

Chapter 3 Homework 2012

Wednesday, August 31, 2011

8:52 AM

$$\textcircled{10} \textcircled{a} \quad {}_{40}p_0 = \frac{l_{40}}{l_0} = \frac{9,313,166}{10,000,000}$$

$$= 0.93132$$

$$\textcircled{b} \quad {}_{40}q_0 = 1 - {}_{40}p_0 = 1 - 0.93132$$

$$= 0.06868$$

$$\textcircled{c} \quad \Pr(60 \leq T_0 \leq 80) =$$

$${}_{60|20}q_0 = S_0(60) - S_0(80)$$

$$= {}_{60}p_0 - {}_{80}p_0 = \frac{l_{60}}{l_0} - \frac{l_{80}}{l_0}$$

$$= \frac{l_{60} - l_{80}}{l_0} =$$

$$\frac{8,188,074 - 3,914,365}{10,000,000} = 0.42737$$

$$\textcircled{d} \quad {}_{10}p_{75} = \frac{l_{85}}{l_{75}} = \frac{2,358,246}{5,396,081}$$

$$= 0.43703$$

$$\textcircled{e} \quad {}_{10}q_{75} = 1 - {}_{10}p_{75} = 1 - 0.43703$$

$$= 0.56297$$

$$\textcircled{f} \quad {}_{10|5}q_{75} = {}_{10}p_{75} - {}_{15}p_{75}$$

$$= \frac{l_{85} - l_{90}}{l_{75}}$$

$$= \frac{2,358,246 - 1,058,491}{5,394,081}$$

$$= 0.24087$$

$$\textcircled{9} \quad p_{80} = 1 - q_{80} = 1 - 0.0803 = 0.91970$$

$$\textcircled{11} \textcircled{a} \quad 0.5 q_{80} = (0.5)(q_{80})$$

$$= \frac{0.0803}{2} = 0.04015$$

$$\text{or } 0.5 q_{80} = \frac{l_{80} - l_{80.5}}{l_{80}}$$

$$l_{80.5} = \frac{1}{2} l_{80} + \frac{1}{2} l_{81} =$$

$$\frac{1}{2} (3,914,365 + 3,600,038) =$$

$$3,757,201.5$$

$$= \frac{3,914,365 - 3,757,201.5}{3,914,365} = 0.04015$$

$$\textcircled{b} \quad 0.5 p_{80} = 1 - 0.5 q_{80} = 1 - 0.04015$$

$$= 0.95985$$

$$\textcircled{c} \quad \mu_{80.5} = \frac{q_{80}}{1 - 0.5 q_{80}} =$$

$$\frac{q_{80}}{1 - 0.5 q_{80}} = \frac{0.0803}{1 - (1/2)(0.0803)} = 0.08366$$

$$\frac{q_{80}}{1 - (0.5)q_{80}} = \frac{0.0803}{1 - (\frac{1}{2})(0.0803)} = 0.08366$$

$$\begin{aligned} \textcircled{d} \quad 1.5 p_{80} &= p_{80} \cdot 0.5 p_{81} \\ &= p_{80} (1 - 0.5 q_{81}) \\ &= (1 - q_{80}) (1 - (0.5)(q_{81})) \\ &= (1 - 0.08030) (1 - \frac{1}{2} (0.08764)) \\ &= 0.87940 \end{aligned}$$

or

$$1.5 p_{80} = \frac{l_{81.5}}{l_{80}}$$

$$\begin{aligned} l_{81.5} &= \frac{1}{2} l_{81} + \frac{1}{2} l_{82} \\ &= \frac{1}{2} (3,600,038 + 3,284,542) \\ &= 3,442,290 \end{aligned}$$

$$1.5 p_{80} = \frac{3,442,290}{3,914,365} = 0.87940$$

$$\textcircled{e} \quad 1.5 q_{80} = 1 - 1.5 p_{80} = 0.12060$$

$$\textcircled{f} \quad 0.5 q_{80.5} = 1 - 0.5 p_{80.5}$$

$$\begin{aligned} \textcircled{f} \quad 0.5 \, q_{80.5} &= 1 - 0.5 p_{80.5} \\ &= 1 - \frac{l_{81}}{l_{80.5}} = 1 - \frac{3,600,038}{3,757,201.5} \end{aligned}$$

