

طراحی مدل مدیریت درآمد در شرکت‌های حمل و نقل عمومی:
موردکاوی قطار غزال تهران - مشهد

*

-

(// , //)

»

EMSR-b

-

b

:

...

[]

-

«

»

»

«¹

«

»

«

»

-

:

,

:

:

*

- « ».

-

[] « ».

Ultimate Super Saver Fares

: « » « » .

• » .

« » «

•

« »

• / « »"

[] « »

« »

[-]

« »

[] « » « » []

« » [5] « »

[] « » « » []

[] « »

« »

[-]

« »

()

n

n

$$b_j = C - y_{j-1} \quad j = 2, \dots, n \quad ()$$

: j

: C

: b

: y

« EMSR-b »

« »

(Static)



$$V_j(x)$$

$$(j \quad x) D_j \quad (\quad) u$$

$$r_j$$

$$r_j u + V_{j-1}(x - u)$$

$$\text{Consr: } 0 \leq u \leq \min\{D_j, x\} \quad ()$$

$$j \quad ()$$

« »

Dj

: «¹⁶ »

$$\begin{aligned}
 & \cdot (y_j) \\
 & \cdot [1] \quad () \\
 & S_i = \sum_{k=1}^j D_k \quad () \\
 & \quad \quad \quad 1, \dots, j \\
 & R_j = \frac{\sum_{k=1}^j r_k E[D_k]}{\sum_{k=1}^j E[D_k]} \quad () \\
 & \quad \quad \quad j \quad E[D_j] \\
 & \quad \quad \quad y_j \quad j \\
 & P(S_i > y_j) = \frac{r_{j+1}}{R_j} \quad () \\
 & V_j(x) = E \left[\max_{0 \leq u \leq \min\{D_j, x\}} \{r_j u + V_{j-1}(x-u)\} \right] \quad () \\
 & V_{n+1}(x) = 0, \quad x = 0, 1, \dots, C \\
 & \Delta V_j(x) = V_j(x) - V_j(x-1) \quad () \\
 & \quad \quad \quad \Delta V_j(x) \\
 & \quad \quad \quad x \\
 & \quad \quad \quad j \\
 & \quad \quad \quad V_j(x) \quad \Delta V_j(x) \\
 & (i) \quad \Delta V_j(x+1) \leq \Delta V_j(x) \quad V_{x,j} \quad () \\
 & (ii) \quad \Delta V_{j+1}(x) \geq \Delta V_j(x) \quad V_{x,j}
 \end{aligned}$$

✓

b

✓

✓

j+1

| Different price of original price | price | Class name |
|-----------------------------------|-------|------------|
| | | Ghazal |
| | | Delijan |
| | | Lux |

✓

ESMR-b

Input Analyzer Arena v.7.1

« » « - »

[]

EMSR-b

$N(\mu, \delta)$

[-]

//

//

- ()

()

C^* () ()

()

Y_i

()

| Lux | Delijan | Ghazal |
|---|--|---|
| Distribution: Normal Expression: NORM (431, 20.5) Square Error = 0.028015 | Distribution: Normal Expression: NORM (438, 68.1) Square Error = 0.061999 | Distribution: Normal Expression: NORM (321, 55.5) Square Error = 0.379287 |
| Chi Square Test Number of intervals = 26 Degrees of freedom = 23 Test Statistic = 678 Corresponding p-value < 0.005 | Chi Square Test Number of intervals = 5 Degrees of freedom = 2 Test Statistic = 18 Corresponding p-value < 0.005 | Chi Square Test Number of intervals = 13 Degrees of freedom = 10 Test Statistic = 1.18e+003 Corresponding p-value < 0.005 |
| Data Summary Number of Data Points = 348 Min Data Value = 399 Max Data Value = 497 Sample Mean = 431 Sample STD Dev = 20.5 | Kolmogorov-Smirnov Test Test Statistic = 0.195 Corresponding p-value = 0.043 | Kolmogorov-Smirnov Test Test Statistic = 0.34 Corresponding p-value < 0.01 |
| | Data Summary Number of Data Points = 49 Min Data Value = 283 Max Data Value = 516 Sample Mean = 438 Sample STD Dev = 68.8 | Data Summary Number of Data Points = 305 Min Data Value = 149 Max Data Value = 416 Sample Mean = 321 Sample STD Dev = 55.6 |

ESMR-b

| Lux | Delijan | Ghazal | name |
|-----|---------|--------|-------|
| . | 140 | 456 | C^* |
| . | ۱۴۰ | ۳۱۶ | Y_i |

