R207 | 100 | 0.75 | 1.00 | 1304.7 | 0.29 | 591248 | 0.04 | 222598 | 0.03 | 213764 | 156.7 | 1721.3 | 1721.3 |
| R208 | 100 | 0.25 | 1.00 | 1253.1 | 0.44 | 947409 | 0.23 | 409144 | 0.21 | 354361 | 365.9 | 2860.7 | 2860.7 |
| R208 | 100 | 0.50 | 1.00 | 1253.1 | 0.47 | 912942 | 0.22 | 318392 | 0.22 | 314955 | 326.0 | 2312.6 | 2312.6 |
| R208 | 100 | 0.75 | 1.00 | 1253.1 | 0.35 | 993215 | 0.15 | 472540 | 0.13 | 423452 | 299.8 | 2517.3 | 2517.3 |

| Name | $ \mathcal{V} $ | κ | $UB_g\%$ | OBJ | $\hat{LB}_1\%$ | $ \hat{\mathcal{R}}_1 $ | $LB_1\%$ | $ \mathcal{R}_1 $ | $LB_2\%$ | $ \mathcal{R}_2 $ | T_{int} | T_{valid} | T_{tot} |
|-------|-----------------|----------|----------|--------|----------------|-------------------------|----------|-------------------|----------|-------------------|-----------|-------------|-----------|
| R209 | 100 | 0.25 | 1.00 | 1255.8 | 0.93 | 293896 | 0.64 | 104189 | 0.63 | 99504 | 481.4 | 1914.4 | 1914.4 |
| R209 | 100 | 0.50 | 1.30 | 1258.8 | 1.05 | 928832 | 0.83 | 494667 | 0.81 | 454729 | 1970.4 | 3440.5 | 5376.8 |
| R209 | 100 | 0.75 | 1.00 | 1288.6 | 0.13 | 210263 | 0.00 | 129041 | 0.00 | 117975 | 29.9 | 776.6 | 776.6 |
| R210 | 100 | 0.25 | 1.30 | 1277.3 | 1.02 | 1082407 | 0.67 | 406145 | 0.67 | 401742 | 1105.1 | 2566.8 | 3968.1 |
| R210 | 100 | 0.50 | 1.00 | 1283.7 | 0.58 | 314162 | 0.31 | 139275 | 0.31 | 135511 | 107.3 | 1592.0 | 1592.0 |
| R210 | 100 | 0.75 | 1.00 | 1341.5 | 0.44 | 259971 | 0.28 | 155487 | 0.25 | 138572 | 108.6 | 1349.1 | 1349.1 |
| R211 | 100 | 0.25 | 1.00 | 1171.4 | 0.40 | 527288 | 0.08 | 144592 | 0.04 | 124031 | 398.3 | 2837.5 | 2837.5 |
| R211 | 100 | 0.50 | 1.00 | 1175.0 | 0.64 | 614643 | 0.24 | 92042 | 0.23 | 89562 | 236.2 | 2750.9 | 2750.9 |
| R211 | 100 | 0.75 | 1.00 | 1199.3 | 0.93 | 465722 | 0.40 | 42877 | 0.39 | 39448 | 95.7 | 2065.0 | 2065.0 |
| RC201 | 100 | 0.25 | 1.00 | 1839.1 | 0.81 | 30853 | 0.50 | 10600 | 0.50 | 10062 | 5.0 | 218.1 | 218.1 |
| RC201 | 100 | 0.50 | 1.00 | 1849.6 | 0.45 | 26189 | 0.04 | 6649 | 0.04 | 6373 | 1.0 | 212.9 | 212.9 |
| RC201 | 100 | 0.75 | 1.00 | 1871.2 | 0.32 | 23005 | 0.00 | 9978 | 0.00 | 7868 | 0.5 | 94.4 | 94.4 |
| RC202 | 100 | 0.25 | 1.00 | 1790.8 | 0.44 | 45715 | 0.31 | 28249 | 0.31 | 27149 | 11.3 | 247.3 | 247.3 |
| RC202 | 100 | 0.50 | 1.00 | 1813.4 | 0.43 | 47465 | 0.28 | 29769 | 0.28 | 27921 | 8.9 | 272.0 | 272.0 |
| RC202 | 100 | 0.75 | 1.00 | 1841.7 | 0.87 | 44674 | 0.57 | 13525 | 0.57 | 12738 | 6.6 | 255.3 | 255.3 |
| RC203 | 100 | 0.25 | 1.00 | 1808.2 | 0.31 | 312843 | 0.10 | 131207 | 0.10 | 122142 | 49.5 | 1479.1 | 1479.1 |
| RC203 | 100 | 0.50 | 1.00 | 1831.1 | 0.44 | 321045 | 0.26 | 141757 | 0.26 | 140195 | 59.1 | 1142.1 | 1142.1 |