↑
From \textcircled{a}

$$= 0.04183$$

$$\textcircled{g} \quad 0.5 \, q_{80.25} = 1 - \frac{l_{80.75}}{l_{80.25}}$$

$$\begin{aligned} l_{80.75} &= \left(\frac{1}{4}\right)(l_{80}) + \left(\frac{3}{4}\right)(l_{81}) \\ &= \frac{1}{4}(3,914,365) + \frac{3}{4}(3,600,038) \\ &= 3,678,619.75 \end{aligned}$$

$$\begin{aligned} l_{80.25} &= \frac{3}{4}(3,914,365) + \frac{1}{4}(3,600,038) \\ &= 3,835,783.25 \end{aligned}$$

$$0.5 \, q_{80.25} = 1 - \frac{3,678,619.75}{3,835,783.25}$$

$$= 0.04097$$

$$\begin{aligned} \textcircled{h} \quad 3.2 | 2.4 \, q_{80.5} &= 3.2 p_{80.5} - 5.6 p_{80.5} \\ &= l_{83.7} - l_{86.1} \end{aligned}$$

$$l_{80.5}$$

$$l_{80.5} = 3,757,201.5 \leftarrow \text{From (a)}$$

$$l_{83.7} = (.3)(l_{83}) + (.7)(l_{84})$$
$$= 2,753,662.6$$

$$l_{86.1} = (.9)(l_{86}) + (.1)(l_{87})$$
$$= 2,038,210.9$$

$$3.2 | 2.4 q_{80.5} = \frac{2,753,662.6 - 2,038,210.9}{3,757,201.5}$$
$$= 0.19042$$

(14)

$$\text{(a)} \quad 0.5 q_{80} = 1 - 0.5 p_{80} = 1 - (p_{80})^{0.5}$$
$$= 1 - (1 - 0.08030)^{1/2} = 0.04099$$

$$\text{(b)} \quad 0.5 p_{80} = (p_{80})^{1/2} = (1 - 0.08030)^{1/2} = 0.95901$$
$$\text{or } 0.5 p_{80} = 1 - 0.5 q_{80} = 1 - 0.04099 = 0.95901$$

$$\text{(c)} \quad \mu_{80.5} = -\ln(p_x) = -\ln(1 - q_x)$$
$$= -\ln(1 - 0.08030) = 0.08371$$

$$\text{(d)} \quad 1.5 p_{80} = p_{80} \cdot 0.5 p_{81}$$

$$\begin{aligned}
 \textcircled{d} \quad 1.5P_{80} &= P_{80} \cdot 0.5P_{81} \\
 &= (1 - q_{80})(1 - q_{81})^{1/2} \\
 &= (1 - 0.08030)(1 - 0.08764)^{1/2} \\
 &= 0.87847
 \end{aligned}$$

$$\textcircled{e} \quad 1.5q_{80} = 1 - 1.5P_{80} = 1 - 0.87847 = 0.12153$$

$$\textcircled{f} \quad 0.5q_{80.5} = \frac{l_{80.5} - l_{81}}{l_{80.5}}$$

$$\begin{aligned}
 l_{80.5} &= l_{80} \cdot 0.5P_{80} \\
 &= l_{80} (P_{80})^{1/2} \\
 &= 3,914,365 (1 - 0.0803)^{1/2} \\
 &= 3,753,914.81
 \end{aligned}$$

$$0.5q_{80.5} = \frac{3,753,914.81 - 3,600,038}{3,753,914.81}$$

$$= 0.04099$$

$$\begin{aligned}
 \textcircled{g} \quad 0.5q_{80.25} &= \frac{l_{80.25} - l_{80.75}}{l_{80.25}} \\
 &= 1 - \frac{l_{80.75}}{l_{80.25}} = 1 - \frac{l_{80} (P_{80})^{3/4}}{l_{80.25}}
 \end{aligned}$$

$$\begin{aligned}
 & \approx 0.04099 \\
 & l_{80}(p_{80})^{14} \\
 & = 1 - (p_{80})^{1/2} = 1 - (1 - 0.0803)^{1/2} \\
 & = 0.04099
 \end{aligned}$$

$$\begin{aligned}
 \textcircled{h} \quad 3.2 | 2.4 \quad \ddot{q}_{80.5}^{7/10} &= \frac{l_{83.7} - l_{86.1}}{l_{80.5}} \\
 &= \frac{l_{83}(p_{83})^{7/10} - l_{86}(p_{86})^{7/10}}{l_{80}(p_{80})^{1/2}} \\
 &= \frac{(2,970,496)(1 - 0.10428)^{7/10} - 2,066,090(0.86506)^{7/10}}{3,914,365(1 - 0.0803)^{1/2}} \\
 &= 0.19013
 \end{aligned}$$