Matlab

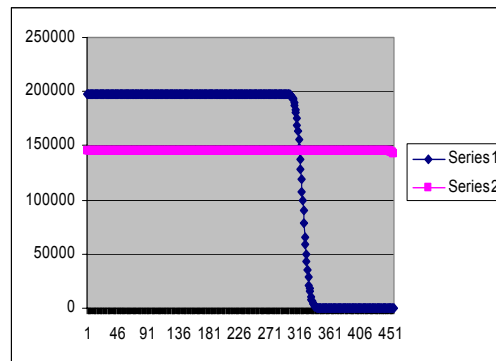
v.7

()

() ()

()

MATLAB



[]

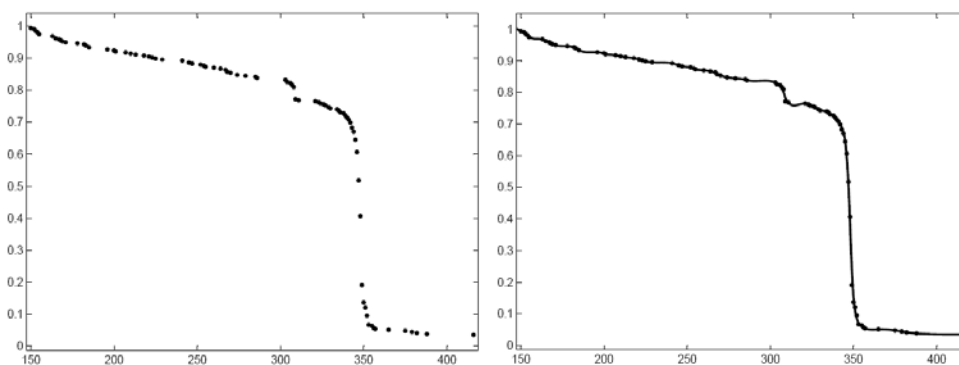
() ()

()

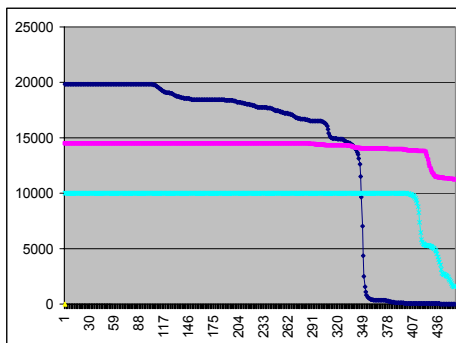
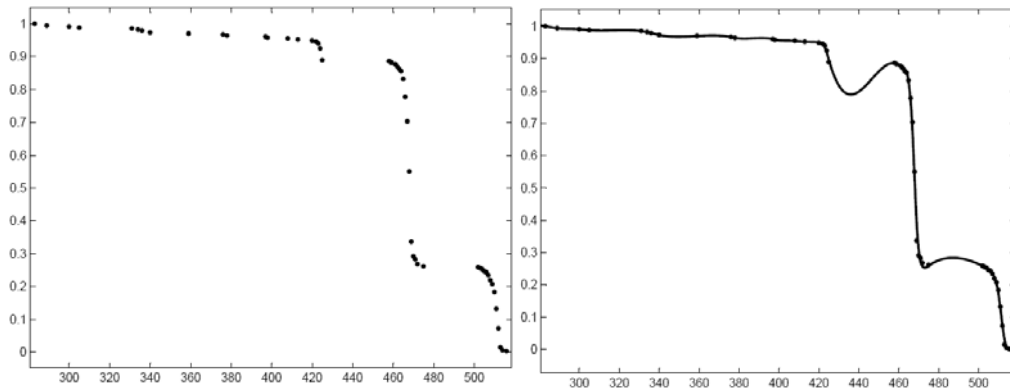
()

