# A Appendix

## A.1 The Nested Logit Model

Suppose that individual $i$'s choice set, $C$, contains $N+1$ alternatives. These alternatives are partitioned into $K$ nests according to certain characteristics. Therefore we can write the choice set as:

$$C = \{B_1, B_2, \ldots, B_k\}$$

Let utility of the individual $i$ from alternative $j$ in nest $k$ be

$$U_{ij} = \delta_{kj} + \varepsilon_{ij}$$

where $\delta_{kj}$ is the mean valuation of the alternative $j$. We can decompose $\delta_{kj}$ as:

$$\delta_{kj} = W_k + V_j$$

where $W_k$ is the valuation related only to the nest characteristics and $V_j$ is the valuation related to alternative $j$'s attributes.

Let $\lambda_k$ be the scale parameter of nest $k$, which is inversely related to the correlation of error terms within nest $k$.

The probability alternative $j$ is chosen conditional on nest $k$ being chosen is given by:

$$P(j|B_k) = \frac{\exp(\frac{V_j}{\lambda_k})}{\sum_{l \in B_k} \exp(\frac{V_l}{\lambda_k})}$$

The probability of nest $k$ being chosen depends on the nest characteristics $W_k$, and inclusive value $I_k$, which depends on all the alternatives in the nest $k$.

$$P(B_k) = \frac{\exp(W_k + \lambda_k I_k)}{\sum_{n=1}^{K} \exp(W_n + \lambda_n I_n)} \quad \text{where} \quad I_k = \log(\sum_{l \in B_k} \exp(\frac{V_l}{\lambda_k}))$$

We can write $P(j)$ as:

$$\begin{aligned} P(j) &= P(j|B_k)P(B_k) \\ &= \frac{\exp(\frac{V_j}{\lambda_k})}{\sum\limits_{l\in B_k}\exp(\frac{V_l}{\lambda_k})}\frac{\exp(W_k+\lambda_k I_k)}{\sum\limits_{n=1}^{K}\exp(W_n+\lambda_n I_n)} \end{aligned}$$

Replace $I_k$ by $\log(\sum\limits_{l\in B_k}\exp(\frac{V_l}{\lambda_k}))$

$$\begin{aligned} P(j) &= \frac{\exp(\frac{V_j}{\lambda_k})}{\sum\limits_{l\in B_k}\exp(\frac{V_l}{\lambda_k})}\frac{\exp(W_k+\lambda_k\log(\sum\limits_{l\in B_k}\exp(\frac{V_l}{\lambda_k})))}{\sum\limits_{n=1}^{K}\exp(W_n+\lambda_n\log(\sum\limits_{l\in B_n}\exp(\frac{V_l}{\lambda_n})))} \\ &= \frac{\exp(\frac{V_j}{\lambda_k})}{\sum\limits_{l\in B_k}\exp(\frac{V_l}{\lambda_k})}\frac{(\exp(W_k))(\sum\limits_{l\in B_k}\exp(\frac{V_l}{\lambda_k}))^{\lambda_k}}{\sum\limits_{n=1}^{K}(\exp(W_n))(\sum\limits_{l\in B_n}\exp(\frac{V_l}{\lambda_n}))^{\lambda_n}} \end{aligned}$$

Multiply both sides by $\frac{\exp(\frac{W_k}{\lambda_k})}{\exp(\frac{W_k}{\lambda_k})}$ :

$$\begin{aligned} P(j) &= \frac{\exp(\frac{W_k}{\lambda_k})}{\exp(\frac{W_k}{\lambda_k})}\frac{(\exp(W_k))(\exp(\frac{V_j}{\lambda_k}))(\sum\limits_{l\in B_k}\exp(\frac{V_l}{\lambda_k}))^{\lambda_k-1}}{\sum\limits_{n=1}^{K}(\exp(W_n))(\sum\limits_{l\in B_n}\exp(\frac{V_l}{\lambda_n}))^{\lambda n}} \\ &= \frac{\exp(\frac{W_k}{\lambda_k})}{\exp(\frac{W_k}{\lambda_k})}\frac{(\exp(\frac{W_k}{\lambda_k})^{\lambda_k})(\exp(\frac{V_j}{\lambda_k}))(\sum\limits_{l\in B_k}\exp(\frac{V_l}{\lambda_k}))^{\lambda_k-1}}{\sum\limits_{n=1}^{K}(\exp(\frac{W_n}{\lambda_n})^{\lambda_n})(\sum\limits_{l\in B_n}\exp(\frac{V_l}{\lambda_n}))^{\lambda_n}} \\ &= \frac{\exp(\frac{W_k}{\lambda_k})^{\lambda_k-1}(\exp(\frac{V_j}{\lambda_k}+\frac{W_k}{\lambda_k}))(\sum\limits_{l\in B_k}\exp(\frac{V_l}{\lambda_k}))^{\lambda_k-1}}{\sum\limits_{n=1}^{K}(\exp(\frac{W_n}{\lambda_n})^{\lambda_n})(\sum\limits_{l\in B_n}\exp(\frac{V_l}{\lambda_n}))^{\lambda_n}} \end{aligned}$$