$$\textcircled{13} \textcircled{a} \quad 0.5 \ddot{q}_{80} = 1 - 0.5 p_{80} =$$

$$\begin{aligned}
 & 1 - \frac{p_{80}}{p_{80} + (0.5)(\ddot{q}_{80})} = \\
 & = 1 - \frac{1 - 0.0803}{(1 - 0.0803) + (0.5)(0.0803)} \\
 & = 0.04183
 \end{aligned}$$

$$\begin{aligned}
 \textcircled{b} \quad 0.5 p_{80} &= 1 - 0.5 \ddot{q}_{80} = 1 - 0.04183 \\
 & = 0.95817
 \end{aligned}$$

$$\textcircled{c} 1.5 P_{80} = P_{80} \cdot 0.5 P_{81} =$$

$$P_{80} \cdot \frac{P_{81}}{P_{81} + (0.5) q_{81}} =$$

$$(1 - 0.0803) \left(\frac{1 - 0.08764}{1 - 0.08764 + (1/2)(0.08764)} \right)$$

$$= 0.87755$$

$$\textcircled{d} 1.5 q_{80} = 1 - 1.5 P_{80} = 1 - 0.87755$$

$$= 0.12245$$

$$\textcircled{e} 0.5 q_{80.5} = 1 - \frac{l_{81}}{l_{80.5}} =$$

$$1 - \frac{3,600,038}{(l_{80} \times 0.5 P_{80})} =$$

$$1 - \frac{3,600,038}{3,914,365 \left(\frac{1 - 0.0803}{1 - 0.0803 + 1/2 \cdot 0.0803} \right)}$$

$$= 0.04015$$

$$\textcircled{f} 0.5 q_{80.25} = 1 - \frac{l_{80.75}}{l_{80.25}}$$

$$= 1 - \frac{l_{80} \cdot 0.75 P_{80}}{l_{80} \cdot 0.25 P_{80}} =$$

$$1 - \frac{P_{80}}{P_{80} + 0.75 q_{80}} = 1 - \frac{P_{80} + 0.25 q_{80}}{P_{80} + 0.75 q_{80}}$$

$$P_{80} + 0.25 q_{80}$$

$$= 1 - \frac{1 - 0.0803 + \frac{1000}{2000} (0.0803)}{1 - 0.0803 + \frac{3}{4}(0.0803)} = 0.04097$$