MATLAB

| probability | No. of event | All passengers | probability | No. of event | All passengers | probability | No. of event | All passengers |
|-------------|--------------|----------------|-------------|--------------|----------------|-------------|--------------|----------------|
| 0.739683 | 233 | 334 | 0.885714 | 279 | 245 | 1 | 315 | 149 |
| 0.736508 | 232 | 335 | 0.88254 | 278 | 247 | 0.993650794 | 313 | 150 |
| 0.730159 | 230 | 336 | 0.879365 | 277 | 252 | 0.99047619 | 312 | 152 |
| 0.726984 | 229 | 338 | 0.87619 | 276 | 254 | 0.984126984 | 310 | 153 |
| 0.720635 | 227 | 339 | 0.873016 | 275 | 255 | 0.980952381 | 309 | 154 |
| 0.714286 | 225 | 340 | 0.869841 | 274 | 260 | 0.974603175 | 307 | 155 |
| 0.707937 | 223 | 341 | 0.866667 | 273 | 264 | 0.968253968 | 305 | 163 |
| 0.698413 | 220 | 342 | 0.863492 | 272 | 267 | 0.961904762 | 303 | 165 |
| 0.68254 | 215 | 343 | 0.857143 | 270 | 268 | 0.958730159 | 302 | 167 |
| 0.669841 | 211 | 344 | 0.853968 | 269 | 270 | 0.955555556 | 301 | 168 |
| 0.644444 | 203 | 345 | 0.847619 | 267 | 274 | 0.952380952 | 300 | 169 |
| 0.606349 | 191 | 346 | 0.844444 | 266 | 279 | 0.949206349 | 299 | 171 |
| 0.51746 | 163 | 347 | 0.84127 | 265 | 285 | 0.946031746 | 298 | 178 |
| 0.406349 | 128 | 348 | 0.838095 | 264 | 286 | 0.942857143 | 297 | 182 |
| 0.190476 | 60 | 349 | 0.831746 | 262 | 303 | 0.93968254 | 296 | 183 |
| 0.136508 | 43 | 350 | 0.825397 | 260 | 304 | 0.933333333 | 294 | 185 |
| 0.120635 | 38 | 351 | 0.822222 | 259 | 306 | 0.926984127 | 292 | 196 |
| 0.095238 | 30 | 352 | 0.815873 | 257 | 307 | 0.923809524 | 291 | 200 |
| 0.066667 | 21 | 353 | 0.809524 | 255 | 308 | 0.920634921 | 290 | 201 |
| 0.063492 | 20 | 355 | 0.771429 | 243 | 309 | 0.917460317 | 289 | 207 |
| 0.057143 | 18 | 356 | 0.768254 | 242 | 311 | 0.914285714 | 288 | 210 |
| 0.053968 | 17 | 357 | 0.765079 | 241 | 321 | 0.911111111 | 287 | 213 |
| 0.050794 | 16 | 365 | 0.761905 | 240 | 323 | 0.907936508 | 286 | 218 |
| 0.047619 | 15 | 375 | 0.75873 | 239 | 324 | 0.904761905 | 285 | 221 |
| 0.044444 | 14 | 379 | 0.755556 | 238 | 326 | 0.901587302 | 284 | 223 |
| 0.04127 | 13 | 382 | 0.752381 | 237 | 327 | 0.898412698 | 283 | 225 |
| 0.038095 | 12 | 388 | 0.746032 | 235 | 329 | 0.895238095 | 282 | 229 |
| 0.034921 | 11 | 416 | 0.742857 | 234 | 330 | 0.892063492 | 281 | 241 |



| probability | No. of event | All passengers | probability | No. of event | All passengers | probability | No. of event | All passengers |
|-------------|--------------|----------------|-------------|--------------|----------------|-------------|--------------|----------------|
| 0.267267 | 89 | 472 | 0.93994 | 313 | 423 | 1 | 333 | 283 |
| 0.261261 | 87 | 475 | 0.924925 | 308 | 424 | 0.993993994 | 331 | 289 |
| 0.258258 | 86 | 502 | 0.888889 | 296 | 425 | 0.990990991 | 330 | 300 |
| 0.255255 | 85 | 503 | 0.885886 | 295 | 458 | 0.987987988 | 329 | 305 |
| 0.252252 | 84 | 504 | 0.882883 | 294 | 459 | 0.984984985 | 328 | 331 |
| 0.246246 | 82 | 505 | 0.876877 | 292 | 461 | 0.981981982 | 327 | 334 |
| 0.243243 | 81 | 506 | 0.870871 | 290 | 462 | 0.978978979 | 326 | 336 |
| 0.234234 | 78 | 507 | 0.861862 | 287 | 463 | 0.972972973 | 324 | 340 |
| 0.219219 | 73 | 508 | 0.855856 | 285 | 464 | 0.96996997 | 323 | 359 |
| 0.207207 | 69 | 509 | 0.831832 | 277 | 465 | 0.966966967 | 322 | 376 |
| 0.183183 | 61 | 510 | 0.777778 | 259 | 466 | 0.963963964 | 321 | 378 |
| 0.132132 | 44 | 511 | 0.702703 | 234 | 467 | 0.960960961 | 320 | 397 |
| 0.072072 | 24 | 512 | 0.54955 | 183 | 468 | 0.957957958 | 319 | 398 |
| 0.015015 | 5 | 513 | 0.336336 | 112 | 469 | 0.954954955 | 318 | 408 |
| 0.006006 | 2 | 514 | 0.291291 | 97 | 470 | 0.951951952 | 317 | 413 |
| 0.003003 | 1 | 516 | 0.282282 | 94 | 471 | 0.948948949 | 316 | 420 |
| | | | | | | 0.945945946 | 315 | 422 |



()

:

| Number of sell | Class name |
|----------------|------------|
| Ghazal | 439 |
| Delijan | 117 |
| Lux | 0 |