Therefore

$$P(j) = \frac{(\exp(\frac{\delta_{kj}}{\lambda_k}))(\sum\limits_{l\in B_k}\exp(\frac{\delta_{kl}}{\lambda_k}))^{\lambda_k-1}}{\sum\limits_{n=1}^{K}(\sum\limits_{l\in B_n}\exp(\frac{\delta_{nl}}{\lambda_n}))^{\lambda_n}}$$

## A.2 Cameron and Kim (2001)

Suppose that $\varepsilon_1$ and $\varepsilon_2$ are jointly distributed with bivariate extreme value distribution

$$H(\varepsilon_1, \varepsilon_2) = \exp\left(-\left(\exp(-\frac{\varepsilon_1}{\lambda}) + \exp(-\frac{\varepsilon_2}{\lambda})\right)^{\lambda}\right)$$

Cameron and Kim (2001) propose that

$$\varepsilon_1 = a\xi + bv_1 + c$$

$$\varepsilon_2 = a\xi + bv_2 + c$$

where $\xi, v_1, v_2$ are independently distributed with extreme value distribution, and $a, b$ and $c$ are the weights that match the moments of extreme value distribution.

$$E(\varepsilon_i) = E(a\xi + bv_1 + c) = a\gamma + b\gamma + c = \gamma$$

$$Var(\varepsilon_i) = a^2\frac{\pi^2}{6} + b^2\frac{\pi^2}{6} = \frac{\pi^2}{6}$$

$$Corr(\varepsilon_1, \varepsilon_2) = [1 - \lambda^2] = \frac{a^2}{a^2 + b^2}$$

This results in

$$a = \sqrt{1 - \lambda^2}$$

$$b = \sqrt{1 - a^2}$$

$$c = (1 - a - b)\gamma$$

where $\gamma$ is the Euler constant.

Table A.1: Correlation in Minimum Cutoff Scores

| Min Score | 2000 | 2001 | 2002 | 2003 | 2004 |
|---|---|---|---|---|---|
| 2000 | 1.00 | 0.97 | 0.97 | 0.96 | 0.96 |
| 2001 | 0.97 | 1.00 | 0.97 | 0.96 | 0.95 |
| 2002 | 0.97 | 0.97 | 1.00 | 0.98 | 0.97 |
| 2003 | 0.96 | 0.96 | 0.98 | 1.00 | 0.98 |
| 2004 | 0.96 | 0.95 | 0.97 | 0.98 | 1.00 |

Source: Science and Anatolian high school's cutoff scores from 2000 - 2004 from the Ministry of Education website

This method is generalized to the multivariate extreme value distribution,

$$H(\varepsilon_{i0}, \varepsilon_{i1}, \ldots, \varepsilon_{iN}) = \exp\left(-\sum_{k=1}^{K}\left(\sum_{j \in B_k} \exp(-\frac{\varepsilon_{ij}}{\lambda_k})\right)^{\lambda_k}\right)$$

such that

$$\varepsilon_j = a_k \xi + b_k v_j + c_k$$

where

$$a_k = \sqrt{1-\lambda_k^2},\ b_k = \sqrt{1-a_k^2},\ c_k = (1 - a_k - b_k)\gamma$$

## A.3 Stability of Exam Schools' Cutoff Scores

The following tables show the correlation of cutoff scores over the five year period from 2000 to 2004. As Tables A.I and A.II show the correlation between minimum cutoff scores over the years is never less than 0.95. The correlation between maximum cutoff scores is lower than between minimum cutoff scores, but it is still around 0.8. Similarly we also look at how the ranks of schools with respect to their minimum and maximum scores are correlated over time. Table A.III shows the correlation in rank of schools' minimum cutoff scores over the five year period. Similarly, Table A.IV shows the corresponding table for the maximum cutoff scores. These tables show that exam schools' cutoff scores are stable in Turkey.