| RC203 | 100 | 0.75 | 1.00 | 1880.7 | 0.56 | 421120 | 0.42 | 196375 | 0.42 | 192929 | 122.0 | 1313.1 | 1313.1 |
| RC204 | 100 | 0.25 | 1.00 | 1749.4 | 0.39 | 316764 | 0.05 | 106512 | 0.05 | 99790 | 26.7 | 683.9 | 683.9 |
| RC204 | 100 | 0.50 | 1.00 | 1749.4 | 0.36 | 326068 | 0.06 | 118456 | 0.06 | 112250 | 41.6 | 732.6 | 732.6 |
| RC204 | 100 | 0.75 | 1.00 | 1780.4 | 0.21 | 385679 | 0.05 | 206465 | 0.05 | 200333 | 53.1 | 841.1 | 841.1 |
| RC205 | 100 | 0.25 | 1.00 | 1760.4 | 0.56 | 65276 | 0.27 | 21591 | 0.25 | 18043 | 15.1 | 676.5 | 676.5 |
| RC205 | 100 | 0.50 | 1.00 | 1819.0 | 0.81 | 60924 | 0.51 | 23320 | 0.51 | 23037 | 20.0 | 575.0 | 575.0 |
| RC205 | 100 | 0.75 | 1.00 | 1877.8 | 0.59 | 54890 | 0.29 | 22171 | 0.28 | 19242 | 21.4 | 402.3 | 402.3 |
| RC206 | 100 | 0.25 | 1.00 | 1734.1 | 0.46 | 71972 | 0.06 | 19021 | 0.06 | 17994 | 6.9 | 371.3 | 371.3 |
| RC206 | 100 | 0.50 | 1.00 | 1746.9 | 0.57 | 61198 | 0.23 | 19773 | 0.23 | 19497 | 9.7 | 398.6 | 398.6 |
| RC206 | 100 | 0.75 | 1.00 | 1793.6 | 0.29 | 44781 | 0.13 | 29879 | 0.13 | 29293 | 5.0 | 191.5 | 191.5 |
| RC207 | 100 | 0.25 | 1.30 | 1694.4 | 1.13 | 327301 | 0.31 | 16756 | 0.30 | 14729 | 22.8 | 502.5 | 886.3 |
| RC207 | 100 | 0.50 | 1.30 | 1694.4 | 1.10 | 330583 | 0.28 | 15779 | 0.27 | 14561 | 16.1 | 699.4 | 1128.9 |
| RC207 | 100 | 0.75 | 1.00 | 1780.4 | 0.36 | 83813 | 0.07 | 31990 | 0.07 | 30998 | 17.5 | 370.2 | 370.2 |
| RC208 | 100 | 0.25 | 1.30 | 1595.5 | 1.08 | 816396 | 0.42 | 75267 | 0.12 | 14603 | 31.3 | 1472.6 | 2117.5 |
| RC208 | 100 | 0.50 | 1.60 | 1602.5 | 1.51 | 2043801 | 0.74 | 199659 | 0.51 | 78017 | 1105.5 | 2520.8 | 4082.4 |
| RC208 | 100 | 0.75 | 1.00 | 1620.1 | 0.98 | 213608 | 0.26 | 6053 | 0.19 | 3322 | 6.3 | 886.3 | 886.3 |

Table EC.5: Detailed computational results for DRP

| Name | $ \mathcal{V} $ | $UB_g\%$ | OBJ | $\hat{LB}_1\%$ | $ \hat{\mathcal{R}}_1 $ | $LB_1\%$ | $ \mathcal{R}_1 $ | $LB_2\%$ | $ \mathcal{R}_2 $ | T_{int} | T_{valid} | T_{tot} |
|-------|-----------------|----------|--------|----------------|-------------------------|----------|-------------------|----------|-------------------|-----------|-------------|-----------|
| C201 | 70 | 1.00 | 1862.8 | 0.48 | 10372 | 0.00 | 2959 | 0.00 | 2509 | 0.4 | 8.5 | 8.5 |
| C202 | 70 | 1.00 | 1856.9 | 0.28 | 12198 | 0.00 | 6112 | 0.00 | 5910 | 0.3 | 5.9 | 5.9 |
| C203 | 70 | 1.00 | 1852.1 | 0.34 | 17155 | 0.00 | 7527 | 0.00 | 7176 | 0.3 | 6.3 | 6.3 |
| C204 | 70 | 1.00 | 1851.6 | 0.34 | 24308 | 0.00 | 11135 | 0.00 | 6629 | 65.8 | 75.0 | 75.0 |
| C205 | 70 | 1.00 | 1853.0 | 0.30 | 12103 | 0.00 | 6234 | 0.00 | 4687 | 0.6 | 5.5 | 5.5 |
| C206 | 70 | 1.00 | 1851.9 | 0.29 | 13931 | 0.00 | 6040 | 0.00 | 5296 | 0.7 | 5.3 | 5.3 |
| C207 | 70 | 1.00 | 1851.9 | 0.36 | 13317 | 0.00 | 6270 | 0.00 | 5204 | 1.6 | 8.4 | 8.4 |