VBA

Excel

VB

.() :

| | |
|-----------------------------|---------|
| Time of study | // - // |
| Revenue of period(IRR) | |
| Max daily revenue (IRR) | |
| Min daily revenue (IRR) | |
| Average daily revenue (IRR) | |

()

| Average random generation | simulation process |
|---------------------------|-----------------------|
| ۰.۵۰۰۱۱۴ | b-EMSR |
| ۰.۵۰۰۰۳۴ | Static Multiple Class |

()

//

EMSR-b

//

()

| No.of sold seats in Ghazal class | Revenue of Ghazal class | No. of sold seats in Delijan class | Revenue of Delijan class | Average of total sold seats | Average daily revenue (IRR) | metod |
|----------------------------------|-------------------------|------------------------------------|--------------------------|-----------------------------|-----------------------------|-----------------------|
| 314.5184 | 62274640 | 140 | 2030000 | 454.5184 | 82574640 | EMSR-b |
| 311.1462 | 61606950 | 104.4029 | 15138420 | 415.5491 | 76745370 | Static Multiple Class |

| Average revenue for 353 days(IRR) | Average daily revenue (IRR) | Min daily revenue (IRR) | Max daily revenue (IRR) | No.of simulation | metod |
|-----------------------------------|-----------------------------|-------------------------|-------------------------|------------------|-----------------------------|
| 29148847920 | 82574640 | 81482000 | 82868000 | | EMSR-b |
| 27091115610 | 76745370 | 72606000 | 80498000 | | Static Multiple Class |

EMSR-b

EMSR-b

1- Garrett J. van Ryzin and Kalyan T. Talluri (2002). *Revenue Management Handbook of Transportation Science*. Chapter 1-2. Kluwer Academic Publishers. PP .27-75.

2- Netessine and Shumsky,(2003). Introduction to the Theory and Practice of Yield Management. The Wharton School University of Pennsylvania Robert Shumsky W. E. Simon Graduate School of Business Administration University of Rochester. *3rd Int. Conf* INFORMS Transactions on Education. PP .34-44.

- 3- Shlifer AND, R., VARDI, Y. (1975). *An Airline Overbooking Policy, Transportation Science*9. PP .101–114.
- 4- BELOBABA, P. P. (1987). *Air Travel Demand and Airline Seat Inventory Management, Ph.D. Thesis Flight Transportation Laboratory, Massachusetts Institute of Technology, Cambridge, MA.* PP .32-50.
- 5- Thompson, H. R. (1961). *Statistical Problems in Airline Reservations Control, Operations Research Quarterly*, 12. PP .167–185.
- 6- Rothstein, M. and Stone, A. W. (1967). "Passenger booking levels." In *Proceedings of The Seventh AGIFORS Symposium*.
- 7- Martinez, R. and Sanchez, M.(1970). "Automatic booking level control." In *Proceedings of the Tenth AGIFORS Symposium, Australia*.
- 8- Littlewood, K.. (1972). "Forecasting and control of passenger bookings." In *AGIFORS Symposium Proc.* 12.
- 9- Chatwin, E. (1999). "Multiperiod airline overbooking with a single fare class." *Opns. Res.* 46.PP. 805–819.
- 10- Chatwin, R. E. (1999). "Continuous-time airline overbooking with time dependent fares and refunds." *transportation science.* 33 .PP.182–191
- 11- IDEaS (Integrated Decisions and Systems, Inc.)(2005) *The Basics of Revenue Management by IDEaS.* PP 1-47
- 12- David J. Olive (2006). "Applied robust statistics" *Southern Illinois Uni. Department of Mathematics*, 14 June. . Chapter 4. Special Volume on Robustness, 10, Issue 4. PP 104-127.
- 13- Samadi, M. (1382). *The Consumer Behavior* .Nashr Aeizh Publisher. Chapter 1. PP 10-25
- 14- Salvatore, D. (1379). *Micro Economics Theory and Applications*, Translate by Sobhani .H., Nashreney Publishing
- 15- Tabibiyan M .(1383). *Advanced Micro economics*. Chapter 2. Pishbord Danesh Publisher.
- 16- Albert Hosmer Bowker, Gerald Lieberman, J..(1379). *Engineering Statistics*, Translate by Mahlooji.H. Chapter4-5.Iran University Press

1- Revenue Management
 3- American Airlines
 5 - Belobaba
 7- Vardi
 9 - Stone
 11- Sanchez
 13- Chatwin
 15- Static Multiple Class

2- People Express
 4- Dynamic Inventory Allocation and Maintenance Optimizer
 6- Shlifer
 8- Thompson
 10- Martinez
 12- Little wood
 14- Excepted Marginal Seat Revenue
 16- Bellman