Table A.2: Correlation in Maximum Cutoff Scores

| Max Score | 2000 | 2001 | 2002 | 2003 | 2004 |
|---|---|---|---|---|---|
| 2000 | 1.00 | 0.82 | 0.83 | 0.83 | 0.82 |
| 2001 | 0.82 | 1.00 | 0.80 | 0.82 | 0.78 |
| 2002 | 0.83 | 0.80 | 1.00 | 0.87 | 0.85 |
| 2003 | 0.83 | 0.82 | 0.87 | 1.00 | 0.86 |
| 2004 | 0.82 | 0.78 | 0.85 | 0.86 | 1.00 |

Source: Science and Anatolian high school's cutoff scores from 2000 - 2004 from the Ministry of Education website

Table A.3: Correlation in Rank of Minimum Cutoff Scores

| Rank of Min Score | 2000 | 2001 | 2002 | 2003 | 2004 |
|---|---|---|---|---|---|
| 2000 | 1.000 | 0.953 | 0.946 | 0.943 | 0.946 |
| 2001 | 0.953 | 1.000 | 0.973 | 0.969 | 0.968 |
| 2002 | 0.946 | 0.973 | 1.000 | 0.985 | 0.979 |
| 2003 | 0.943 | 0.969 | 0.985 | 1.000 | 0.979 |
| 2004 | 0.946 | 0.968 | 0.979 | 0.979 | 1.000 |

Source: Science and Anatolian high school's cutoff scores from 2000 - 2004 from the Ministry of Education website

Table A.4: Correlation in Rank of Maximum Cutoff Scores

| Rank of Max Score | 2000 | 2001 | 2002 | 2003 | 2004 |
|---|---|---|---|---|---|
| 2000 | 1.000 | 0.785 | 0.800 | 0.793 | 0.771 |
| 2001 | 0.785 | 1.000 | 0.829 | 0.837 | 0.798 |
| 2002 | 0.800 | 0.829 | 1.000 | 0.858 | 0.838 |
| 2003 | 0.793 | 0.837 | 0.858 | 1.000 | 0.847 |
| 2004 | 0.771 | 0.798 | 0.838 | 0.847 | 1.000 |

Source: Science and Anatolian high school's cutoff scores from 2000 - 2004 from the Ministry of Education website