$$(14) \quad q_{50} = \frac{d_{50}}{l_{50}} = \frac{800}{20,000} = 0.04$$

$$l_{51} = l_{50} - d_{50} = 20,000 - 800 = 19,200$$

$$d_{51} = l_{51} - l_{52} = 19,200 - 18,000 = 1,200$$

$$q_{51} = \frac{d_{51}}{l_{51}} = \frac{1200}{19200} = 0.0625$$

$$p_{52} \cdot p_{53} = \frac{l_{54}}{l_{52}} = \frac{14,985}{18000}$$

$$\text{but } p_{53} = 1 - q_{53} = 1 - 0.1 = .9$$

$$\text{so } p_{52} = \frac{14,985}{18,000} / .9 = 0.925$$

$$q_{52} = 1 - p_{52} = 1 - 0.925 = 0.075$$

$$d_{52} = l_{52} q_{52} = 18000 (0.075) = 1350$$

$$l_{53} = l_{52} - d_{52} = 18000 - 1350 = 16,650$$

$$d_{53} = (l_{53})(q_{53}) = (16,650)(0.1)$$

$$d_{54} = (l_{54})(q_{54}) = (14,985)(0.125) = 1873.125$$

$$(15) \quad {}_{t+1}q_x = \frac{d_{x+t}}{l_x}$$

let $l_x = 20$ then $d_{x+t} =$

$$(20)({}_{t+1}q_x) = (20)(0.05) = 1$$

$${}_4q_{x+8} = \frac{d_{x+8} + d_{x+9} + d_{x+10} + d_{x+11}}{l_{x+8}}$$

$$d_{x+8} = d_{x+9} = d_{x+10} = d_{x+11} = 1$$

$$d_{x+8} = l_x - \sum_{t=0}^7 d_{x+t} = 20 - 8 = 12$$

$${}_4q_{x+8} = \frac{4}{12} = \frac{1}{3}$$

$$(16) \quad (a) \quad P[54] = 1 - q[54] = 1 - 0.04 = 0.96$$

$$(b) \quad P[53]_{+1} = 1 - q[53]_{+1} = 1 - 0.049 = 0.951$$

$$(c) \quad P[52]_{+2} = 1 - q[52]_{+2} = 1 - 0.057 = 0.943$$

$$(d) \quad P[51]_{+3} = 1 - q[51]_{+3} = 1 - 0.065 = 0.935$$

$$(e) \quad P_{54} = 1 - q_{54} = 1 - 0.065 = 0.935$$

$$(f) \quad {}_5P[54] = P[54] \cdot P[54]_{+1} \cdot P[54]_{+2} \cdot P_{57} \cdot P_{58}$$

$$= (1 - 0.04)(1 - 0.055)(1 - 0.076)(1 - 0.113)(1 - 0.140)$$

$$= 0.63944$$

$$\begin{aligned} \textcircled{g} 2|2 \text{ } \mathcal{P} [52] &= 2 \mathcal{P} [52] - 4 \mathcal{P} [52] \\ &= \mathcal{P} [52] \mathcal{P} [52]_{+1} (1 - \mathcal{P} [52]_{+2} \cdot \mathcal{P} 55) \\ &= (1 - 0.03)(1 - 0.043)(1 - (1 - 0.057)(1 - 0.072)) \\ &= 0.11594 \end{aligned}$$

$$\begin{aligned} \textcircled{h} 5 \mathcal{P} [52]_{+2} &= \mathcal{P} [52]_{+2} \mathcal{P} 55 \mathcal{P} 56 \mathcal{P} 57 \mathcal{P} 58 \\ &= (1 - 0.037)(1 - 0.072)(1 - 0.091)(1 - 0.113)(1 - 0.14) \\ &= 0.60680 \end{aligned}$$

i) Rose

$$\begin{aligned} 4 \mathcal{P} [54] &= 1 - 4 \mathcal{P} [54] = \\ &1 - \mathcal{P} [54] \cdot \mathcal{P} [54]_{+1} \cdot \mathcal{P} [54]_{+2} \cdot \mathcal{P} 57 \\ &= 1 - (1 - 0.04)(1 - 0.055)(1 - 0.076)(1 - 0.113) \\ &= 0.25647 \end{aligned}$$

Jeff

$$\begin{aligned} 4 \mathcal{P} 54 &= 1 - \mathcal{P} 54 \mathcal{P} 55 \mathcal{P} 56 \mathcal{P} 57 \\ &= 1 - (1 - 0.065)(1 - 0.072)(1 - 0.091)(1 - 0.113) \\ &= 0.30040 \end{aligned}$$

$$\begin{aligned} \text{JEFF} - \text{ROSE} &= 0.30040 - 0.25647 \\ &= 0.04393 \end{aligned}$$

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(0.4 " " " \

$$\begin{aligned}
(17) \quad 0.4p_0 &= 0.5 = \exp\left(-\int_0^{0.4} \mu_x dx\right) \\
&= \exp\left(-\int_0^{0.4} (F + e^{2x}) dx\right) \\
&= \exp\left(-Fx - \frac{1}{2}e^{2x}\right)\Big|_0^{0.4} \\
&= \exp\left(-0.4F - \frac{1}{2}e^{2(0.4)} + 0 + \frac{1}{2}(1)\right) \\
&= \exp\left(-0.4F - 0.61277\right) = 0.5 \\
-0.4F - 0.61277 &= \ln(0.5) \\
F &= \frac{\ln(0.5) + 0.61277}{-0.4} = \underline{\underline{0.20}}
\end{aligned}$$

$$\begin{aligned}
(18) \quad \mu_{x+t} &= \frac{g_x}{1-t \cdot g_x} \\
\Rightarrow \mu_{x+0.5} &= \frac{g_x}{1-0.5g_x} \\
(1-0.5g_x)\mu_{x+0.5} &= g_x \\
\mu_{x+0.5} &= g_x(1+0.5\mu_{x+t}) \\
g_x &= \frac{\mu_{x+0.5}}{1+0.5\mu_{x+0.5}} \\
\therefore g_{80} &= \frac{0.0202}{1+(0.5)(0.0202)} = 0.02
\end{aligned}$$