| C208 | 70 | 1.00 | 1851.9 | 0.36 | 12660 | 0.00 | 6398 | 0.00 | 4875 | 1.4 | 6.0 | 6.0 |
| R201 | 70 | 1.00 | 1531.5 | 0.59 | 4286 | 0.42 | 2798 | 0.42 | 2608 | 1.5 | 59.2 | 59.2 |
| R202 | 70 | 1.00 | 1462.2 | 0.13 | 7931 | 0.02 | 5149 | 0.02 | 5089 | 1.1 | 70.6 | 70.6 |
| R203 | 70 | 1.00 | 1412.9 | 0.39 | 14401 | 0.19 | 8705 | 0.16 | 7968 | 3.4 | 103.9 | 103.9 |
| R204 | 70 | 1.00 | 1393.1 | 0.49 | 21066 | 0.27 | 11744 | 0.27 | 11490 | 8.6 | 76.9 | 76.9 |
| R205 | 70 | 1.00 | 1458.7 | 0.39 | 7326 | 0.39 | 5852 | 0.39 | 5392 | 0.6 | 26.1 | 26.1 |
| R206 | 70 | 1.00 | 1429.2 | 0.38 | 12692 | 0.26 | 8462 | 0.09 | 6080 | 1.4 | 56.3 | 56.3 |
| R207 | 70 | 1.00 | 1403.0 | 0.64 | 18359 | 0.15 | 3719 | 0.14 | 3242 | 6.1 | 115.9 | 115.9 |
| R208 | 70 | 1.00 | 1390.4 | 0.64 | 23120 | 0.21 | 5949 | 0.21 | 5700 | 63.8 | 153.9 | 153.9 |
| R209 | 70 | 1.00 | 1417.8 | 0.95 | 9746 | 0.38 | 2045 | 0.36 | 1712 | 1.8 | 103.5 | 103.5 |
| R210 | 70 | 1.00 | 1433.9 | 0.45 | 14109 | 0.23 | 8001 | 0.21 | 7227 | 3.0 | 112.5 | 112.5 |
| R211 | 70 | 1.00 | 1390.2 | 0.64 | 18297 | 0.19 | 5123 | 0.19 | 4846 | 4.6 | 74.5 | 74.5 |
| RC201 | 70 | 1.30 | 2328.5 | 1.18 | 3658 | 0.67 | 2019 | 0.36 | 1029 | 0.8 | 69.5 | 133.2 |
| RC202 | 70 | 1.00 | 2253.2 | 0.93 | 3415 | 0.26 | 803 | 0.08 | 404 | 0.2 | 12.4 | 12.4 |

| Name | $ \mathcal{V} $ | $UB_g\%$ | OBJ | $\hat{LB}_1\%$ | $ \hat{\mathcal{R}}_1 $ | $LB_1\%$ | $ \mathcal{R}_1 $ | $LB_2\%$ | $ \mathcal{R}_2 $ | T_{int} | T_{valid} | T_{tot} |
|-------|-----------------|----------|--------|----------------|-------------------------|----------|-------------------|----------|-------------------|-----------|-------------|-----------|
| RC203 | 70 | 1.00 | 2227.5 | 0.67 | 5756 | 0.00 | 2004 | 0.00 | 1919 | 0.1 | 13.8 | 13.8 |
| RC204 | 70 | 1.00 | 2225.4 | 0.73 | 6142 | 0.00 | 1735 | 0.00 | 1348 | 8.0 | 41.1 | 41.1 |
| RC205 | 70 | 1.00 | 2270.7 | 0.76 | 3642 | 0.16 | 1315 | 0.02 | 714 | 0.3 | 44.8 | 44.8 |
| RC206 | 70 | 1.00 | 2259.0 | 0.54 | 3700 | 0.12 | 1773 | 0.03 | 1424 | 0.4 | 41.1 | 41.1 |
| RC207 | 70 | 1.00 | 2233.0 | 0.76 | 4630 | 0.01 | 1248 | 0.00 | 934 | 1.5 | 36.5 | 36.5 |
| RC208 | 70 | 1.00 | 2225.4 | 0.74 | 7808 | 0.00 | 2052 | 0.00 | 1484 | 3.5 | 20.8 | 20.8 |
| C201 | 100 | 1.00 | 2733.4 | 0.91 | 33523 | 0.00 | 524 | 0.00 | 473 | 0.1 | 43.9 | 43.9 |
| C202 | 100 | 1.00 | 2729.1 | 0.84 | 62500 | 0.00 | 1560 | 0.00 | 1280 | 0.1 | 22.8 | 22.8 |
| C203 | 100 | 1.00 | 2725.8 | 0.84 | 95547 | 0.00 | 2087 | 0.00 | 1972 | 0.2 | 45.8 | 45.8 |
| C204 | 100 | 1.00 | 2720.8 | 0.82 | 114333 | 0.00 | 2695 | 0.00 | 1942 | 26.6 | 61.4 | 61.4 |
| C205 | 100 | 1.00 | 2726.9 | 0.91 | 47572 | 0.00 | 478 | 0.00 | 424 | 0.1 | 25.3 | 25.3 |