Table A.5: Descriptive Statistics: High School Entrance Exam

| Variable | Obs | Mean | Std.Dev. | Min | Max |
|---|---|---|---|---|---|
| **Anatolian High Schools in Ankara** | | | | | |
| Number of Available Seats | 24 | 85.000 | 49.782 | 30 | 240 |
| Minimum Cutoff Score | 24 | 813.573 | 30.792 | 768.819 | 872.254 |
| Maximum Cutoff Score | 24 | 859.001 | 21.543 | 825.171 | 912.31 |
| Age | 24 | 10.292 | 6.182 | 5 | 30 |
| Average Math Score in 2000 ÖSS* | 17 | 29.071 | 3.598 | 23.07 | 34.84 |
| Average Science Score in 2000 ÖSS* | 17 | 18.425 | 6.691 | 3.1 | 28.41 |
| Average Turkish Score in 2000 ÖSS* | 17 | 34.656 | 1.857 | 31.35 | 37.81 |
| Average Social Science Score in 2000 ÖSS* | 17 | 25.920 | 2.477 | 21.78 | 30.21 |
| Language offered: English | 24 | 0.792 | 0.415 | 0 | 1 |
| Language offered: German | 24 | 0.167 | 0.381 | 0 | 1 |
| Language offered: French | 24 | 0.042 | 0.204 | 0 | 1 |
| Dormitory Availability | 24 | 0.167 | 0.381 | 0 | 1 |
| **Anatolian High Schools in Istanbul** | | | | | |
| Number of Available Seats | 38 | 100.658 | 48.186 | 30 | 240 |
| Minimum Cutoff Score | 38 | 827.916 | 41.686 | 654.059 | 898.332 |
| Maximum Cutoff Score | 38 | 874.426 | 23.135 | 830.076 | 933.735 |
| Age | 38 | 10.105 | 6.501 | 1 | 26 |
| Average Math Score in 2000 ÖSS* | 23 | 29.201 | 4.152 | 18.72 | 37.61 |
| Average Science Score in 2000 ÖSS* | 23 | 19.553 | 4.568 | 11.85 | 32.48 |
| Average Turkish Score in 2000 ÖSS* | 23 | 35.819 | 2.524 | 29.19 | 41.05 |
| Average Social Science Score in 2000 ÖSS* | 23 | 26.359 | 3.446 | 20.83 | 34.74 |
| Language offered: English | 38 | 0.763 | 0.431 | 0 | 1 |
| Language offered: German | 38 | 0.184 | 0.393 | 0 | 1 |
| Language offered: French | 38 | 0.053 | 0.226 | 0 | 1 |
| Dormitory Availability | 38 | 0.184 | 0.393 | 0 | 1 |
| **Anatolian High Schools in Izmir** | | | | | |
| Number of Available Seats | 18 | 90.000 | 63.431 | 30 | 300 |
| Minimum Cutoff Score | 18 | 810.994 | 32.805 | 762.369 | 878.236 |
| Maximum Cutoff Score | 18 | 868.863 | 30.033 | 818.16 | 915.172 |
| Age | 18 | 14.500 | 16.111 | 1 | 48 |
| Average Math Score in 2000 ÖSS* | 12 | 26.553 | 6.916 | 12.61 | 31.03 |
| Average Science Score in 2000 ÖSS* | 12 | 17.968 | 4.550 | 9.45 | 22.17 |
| Average Turkish Score in 2000 ÖSS* | 12 | 33.875 | 4.792 | 24.02 | 37.48 |
| Average Social Science Score in 2000 ÖSS* | 12 | 25.014 | 5.621 | 14.59 | 33.3779 |
| Language offered: English | 18 | 0.556 | 0.511 | 0 | 1 |
| Language offered: German | 18 | 0.278 | 0.461 | 0 | 1 |

(continued on next page)

| Variable | Obs | Mean | Std.Dev. | Min | Max |
|---|---|---|---|---|---|
| Language offered: French | 18 | 0.167 | 0.383 | 0 | 1 |
| Dormitory Availability | 18 | 0.278 | 0.461 | 0 | 1 |
| **Science High Schools** | | | | | |
| Number of Available Seats | 48 | 83.000 | 21.556 | 48 | 96 |
| Minimum Cutoff Score | 48 | 878.010 | 18.120 | 837.949 | 920.268 |
| Maximum Cutoff Score | 48 | 910.355 | 14.484 | 879.825 | 941.566 |
| Age | 48 | 8.250 | 6.380 | 1 | 38 |
| Average Math Score in 2000 ÖSS* | 38 | 37.270 | 2.652 | 29.22 | 41.4 |
| Average Science Score in 2000 ÖSS* | 38 | 32.973 | 3.919 | 22.54 | 39.59 |
| Average Turkish Score in 2000 ÖSS* | 38 | 35.945 | 3.908 | 26.07 | 41.35 |
| Average Social Science Score in 2000 ÖSS* | 38 | 27.843 | 6.209 | 12.92 | 38.06 |
| Language offered: English | 48 | 1 | 0 | 1 | 1 |
| Language offered: German | 48 | 0 | 0 | 0 | 0 |
| Language offered: French | 48 | 0 | 0 | 0 | 0 |
| Dormitory Availability | 48 | 1 | 0 | 1 | 1 |
| **Anatolian Teacher Training High Schools** | | | | | |
| Number of Available Seats | 91 | 56.703 | 21.322 | 24 | 120 |
| Minimum Cutoff Score | 91 | 798.716 | 35.943 | 712.758 | 864.296 |
| Maximum Cutoff Score | 91 | 864.419 | 16.861 | 827.49 | 902.864 |
| Age | 91 | 8.571 | 3.763 | 1 | 12 |
| Average Math Score in 2000 ÖSS* | 71 | 15.401 | 4.704 | 5.2 | 27.65 |
| Average Science Score in 2000 ÖSS* | 71 | 9.745 | 3.340 | 2.26 | 18.35 |
| Average Turkish Score in 2000 ÖSS* | 71 | 31.726 | 3.405 | 22.65 | 37.87 |
| Average Social Science Score in 2000 ÖSS* | 71 | 23.476 | 3.483 | 10.81 | 30.19 |
| Language offered: English | 91 | 1 | 0 | 1 | 1 |
| Language offered: German | 91 | 0 | 0 | 0 | 0 |
| Language offered: French | 91 | 0 | 0 | 0 | 0 |
| Dormitory Availability | 91 | 0.846 | 0.363 | 0 | 1 |

* : The differences in the number of observations across variables comes from some schools being new so that there are no students graduating in 2000.