$$f_{81} = \frac{0.0408}{1 + 0.5(0.0408)} = 0.04$$

$$f_{82} = \frac{0.0619}{1 + 0.5(0.0619)} = 0.06$$

$$2f_{80.5} = 1 - 2P_{80.5}$$

$$= 1 - \frac{l_{82.5}}{l_{80.5}}$$

$$\text{Let } l_{80} = 1000$$

$$l_{81} = 980$$

$$l_{82} = 940.8$$

$$l_{83} = 884.352$$

$$l_{80.5} = \frac{1}{2}(1000 + 980) = 990$$

$$l_{82.5} = \frac{1}{2}(940.8 + 884.352) \\ = 912.576$$

$$1 - \frac{912.576}{990} = 0.0782$$

$$\textcircled{19} \quad e_{[94]} = 1P_{[94]} + 2P_{[94]} +$$

$$3P_{[94]} + 4P_{94} + 5P_{94}$$

$$= (1 - 0.21) + (.79)(.68) +$$

$$(.79)(.68)(.55) + (.79)(.68)(.55)(.3)$$

$$+ (.79)(.68)(.55)(.3)(.1) =$$

$$+ (.79)(.68)(.55)(.3)(.1) =$$

$$e_{94} = {}_1p_{94} + {}_2p_{94} + {}_3p_{94} +$$

$${}_4p_{94} + {}_5p_{94} = 1.7202$$

$$(1.7) + (1.7)(.6) + (1.7)(.6)(.5) +$$

$$(1.7)(.6)(.5)(.3) + (1.7)(.6)(.5)(.3)(.1)$$

$$= 1.3993$$

$$\textcircled{20} \quad 1.5 \ddot{q}_{\lceil 53 \rceil + 2} = \frac{l_{\lceil 53 \rceil + 2} - l_{\lceil 53 \rceil + 3\frac{1}{2}}}{l_{\lceil 53 \rceil + 2}}$$

$$\text{Let } l_{\lceil 53 \rceil + 2} = 1000$$

$$l_{\lceil 53 \rceil + 3} = (1000)(1 - 0.065) = 935$$

$$l_{\lceil 53 \rceil + 4} = (935)(1 - 0.091) = 849.915$$

$$l_{\lceil 53 \rceil + 3\frac{1}{2}} = \left(\frac{1}{2}\right)(935) + \left(\frac{1}{2}\right)(849.915)$$

$$= 892.4575$$

$$\text{so } 1.5 \ddot{q}_{\lceil 53 \rceil + 2} = \frac{1000 - 892.4575}{1000}$$

$$= 0.10754$$

$$\textcircled{21} \quad l_{54} = l_{\lceil 51 \rceil} (1 - q_{\lceil 51 \rceil}) (1 - q_{\lceil 51 \rceil + 1})$$

$$\begin{aligned}
 & (1 - q_{[51]+2}) \\
 &= (100,000)(1 - 0.025)(1 + 0.037)(1 - 0.05) \\
 &= 89,197.875
 \end{aligned}$$

$$\begin{aligned}
 l_{54} &= l_{[50]} (1 - q_{[50]})(1 - q_{[50]+1}) \\
 & \quad (1 - q_{[50]+2})(1 - q_{53})
 \end{aligned}$$

so

$$\begin{aligned}
 89,197.875 &= l_{[50]} (1 - 0.02)(1 - 0.031) \\
 & \quad (1 - 0.043)(1 - 0.056)
 \end{aligned}$$

$$\begin{aligned}
 \therefore l_{[50]} &= \frac{89,197.875}{(.98)(.969)(.957)(.944)} \\
 &= 103,973.64
 \end{aligned}$$

(22)

Cohort A

$$1000(1 - 0.035)(1 - 0.049) = 917.715$$

Cohort B

$$(1000)(1 - 0.056)(1 - 0.065) = \underline{882.64}$$

$$\text{TOTAL} \Rightarrow \underline{\underline{1800.355}}$$

$$(23) \quad q_{107} = q_{106+1} = 1 - \frac{l_{108}}{l_{107}}$$

$$= 1 - \frac{1200}{1500} = 0.2$$

$$q_{[106]+1} = 0.75 q_{206+1} =$$

$$(0.75)(.20) = 0.15$$

$$p_{[106]+1} = 1 - 0.15 = 0.85$$

$$= \frac{l_{[106]+2}}{l_{[106]+1}} = \frac{l_{108}}{l_{[106]+1}} = \frac{1200}{l_{[106]+1}}$$