| C206 | 100 | 1.00 | 2722.3 | 0.79 | 51895 | 0.00 | 2325 | 0.00 | 2121 | 0.2 | 23.7 | 23.7 |
| C207 | 100 | 1.00 | 2720.9 | 0.80 | 49924 | 0.00 | 2058 | 0.00 | 1998 | 0.2 | 16.7 | 16.7 |
| C208 | 100 | 1.00 | 2720.7 | 0.81 | 52824 | 0.00 | 2557 | 0.00 | 2419 | 0.2 | 22.9 | 22.9 |
| R201 | 100 | 1.00 | 1974.3 | 0.34 | 39814 | 0.22 | 27119 | 0.21 | 25562 | 7.0 | 153.5 | 153.5 |
| R202 | 100 | 1.00 | 1919.0 | 0.80 | 92080 | 0.59 | 42506 | 0.46 | 24748 | 27.3 | 231.7 | 231.7 |
| R203 | 100 | 1.00 | 1845.7 | 0.54 | 234648 | 0.37 | 123800 | 0.36 | 115292 | 515.5 | 801.8 | 801.8 |
| R204 | 100 | 1.00 | 1819.2 | 0.16 | 377567 | 0.02 | 255167 | 0.02 | 246755 | 43.1 | 354.2 | 354.2 |
| R205 | 100 | 1.00 | 1884.4 | 0.40 | 90585 | 0.24 | 53342 | 0.20 | 45416 | 78.0 | 275.3 | 275.3 |
| R206 | 100 | 1.00 | 1852.8 | 0.40 | 173142 | 0.17 | 81846 | 0.17 | 71998 | 198.6 | 413.6 | 413.6 |
| R207 | 100 | 1.00 | 1831.5 | 0.35 | 263208 | 0.15 | 122763 | 0.15 | 120924 | 325.5 | 511.5 | 511.5 |
| R208 | 100 | 1.00 | 1815.5 | 0.14 | 424055 | 0.00 | 272221 | 0.00 | 269705 | 29.2 | 136.1 | 136.1 |
| R209 | 100 | 1.00 | 1846.0 | 0.53 | 143066 | 0.27 | 57906 | 0.26 | 52291 | 59.5 | 296.1 | 296.1 |
| R210 | 100 | 1.00 | 1853.6 | 0.53 | 188061 | 0.34 | 99351 | 0.32 | 87776 | 429.3 | 650.9 | 650.9 |
| R211 | 100 | 1.00 | 1815.5 | 0.20 | 456949 | 0.00 | 224523 | 0.00 | 216033 | 775.2 | 944.8 | 944.8 |
| RC201 | 100 | 1.00 | 2960.3 | 0.62 | 24133 | 0.44 | 15320 | 0.18 | 5888 | 10.6 | 124.4 | 124.4 |
| RC202 | 100 | 1.00 | 2870.7 | 0.40 | 51077 | 0.08 | 29168 | 0.08 | 27518 | 26.6 | 140.9 | 140.9 |
| RC203 | 100 | 1.00 | 2853.0 | 0.38 | 94424 | 0.07 | 47590 | 0.07 | 47348 | 61.9 | 222.0 | 222.0 |
| RC204 | 100 | 1.00 | 2847.0 | 0.41 | 109283 | 0.03 | 42012 | 0.03 | 40919 | 546.5 | 644.8 | 644.8 |
| RC205 | 100 | 1.00 | 2898.2 | 0.52 | 39793 | 0.25 | 22801 | 0.21 | 20383 | 11.1 | 136.6 | 136.6 |
| RC206 | 100 | 1.00 | 2886.3 | 0.38 | 44160 | 0.16 | 27769 | 0.08 | 22345 | 9.1 | 112.5 | 112.5 |
| RC207 | 100 | 1.00 | 2854.6 | 0.38 | 60465 | 0.04 | 31813 | 0.03 | 29840 | 218.0 | 347.2 | 347.2 |
| RC208 | 100 | 1.00 | 2846.7 | 0.37 | 123931 | 0.03 | 59773 | 0.03 | 57667 | 433.1 | 542.2 | 542.2 |

EC.4.3. Detailed Computational Results on Large-Scale Instances of CMTVRPTW

Detailed computational results for the large-scale CMTVRPTW instances are shown in Table EC.6, using the same notations introduced in Table EC.1. Moreover, column “ K ” indicates the number of available vehicles for each instance. Note that we are able to solve all 30 instances with 120 customers to optimality within one hour on average. For the 60 instances with 140 customers, we could find optimal solutions for 49 instances within three hours.