Table A.6: Descriptive Statistics: High School Entrance Exam Scores

| | | | | Quantiles | | | | |
|---|---|---|---|---|---|---|---|---|
| Variable | Number of Students | Mean | Std.Dev. | Min | 0.25 | Median | 0.75 | Max |
| OKS Score | 553495 | 592.35 | 86.34 | 442.53 | 526.76 | 572.83 | 637.44 | 941.49 |

Table A.7: Validity Check: Instrumental Variables

| Variable | Coefficients |
|---|---|
| Number of Available Seats | 0.083 |
| | (0.061) |
| Average Quantitative Score in 2000 ÖSS | 0.631 |
| | (0.750) |
| Average Verbal Score in 2000 ÖSS | -0.071 |
| | (1.212) |
| Age | 0.166 |
| | (0.420) |
| Science High School | 58.23*** |
| | (14.450) |
| Teacher High School | 45.77** |
| | (16.310) |
| Anatolian High School in Istanbul | 23.990 |
| | (17.990) |
| Anatolian High School in Izmir | 18.230 |
| | (19.210) |
| Education Language- English | 11.720 |
| | (13.900) |
| Education Language- German | -2.157 |
| | (13.680) |
| Dormitory Availability | 12.360 |
| | (6.808) |
| Ankara | 26.90* |
| | (12.590) |
| Istanbul | 23.89* |
| | (11.640) |
| Izmir | 27.06* |
| | (12.300) |
| Instrument for Minimum Score (with better schools) | -0.00465* |
| | (0.002) |
| Instrument for Minimum Score (with worse schools) | 0.002 |
| | (0.002) |
| Residual from min regression | 0.720*** |
| | (0.090) |
| Constant | 756.5*** |
| | (52.540) |

Note: Standard errors are reported in parentheses. *, **, *** indicate significance at the .90, .95 and .99 levels, respectively.