$$\therefore l_{[106]+1} = \frac{1200}{.85} = 1411.765$$

Following same approach

$$q_{108} = 1 - \frac{800}{1200} = \frac{1}{3}$$

$$q_{[107]+1} = .75 q_{108} = 0.25$$

$$p_{[107]+1} = 1 - 0.25 = 0.75$$

$$l_{[107]+1} = \frac{800}{.75} = 1066.667$$

$$q_{\lceil 107 \rceil} = 0.5 q_{107} = 0.5(.2) = 0.1$$

$$p_{\lceil 107 \rceil} = 1 - 0.1 = 0.9$$

$$\frac{l_{\lceil 107 \rceil + 1}}{l_{\lceil 107 \rceil}} = .9 \Rightarrow l_{\lceil 107 \rceil} = \frac{l_{\lceil 107 \rceil + 1}}{0.9}$$

$$= \frac{1066.667}{.9} = 1185.185$$

$$q_{109} = 1 - \frac{400}{800} = .5$$

$$q_{\lceil 108 \rceil + 1} = .75 (q_{109}) = 0.375$$

$$p_{\lceil 108 \rceil + 1} = 1 - 0.375 = 0.625$$

$$l_{\lceil 108 \rceil + 1} = \frac{400}{.625} = 640$$

$$q_{\lceil 108 \rceil} = 0.5 q_{108} = (0.5) \left(\frac{1}{3} \right) = \frac{1}{6}$$

$$p_{\lceil 108 \rceil} = 1 - \frac{1}{6} = \frac{5}{6}$$

$$l_{\lceil 108 \rceil} = \frac{l_{\lceil 108 \rceil + 1}}{p_{\lceil 108 \rceil}} = \frac{640}{\frac{5}{6}} = 768$$

$$q_{110} = 1 - \frac{100}{400} = 0.75$$

$$q_{\lceil 109 \rceil + 1} = (0.75) (q_{110}) = (0.75)^2 = 0.5625$$

$$p_{\lceil 109 \rceil + 1} = 1 - 0.5625 = 0.4375$$

$$p_{[109]+1} = 1 - 0.5625 = 0.4375$$

$$l_{[109]+1} = \frac{100}{.4375} = 228.571$$

$$q_{[109]} = 0.5 q_{109} = 0.5 (.5) = 0.25$$

$$p_{[109]} = 1 - 0.25 = 0.75$$

$$l_{[109]} = \frac{l_{[109]+1}}{p_{[109]}} = \frac{228.571}{.75} = 304.762$$

$$\textcircled{24} \quad p_{51} = \frac{l_{52}}{l_{51}} = \frac{99,000}{100,000} = 0.99$$

$$q_{51} = 1 - p_{51} = 1 - 0.99 = 0.01$$

$$q_{[50]+1} = 0.80 q_{50+1} = (0.8)(0.01) \\ = 0.008$$

$$p_{[50]+1} = 1 - q_{[50]+1} = 1 - 0.008 = 0.992$$

$$p_{[50]+1} = \frac{l_{52}}{l_{[50]+1}} \Rightarrow 0.992 = \frac{99,000}{l_{[50]+1}}$$

$$l_{[50]+1} = \frac{99,000}{.992} = 99,798.4$$

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(25)

$$e_{x+0.6} = {}_1p_{x+0.6} + {}_1p_{x+0.6} e_{x+1.6}$$

so we need ${}_1p_{x+0.6}$

$$= \frac{l_{x+1.6}}{l_{x+0.6}}$$

Let $l_x = 1000$

Then $l_{x+1} = 1000(.95) = 950$

and $l_{x+2} = (950)(.92) = 874$

Need $l_{x+0.6}$

since uniformly distributed

$$l_{x+0.6} = (0.4)(l_x) + (0.6)(l_{x+1})$$

$$= (0.4)(1000) + (0.6)(950) = 970$$

Need $l_{x+1.6}$

since constant force

$$l_{x+1.6} = (l_{x+1})^{0.4} (l_{x+2})^{0.6}$$

$$= (950)^{0.4} (874)^{0.6} = 903.64178$$

$$= (950)^{0.4} (874)^{0.6} = 903.64178$$

Now

$$e_{x+1.6} = \frac{903.64178}{970} (1 + 12)$$

$$= 12.11066$$