Table EC.6: Detailed Computational Results on New Large-Scale CMTVRPTW Instances

| Name | $ \mathcal{V} $ | K | $UB_g\%$ | OBJ | $\hat{LB}_1\%$ | $ \hat{\mathcal{R}}_1 $ | $LB_1\%$ | $ \mathcal{R}_1 $ | $LB_2\%$ | $ \mathcal{R}_2 $ | T_{int} | T_{valid} | T_{tot} |
|--------|-----------------|-----|----------|--------|----------------|-------------------------|----------|-------------------|----------|-------------------|-----------|-------------|-----------|
| C2.2.1 | 120 | 10 | 1.00 | 3049.8 | 0.71 | 152535 | 0.10 | 13616 | 0.10 | 12435 | 6.2 | 515.4 | 515.4 |
| C2.2.2 | 120 | 10 | 1.00 | 2973.9 | 0.85 | 493616 | 0.32 | 44564 | 0.32 | 43399 | 78.7 | 706.4 | 706.4 |
| C2.2.3 | 120 | 10 | 1.00 | 2904.2 | 0.46 | 1164188 | 0.00 | 175737 | 0.00 | 169789 | 36.0 | 423.4 | 423.4 |
| C2.2.4 | 120 | 10 | 1.00 | 2894.8 | 0.66 | 2174454 | 0.03 | 71829 | 0.03 | 69590 | 129.4 | 823.5 | 823.5 |
| C2.2.5 | 120 | 10 | 1.30 | 3003.5 | 1.00 | 639403 | 0.48 | 148814 | 0.45 | 118050 | 148.9 | 714.7 | 1112.1 |
| C2.2.6 | 120 | 10 | 1.30 | 2980.6 | 1.02 | 968174 | 0.50 | 231587 | 0.44 | 177225 | 427.6 | 1116.1 | 1620.0 |
| C2.2.7 | 120 | 10 | 1.30 | 2967.1 | 1.07 | 1240246 | 0.39 | 115661 | 0.34 | 87675 | 305.4 | 959.1 | 1376.8 |
| C2.2.8 | 120 | 10 | 1.30 | 2961.5 | 1.23 | 1254761 | 0.42 | 62899 | 0.40 | 48146 | 264.1 | 1003.9 | 1555.5 |
| C2.2.9 | 120 | 10 | 1.30 | 2944.0 | 1.14 | 1750805 | 0.40 | 95057 | 0.32 | 65309 | 155.8 | 847.0 | 1312.1 |

| Name | $ \mathcal{V} $ | K | $UB_g\%$ | OBJ | $LB_1\%$ | $ \mathcal{R}_1 $ | $LB_1\%$ | $ \mathcal{R}_1 $ | $LB_2\%$ | $ \mathcal{R}_2 $ | T_{int} | T_{valid} | T_{tot} |
|----------|-----------------|-----|----------|--------|----------|-------------------|----------|-------------------|----------|-------------------|-----------|-------------|-----------|
| C2.2.10 | 120 | 10 | 1.30 | 2940.8 | 1.13 | 1698992 | 0.33 | 68330 | 0.27 | 47161 | 60.1 | 758.7 | 1258.4 |
| R2.2.1 | 120 | 10 | 1.00 | 3504.4 | 0.76 | 136558 | 0.63 | 84605 | 0.60 | 73247 | 88.9 | 759.3 | 759.3 |
| R2.2.2 | 120 | 10 | 1.00 | 3257.3 | 0.70 | 307914 | 0.51 | 147237 | 0.51 | 142451 | 180.2 | 1256.2 | 1256.2 |
| R2.2.3 | 120 | 10 | 1.00 | 3109.0 | 0.75 | 673890 | 0.42 | 132693 | 0.42 | 128315 | 112.8 | 956.9 | 956.9 |
| R2.2.4 | 120 | 10 | 1.00 | 3009.8 | 0.57 | 900894 | 0.16 | 144203 | 0.16 | 140474 | 30.9 | 740.3 | 740.3 |
| R2.2.5 | 120 | 10 | 1.00 | 3376.2 | 0.83 | 174632 | 0.67 | 100095 | 0.67 | 98099 | 595.7 | 1249.7 | 1249.7 |
| R2.2.6 | 120 | 10 | 1.00 | 3179.8 | 0.53 | 319904 | 0.25 | 102525 | 0.25 | 98514 | 80.0 | 955.2 | 955.2 |
| R2.2.7 | 120 | 10 | 1.00 | 3069.3 | 0.36 | 741364 | 0.10 | 215307 | 0.09 | 205336 | 69.9 | 996.3 | 996.3 |
| R2.2.8 | 120 | 10 | 1.00 | 3009.8 | 0.56 | 962058 | 0.16 | 159399 | 0.16 | 152698 | 64.8 | 810.6 | 810.6 |