Figure A.1: Model Fit: Science High Schools Nest

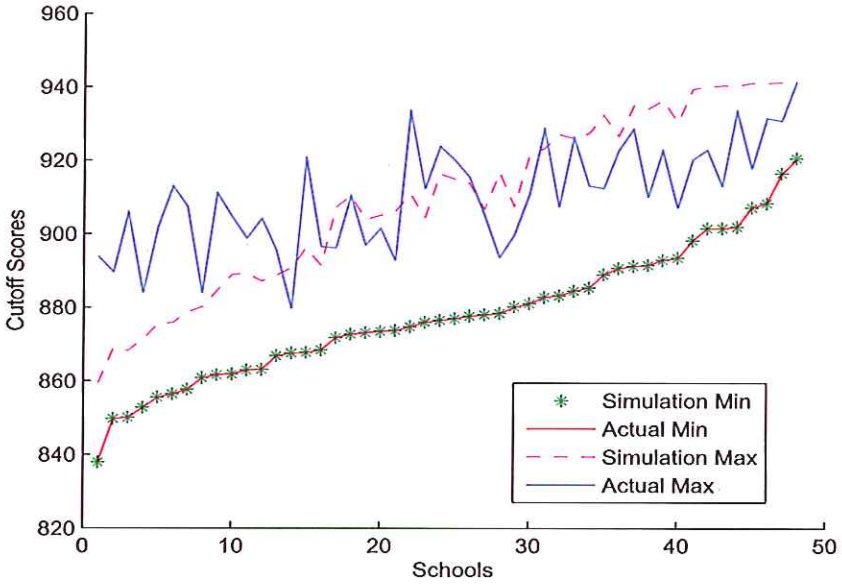


Figure A.2: Model Fit: Teacher High Schools Nest

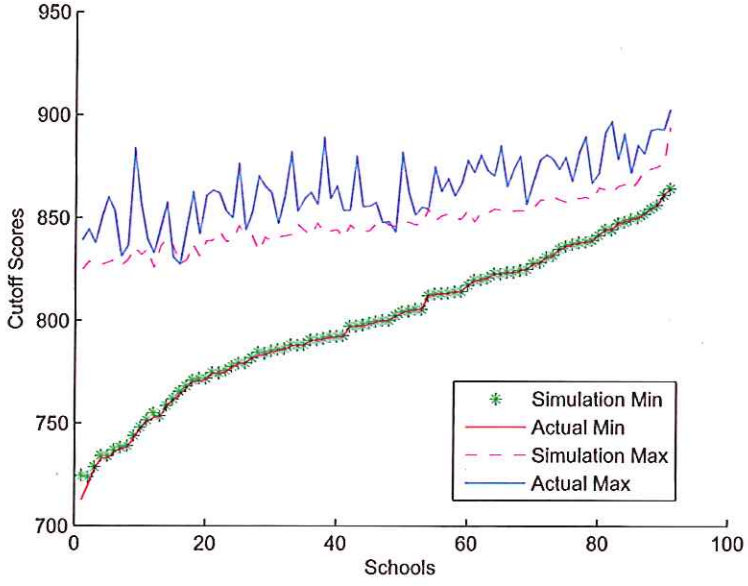

Figure A.3: Model Fit: Ankara Anatolian High Schools Nest

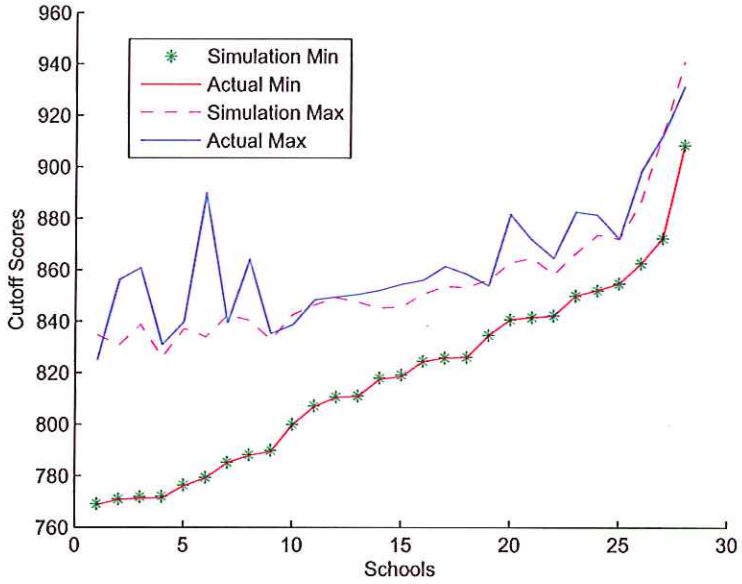


Figure A.4: Model Fit: Istanbul Anatolian High Schools Nest

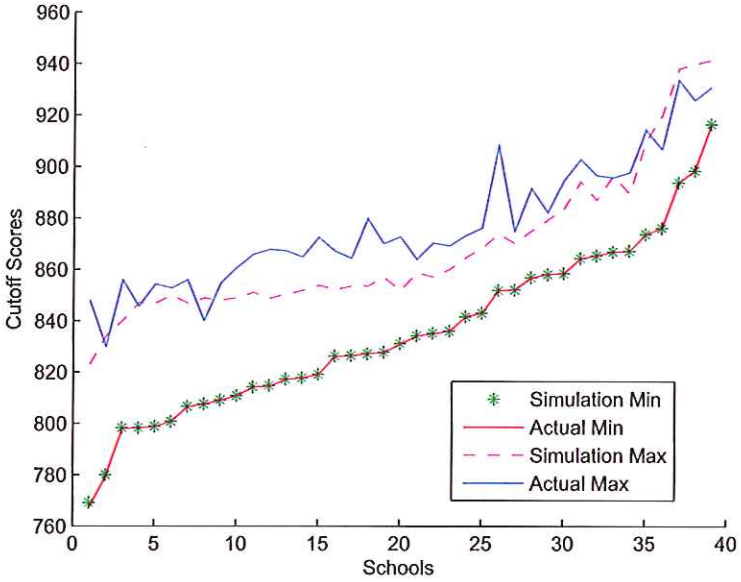

Figure A.5: Model Fit: Izmir Anatolian High Schools Nest