| R2.2.9 | 120 | 10 | 1.00 | 3293.6 | 0.97 | 244189 | 0.64 | 58852 | 0.64 | 55008 | 363.6 | 1136.6 | 1136.6 |
| R2.2.10 | 120 | 10 | 1.00 | 3195.7 | 0.73 | 331524 | 0.39 | 77228 | 0.38 | 69600 | 75.9 | 1102.5 | 1102.5 |
| RC2.2.1 | 120 | 10 | 1.00 | 3270.3 | 0.51 | 248779 | 0.08 | 34545 | 0.08 | 33154 | 10.7 | 910.3 | 910.3 |
| RC2.2.2 | 120 | 10 | 1.00 | 3083.1 | 0.39 | 519157 | 0.00 | 117778 | 0.00 | 114481 | 33.5 | 1645.7 | 1645.7 |
| RC2.2.3 | 120 | 10 | 1.00 | 3008.9 | 0.63 | 1830578 | 0.14 | 123128 | 0.13 | 118094 | 85.6 | 2162.2 | 2162.2 |
| RC2.2.4 | 120 | 10 | 1.00 | 2976.2 | 0.60 | 3484787 | 0.00 | 78980 | 0.00 | 76951 | 12.3 | 1149.1 | 1149.1 |
| RC2.2.5 | 120 | 10 | 1.30 | 3157.3 | 1.08 | 1958837 | 0.45 | 267578 | 0.45 | 260289 | 243.3 | 1866.9 | 2933.1 |
| RC2.2.6 | 120 | 10 | 1.00 | 3168.6 | 0.93 | 478479 | 0.34 | 25668 | 0.34 | 24076 | 19.6 | 919.5 | 919.5 |
| RC2.2.7 | 120 | 10 | 1.30 | 3110.6 | 1.12 | 2744051 | 0.38 | 160959 | 0.37 | 153426 | 591.7 | 2653.3 | 4083.7 |
| RC2.2.8 | 120 | 10 | 1.00 | 3076.9 | 0.96 | 1169751 | 0.30 | 33523 | 0.30 | 33258 | 54.7 | 2611.5 | 2611.5 |
| RC2.2.9 | 120 | 10 | 1.30 | 3082.4 | 1.16 | 2967322 | 0.50 | 298306 | 0.49 | 272243 | 1055.9 | 3607.9 | 4951.0 |
| RC2.2.10 | 120 | 10 | 1.00 | 3050.2 | 0.70 | 1227069 | 0.18 | 86322 | 0.18 | 83674 | 286.2 | 2073.8 | 2073.8 |
| C2.2.1 | 140 | 12 | 1.00 | 3436.2 | 0.86 | 721443 | 0.20 | 26795 | 0.20 | 24158 | 21.7 | 870.2 | 870.2 |
| C2.2.2 | 140 | 12 | 1.00 | 3380.3 | 0.90 | 2231726 | 0.29 | 76226 | 0.29 | 75210 | 106.8 | 923.4 | 923.4 |
| C2.2.3 | 140 | 12 | 1.00 | 3304.6 | 0.72 | 7517374 | 0.12 | 182589 | 0.12 | 174588 | 103.6 | 1347.8 | 1347.8 |
| C2.2.4 | 140 | 12 | 1.00 | 3289.5 | 0.70 | 14742871 | 0.03 | 167120 | 0.03 | 160975 | 379.1 | 2036.4 | 2036.4 |
| C2.2.5 | 140 | 12 | 1.30 | 3382.9 | 1.02 | 2781054 | 0.31 | 200403 | 0.30 | 168302 | 142.2 | 847.2 | 1188.5 |
| C2.2.6 | 140 | 12 | 1.30 | 3367.4 | 1.05 | 4004431 | 0.42 | 387342 | 0.39 | 304098 | 808.2 | 1600.8 | 2237.0 |
| C2.2.7 | 140 | 12 | 1.30 | 3362.5 | 1.01 | 5682914 | 0.30 | 305279 | 0.27 | 248925 | 214.4 | 1244.8 | 1711.0 |
| C2.2.8 | 140 | 12 | 1.30 | 3354.6 | 1.15 | 4733990 | 0.42 | 339600 | 0.39 | 232720 | 1039.1 | 1946.7 | 2500.5 |
| C2.2.9 | 140 | 12 | 1.30 | 3345.1 | 1.20 | 9151846 | 0.44 | 373258 | 0.42 | 292732 | 1350.6 | 2735.5 | 3429.9 |
| C2.2.10 | 140 | 12 | 1.30 | 3337.4 | 1.18 | 8867498 | 0.41 | 312725 | 0.39 | 243788 | 1089.0 | 2238.3 | 2866.5 |
| R2.2.1 | 140 | 12 | 1.00 | 3998.9 | 0.79 | 373014 | 0.64 | 207834 | 0.64 | 200474 | 1356.3 | 2228.5 | 2228.5 |
| R2.2.2 | 140 | 12 | 1.00 | 3734.7 | 0.53 | 900085 | 0.36 | 462946 | 0.34 | 419496 | 755.8 | 2509.9 | 2509.9 |
| R2.2.3 | 140 | 12 | 1.00 | 3601.9 | 0.82 | 2565404 | 0.53 | 636144 | 0.53 | 622507 | 9943.4 | 12631.3 | 12631.3 |
| R2.2.4 | 140 | 12 | 1.00 | 3473.3 | 0.36 | 3828889 | 0.17 | 1565391 | 0.17 | 1540561 | 537.9 | 2553.0 | 2553.0 |
| R2.2.5 | 140 | 12 | 1.00 | 3859.3 | 0.76 | 606210 | 0.64 | 375458 | 0.64 | 372186 | 1985.1 | 2843.9 | 2843.9 |
| R2.2.6 | 140 | 12 | 1.00 | 3671.9 | 0.77 | 1272741 | 0.55 | 474515 | 0.52 | 412491 | 5814.3 | 7487.4 | 7487.4 |
| R2.2.7 | 140 | 12 | - | - | - | - | - | - | - | - | - | - | - |
| R2.2.8 | 140 | 12 | 1.00 | 3468.4 | 0.31 | 3667138 | 0.17 | 2043471 | 0.17 | 2025124 | 957.3 | 2934.1 | 2934.1 |
| R2.2.9 | 140 | 12 | 1.00 | 3779.6 | 0.79 | 753762 | 0.64 | 385975 | 0.64 | 371296 | 6348.3 | 7890.3 | 7890.3 |
| R2.2.10 | 140 | 12 | 1.00 | 3693.5 | 0.91 | 903877 | 0.70 | 380195 | 0.68 | 324917 | 4395.9 | 5623.0 | 5623.0 |
| RC2.2.1 | 140 | 12 | 1.30 | 3718.2 | 1.02 | 1458048 | 0.49 | 370208 | 0.49 | 349064 | 743.6 | 2060.5 | 3202.1 |
| RC2.2.2 | 140 | 12 | - | - | - | - | - | - | - | - | - | - | - |
| RC2.2.3 | 140 | 12 | 1.00 | 3487.5 | 0.91 | 10686438 | 0.35 | 607602 | 0.34 | 531311 | 3950.9 | 8023.3 | 8023.4 |
| RC2.2.4 | 140 | 12 | 1.00 | 3449.3 | 0.63 | 14502589 | 0.12 | 1233234 | 0.12 | 1220740 | 651.2 | 7328.9 | 7328.9 |
| RC2.2.5 | 140 | 12 | 1.30 | 3598.7 | 1.24 | 5084317 | 0.48 | 397997 | 0.47 | 352198 | 3874.2 | 5278.8 | 6229.2 |
| RC2.2.6 | 140 | 12 | - | - | - | - | - | - | - | - | - | - | - |
| RC2.2.7 | 140 | 12 | 1.30 | 3565.6 | 1.11 | 6504537 | 0.29 | 403605 | 0.28 | 353177 | 408.4 | 2204.7 | 3481.4 |
| RC2.2.8 | 140 | 12 | 1.30 | 3539.1 | 1.24 | 8390395 | 0.53 | 1127029 | 0.53 | 1084792 | 13216.0 | 16425.1 | 18468.0 |
| RC2.2.9 | 140 | 12 | 1.30 | 3532.4 | 1.14 | 8333191 | 0.44 | 1104080 | 0.44 | 1025095 | 7878.4 | 10781.4 | 12812.6 |
| RC2.2.10 | 140 | 12 | - | - | - | - | - | - | - | - | - | - | - |
| C2.2.1 | 140 | 13 | 1.00 | 3426.2 | 0.99 | 709056 | 0.32 | 28726 | 0.30 | 23396 | 42.0 | 801.5 | 801.5 |
| C2.2.2 | 140 | 13 | 1.00 | 3376.3 | 0.95 | 2361724 | 0.31 | 64578 | 0.31 | 60945 | 153.3 | 1049.1 | 1049.1 |
| C2.2.3 | 140 | 13 | 1.00 | 3304.6 | 0.68 | 7756965 | 0.13 | 275871 | 0.12 | 257097 | 148.6 | 1423.1 | 1423.1 |
| C2.2.4 | 140 | 13 | 1.00 | 3289.5 | 0.70 | 14869058 | 0.03 | 159449 | 0.03 | 152295 | 49.6 | 1827.5 | 1827.5 |
| C2.2.5 | 140 | 13 | 1.00 | 3369.7 | 0.92 | 1083879 | 0.16 | 12649 | 0.16 | 11035 | 8.5 | 628.5 | 628.5 |
| C2.2.6 | 140 | 13 | 1.00 | 3356.7 | 0.91 | 1516373 | 0.25 | 41968 | 0.24 | 34507 | 32.2 | 840.6 | 840.6 |
| C2.2.7 | 140 | 13 | 1.30 | 3356.6 | 1.02 | 4851720 | 0.30 | 316678 | 0.27 | 244925 | 577.1 | 1476.3 | 2034.2 |
| C2.2.8 | 140 | 13 | 1.30 | 3351.2 | 1.19 | 5033977 | 0.44 | 277629 | 0.42 | 228774 | 1329.2 | 2330.5 | 3166.9 |
| C2.2.9 | 140 | 13 | 1.30 | 3341.5 | 1.21 | 9903031 | 0.40 | 323122 | 0.40 | 295791 | 4042.6 | 5367.1 | 6422.0 |

| Name | $ \mathcal{V} $ | K | $UB_g\%$ | OBJ | $LB_1\%$ | $ \mathcal{R}_1 $ | $LB_1\%$ | $ \mathcal{R}_1 $ | $LB_2\%$ | $ \mathcal{R}_2 $ | T_{int} | T_{valid} | T_{tot} |
|----------|-----------------|-----|----------|--------|----------|-------------------|----------|-------------------|----------|-------------------|-----------|-------------|-----------|
| C2.2.10 | 140 | 13 | 1.30 | 3333.0 | 1.15 | 8287717 | 0.30 | 169028 | 0.30 | 162585 | 981.1 | 2139.6 | 2878.3 |
| R2.2.1 | 140 | 13 | 1.00 | 3960.7 | 0.74 | 386369 | 0.56 | 171599 | 0.55 | 164804 | 644.0 | 1425.9 | 1425.9 |
| R2.2.2 | 140 | 13 | 1.00 | 3717.5 | 0.60 | 922198 | 0.45 | 518715 | 0.43 | 461049 | 469.5 | 1888.3 | 1888.3 |
| R2.2.3 | 140 | 13 | 1.00 | 3593.3 | 0.74 | 2590414 | 0.49 | 835187 | 0.49 | 818631 | 6774.2 | 9504.6 | 9504.6 |
| R2.2.4 | 140 | 13 | 1.00 | 3473.3 | 0.36 | 3828889 | 0.21 | 1856081 | 0.21 | 1848094 | 861.6 | 2835.4 | 2835.4 |
| R2.2.5 | 140 | 13 | 1.00 | 3835.2 | 0.65 | 661583 | 0.55 | 408924 | 0.55 | 403471 | 3231.7 | 4022.4 | 4022.4 |
| R2.2.6 | 140 | 13 | 1.00 | 3657.4 | 0.72 | 1278196 | 0.53 | 604051 | 0.50 | 495669 | 3104.2 | 4759.2 | 4759.2 |
| R2.2.7 | 140 | 13 | 1.00 | 3551.9 | 0.56 | 2907993 | 0.36 | 1171649 | 0.34 | 1047507 | 3008.3 | 5599.6 | 5599.6 |
| R2.2.8 | 140 | 13 | 1.00 | 3468.4 | 0.31 | 3667138 | 0.19 | 2332072 | 0.19 | 2289422 | 1000.3 | 2976.5 | 2976.5 |
| R2.2.9 | 140 | 13 | 1.00 | 3755.8 | 0.66 | 749721 | 0.51 | 410904 | 0.51 | 387538 | 3257.4 | 4982.3 | 4982.3 |
| R2.2.10 | 140 | 13 | 1.00 | 3677.3 | 0.87 | 924806 | 0.65 | 371466 | 0.63 | 328234 | 7941.2 | 9034.1 | 9034.1 |
| RC2.2.1 | 140 | 13 | 1.00 | 3689.9 | 0.93 | 588100 | 0.34 | 45035 | 0.34 | 44650 | 84.1 | 1230.5 | 1230.5 |
| RC2.2.2 | 140 | 13 | - | - | - | - | - | - | - | - | - | - | - |
| RC2.2.3 | 140 | 13 | 1.00 | 3485.2 | 0.85 | 10432669 | 0.33 | 666732 | 0.31 | 576342 | 4643.8 | 9542.3 | 9542.3 |
| RC2.2.4 | 140 | 13 | 1.00 | 3449.3 | 0.63 | 14502589 | 0.12 | 1233234 | 0.12 | 1220740 | 695.9 | 7207.8 | 7207.8 |
| RC2.2.5 | 140 | 13 | 1.30 | 3583.1 | 1.00 | 5319414 | 0.33 | 692845 | 0.32 | 653019 | 1146.9 | 2593.7 | 3580.2 |
| RC2.2.6 | 140 | 13 | 1.60 | 3602.6 | 1.38 | 8144580 | 0.59 | 1579934 | 0.59 | 1524447 | 6858.5 | 8913.6 | 11859.9 |
| RC2.2.7 | 140 | 13 | 1.30 | 3559.6 | 1.10 | 6528744 | 0.32 | 473034 | 0.31 | 451331 | 1721.6 | 3752.5 | 5077.5 |
| RC2.2.8 | 140 | 13 | 1.30 | 3535.6 | 1.20 | 8540104 | 0.51 | 1218919 | 0.51 | 1160435 | 6919.0 | 9875.9 | 12880.8 |
| RC2.2.9 | 140 | 13 | 1.00 | 3524.8 | 0.98 | 2990721 | 0.30 | 100711 | 0.30 | 98214 | 730.1 | 2599.4 | 2599.4 |
| RC2.2.10 | 140 | 13 | - | - | - | - | - | - | - | - | - | - | - |

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